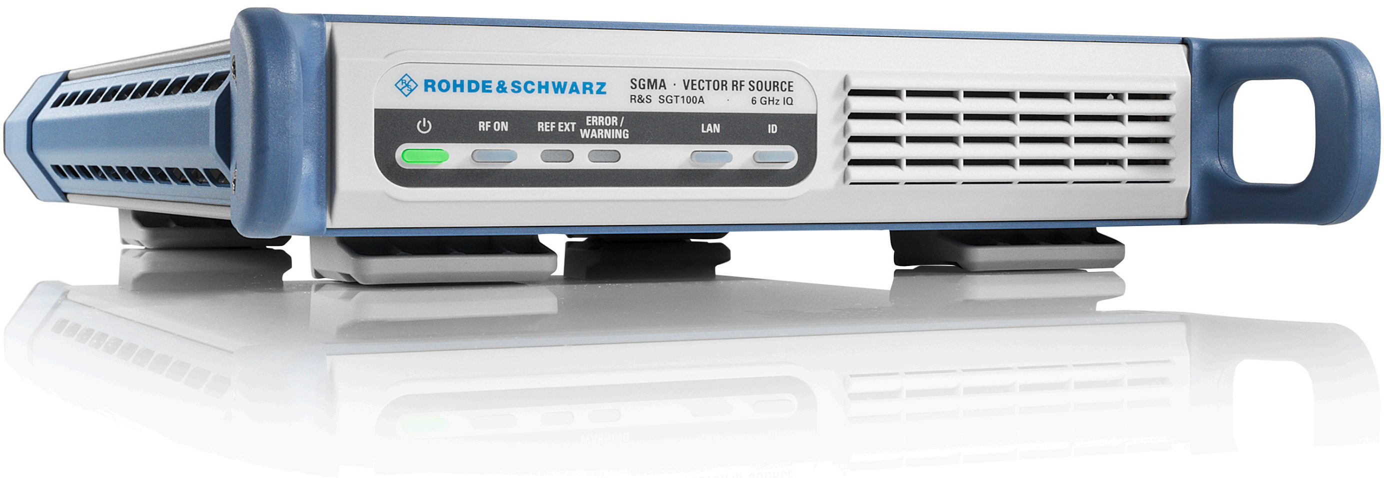
R&S®SGT100A
SGMA Vector RF Source
User Manual



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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following R&S®SGT100A, stock no. 1419.4501.02 and its options.

- R&S®SGT-B1, Reference Oscillator OCXO (1419.5608.02)
- R&S®SGT-B88, Extension Unit (1419.8207.02)
- R&S®SGT-KB106, Frequency extension to 6 GHz (1419.5708.02)
- R&S®SGT-K16, Diff. analog I/Q outputs
- R&S®SGT-K18, Digital baseband connectivity (1419.6240.02)
- R&S®SGT-K22, Pulse modulation (1416.6279.02)
- R&S®SGT-K62, Additive White Gaussian Noise (AWGN) (1419.6304.02)
- R&S®SGT-K90, Phase Coherent Input/Output (1419.6333.02)
- R&S®SGT-K510, ARB baseband generator (1419.7500.02)
- R&S®SGT-K511/512, ARB memory extension (1419.6362.02/1419.6391.02)
- R&S®SGT-K521/522, ARB bandwidth extension (1419.6247.02/1419.6456.02)
- R&S®SGT-K523, Baseband Extension to 240 MHz (1419.7952.02)
- R&S®SGT-K540, Envelope Tracking (1419.7800.02)
- R&S®SGT-K541, AM/AM AM/PM Predisortion (1419.7852.02)
- R&S®SGT-K543, Envelope ARB (1419.7900.02)
- R&S®SGT-K200, Waveform package for signals from R&S®WinIQSIM2™ (1419.5850.71/72/75)
- R&S®SGT-K110/-K111/-K112-/K113/-K114/-K115-/K116/-K117/-K118/-K119/-K120/-K121/-K122/-K151, Waveform Libraries for ARB Generator

This manual describes firmware version FW 3.50.124.xx and later of the R&S®SGT100A.

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R&S®SGT100A is abbreviated as R&S SGT, R&S®SGMA-GUI is abbreviated as R&S SGMA-GUI, R&S®WinIQSIM2™ is abbreviated as R&S WinIQSIM2.

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.

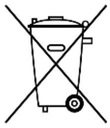
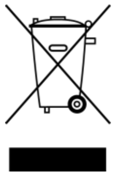
The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and, in some cases, a basic knowledge of English. 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)

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.

Operating states and operating positions

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

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

Electrical safety

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

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

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

Operation

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

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

Repair and service

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

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

Batteries and rechargeable batteries/cells

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

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

Transport

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

Waste disposal/Environmental protection

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

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

Instrucciones de seguridad elementales

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

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

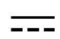
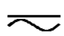
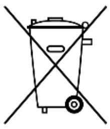
Además queda en la responsabilidad del usuario utilizar el producto en la forma debida. Este producto está destinado exclusivamente al uso en la industria y el laboratorio o, si ha sido expresamente autorizado, para aplicaciones de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa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

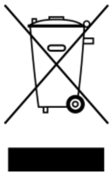
Se parte del uso correcto del producto para los fines definidos si el producto es utilizado conforme a las indicaciones de la correspondiente documentación del producto y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso del producto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

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

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.

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.

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

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

Estados operativos y posiciones de funcionamiento

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

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

Seguridad eléctrica

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

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

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

Funcionamiento

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

Reparación y mantenimiento

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

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.

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

Eliminación/protección del medio ambiente

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

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

Grundlegende Sicherheitshinweise

Lesen und beachten Sie unbedingt die nachfolgenden Anweisungen und Sicherheitshinweise!

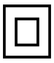
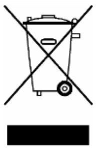
Alle Werke und Standorte der Rohde & Schwarz Firmengruppe sind ständig bemüht, den Sicherheitsstandard unserer Produkte auf dem aktuellsten Stand zu halten und unseren Kunden ein höchstmögliches Maß an Sicherheit zu bieten. Unsere Produkte und die dafür erforderlichen Zusatzgeräte werden entsprechend der jeweils gültigen Sicherheitsvorschriften gebaut und geprüft. Die Einhaltung dieser Bestimmungen wird durch unser Qualitätssicherungssystem laufend überwacht. Das vorliegende Produkt ist gemäß beiliegender EU-Konformitätsbescheinigung gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Benutzer alle Hinweise, Warnhinweise und Warnvermerke beachten. Bei allen Fragen bezüglich vorliegender Sicherheitshinweise steht Ihnen die Rohde & Schwarz Firmengruppe jederzeit gerne zur Verfügung.

Darüber hinaus liegt es in der Verantwortung des Benutzers, das Produkt in geeigneter Weise zu verwenden. Das Produkt ist ausschließlich für den Betrieb in Industrie und Labor bzw., wenn ausdrücklich zugelassen, auch für den Feldeinsatz bestimmt und darf in keiner Weise so verwendet werden, dass einer Person/Sache Schaden zugefügt werden kann. Die Benutzung des Produkts außerhalb des bestimmungsgemäßen Gebrauchs oder unter Missachtung der Anweisungen des Herstellers liegt in der Verantwortung des Benutzers. Der Hersteller übernimmt keine Verantwortung für die Zweckentfremdung des Produkts.

Die bestimmungsgemäße Verwendung des Produkts wird angenommen, wenn das Produkt nach den Vorgaben der zugehörigen Produktdokumentation innerhalb seiner Leistungsgrenzen verwendet wird (siehe Datenblatt, Dokumentation, nachfolgende Sicherheitshinweise). Die Benutzung des Produkts erfordert Fachkenntnisse und zum Teil englische Sprachkenntnisse. Es ist daher zu beachten, dass das Produkt ausschließlich von Fachkräften oder sorgfältig eingewiesenen Personen mit entsprechenden Fähigkeiten bedient werden darf. Sollte für die Verwendung von Rohde & Schwarz-Produkten persönliche Schutzausrüstung erforderlich sein, wird in der Produktdokumentation an entsprechender Stelle darauf hingewiesen. Bewahren Sie die grundlegenden Sicherheitshinweise und die Produktdokumentation gut auf und geben Sie diese an weitere Benutzer des Produkts weiter.

Die Einhaltung der Sicherheitshinweise dient dazu, Verletzungen oder Schäden durch Gefahren aller Art auszuschließen. Hierzu ist es erforderlich, dass die nachstehenden Sicherheitshinweise vor der Benutzung des Produkts sorgfältig gelesen und verstanden sowie bei der Benutzung des Produkts beachtet werden. Sämtliche weitere Sicherheitshinweise wie z.B. zum Personenschutz, die an entsprechender Stelle der Produktdokumentation stehen, sind ebenfalls unbedingt zu beachten. In den vorliegenden Sicherheitshinweisen sind sämtliche von der Rohde & Schwarz Firmengruppe vertriebenen Waren unter dem Begriff „Produkt“ zusammengefasst, hierzu zählen u. a. Geräte, Anlagen sowie sämtliches Zubehör.

Symbole und Sicherheitskennzeichnungen

Symbol	Bedeutung	Symbol	Bedeutung
	Achtung, allgemeine Gefahrenstelle Produktdokumentation beachten		EIN-/AUS (Versorgung)
	Vorsicht beim Umgang mit Geräten mit hohem Gewicht		Stand-by-Anzeige
	Gefahr vor elektrischem Schlag	⎓	Gleichstrom (DC)
	Warnung vor heißer Oberfläche		Wechselstrom (AC)
	Schutzleiteranschluss	≂	Gleichstrom/Wechselstrom (DC/AC)
	Erdungsanschluss		Gerät entspricht den Sicherheits-anforderungen an die Schutzklasse II (Gerät durchgehend durch doppelte / verstärkte Isolierung geschützt.
	Masseanschluss des Gestells oder Gehäuses		EU - Kennzeichnung für Batterien und Akkumulatoren. Das Gerät enthält eine Batterie bzw. einen Akkumulator. Diese dürfen nicht über unsortierten Siedlungsabfall entsorgt werden, sondern sollten getrennt gesammelt werden. Weitere Informationen siehe Seite 7.
	Achtung beim Umgang mit elektrostatisch gefährdeten Bauelementen		EU - Kennzeichnung für die getrennte Sammlung von Elektro- und Elektronikgeräten. Elektroaltgeräte dürfen nicht über unsortierten Siedlungsabfall entsorgt werden, sondern müssen getrennt gesammelt werden. Weitere Informationen siehe Seite 7.
	Warnung vor Laserstrahl Produkte mit Laser sind je nach ihrer Laser-Klasse mit genormten Warnhinweisen versehen. Laser können aufgrund der Eigenschaften ihrer Strahlung und aufgrund ihrer extrem konzentrierten elektromagnetischen Leistung biologische Schäden verursachen. Für zusätzliche Informationen siehe Kapitel „Betrieb“ Punkt 7.		

Signalworte und ihre Bedeutung

Die folgenden Signalworte werden in der Produktdokumentation verwendet, um vor Risiken und Gefahren zu warnen.

GEFAHR kennzeichnet eine unmittelbare Gefährdung mit hohem Risiko, die Tod oder schwere Körperverletzung zur Folge haben wird, wenn sie nicht vermieden wird.

WARNUNG kennzeichnet eine mögliche Gefährdung mit mittlerem Risiko, die Tod oder (schwere) Körperverletzung zur Folge haben kann, wenn sie nicht vermieden wird.

VORSICHT kennzeichnet eine Gefährdung mit geringem Risiko, die leichte oder mittlere Körperverletzungen zur Folge haben könnte, wenn sie nicht vermieden wird.

ACHTUNG weist auf die Möglichkeit einer Fehlbedienung hin, bei der das Produkt Schaden nehmen kann.

Diese Signalworte entsprechen der im europäischen Wirtschaftsraum üblichen Definition für zivile Anwendungen. Neben dieser Definition können in anderen Wirtschaftsräumen oder bei militärischen Anwendungen abweichende Definitionen existieren. Es ist daher darauf zu achten, dass die hier beschriebenen Signalworte stets nur in Verbindung mit der zugehörigen Produktdokumentation und nur in Verbindung mit dem zugehörigen Produkt verwendet werden. Die Verwendung von Signalworten in Zusammenhang mit nicht zugehörigen Produkten oder nicht zugehörigen Dokumentationen kann zu Fehlinterpretationen führen und damit zu Personen- oder Sachschäden führen.

Betriebszustände und Betriebslagen

Das Produkt darf nur in den vom Hersteller angegebenen Betriebszuständen und Betriebslagen ohne Behinderung der Belüftung betrieben werden. Werden die Herstellerangaben nicht eingehalten, kann dies elektrischen Schlag, Brand und/oder schwere Verletzungen von Personen, unter Umständen mit Todesfolge, verursachen. Bei allen Arbeiten sind die örtlichen bzw. landesspezifischen Sicherheits- und Unfallverhütungsvorschriften zu beachten.

1. Sofern nicht anders vereinbart, gilt für R&S-Produkte folgendes:
   als vorgeschriebene Betriebslage grundsätzlich Gehäuseboden unten, IP-Schutzart 2X, Verschmutzungsgrad 2, Überspannungskategorie 2, nur in Innenräumen verwenden, Betrieb bis 2000 m ü. NN, Transport bis 4500 m ü. NN, für die Nennspannung gilt eine Toleranz von ±10%, für die Nennfrequenz eine Toleranz von ±5%.
2. Stellen Sie das Produkt nicht auf Oberflächen, Fahrzeuge, Ablagen oder Tische, die aus Gewichts- oder Stabilitätsgründen nicht dafür geeignet sind. Folgen Sie bei Aufbau und Befestigung des Produkts an Gegenständen oder Strukturen (z.B. Wände und Regale) immer den Installationshinweisen des Herstellers. Bei Installation abweichend von der Produktdokumentation können Personen verletzt, unter Umständen sogar getötet werden.
3. Stellen Sie das Produkt nicht auf hitzeerzeugende Gerätschaften (z.B. Radiatoren und Heizlüfter). Die Umgebungstemperatur darf nicht die in der Produktdokumentation oder im Datenblatt spezifizierte Maximaltemperatur überschreiten. Eine Überhitzung des Produkts kann elektrischen Schlag, Brand und/oder schwere Verletzungen von Personen, unter Umständen mit Todesfolge, verursachen.

Grundlegende Sicherheitshinweise

Elektrische Sicherheit

Werden die Hinweise zur elektrischen Sicherheit nicht oder unzureichend beachtet, kann dies elektrischen Schlag, Brand und/oder schwere Verletzungen von Personen, unter Umständen mit Todesfolge, verursachen.

1. Vor jedem Einschalten des Produkts ist sicherzustellen, dass die am Produkt eingestellte Nennspannung und die Netznennspannung des Versorgungsnetzes übereinstimmen. Ist es erforderlich, die Spannungseinstellung zu ändern, so muss ggf. auch die dazu gehörige Netzsicherung des Produkts geändert werden.
2. Bei Produkten der Schutzklasse I mit beweglicher Netzzuleitung und Gerätesteckvorrichtung ist der Betrieb nur an Steckdosen mit Schutzkontakt und angeschlossenem Schutzleiter zulässig.
3. Jegliche absichtliche Unterbrechung des Schutzleiters, sowohl in der Zuleitung als auch am Produkt selbst, ist unzulässig. Es kann dazu führen, dass von dem Produkt die Gefahr eines elektrischen Schlags ausgeht. Bei Verwendung von Verlängerungsleitungen oder Steckdosenleisten ist sicherzustellen, dass diese regelmäßig auf ihren sicherheitstechnischen Zustand überprüft werden.
4. Sofern das Produkt nicht mit einem Netzschalter zur Netztrennung ausgerüstet ist, beziehungsweise der vorhandene Netzschalter zu Netztrennung nicht geeignet ist, so ist der Stecker des Anschlusskabels als Trennvorrichtung anzusehen.
   Die Trennvorrichtung muss jederzeit leicht erreichbar und gut zugänglich sein. Ist z.B. der Netzstecker die Trennvorrichtung, darf die Länge des Anschlusskabels 3 m nicht überschreiten.
   Funktionsschalter oder elektronische Schalter sind zur Netztrennung nicht geeignet. Werden Produkte ohne Netzschalter in Gestelle oder Anlagen integriert, so ist die Trennvorrichtung auf Anlagenebene zu verlagern.
5. Benutzen Sie das Produkt niemals, wenn das Netzkabel beschädigt ist. Überprüfen Sie regelmäßig den einwandfreien Zustand der Netzkabel. Stellen Sie durch geeignete Schutzmaßnahmen und Verlegearten sicher, dass das Netzkabel nicht beschädigt werden kann und niemand z.B. durch Stolperfallen oder elektrischen Schlag zu Schaden kommen kann.
6. Der Betrieb ist nur an TN/TT Versorgungsnetzen gestattet, die mit höchstens 16 A abgesichert sind (höhere Absicherung nur nach Rücksprache mit der Rohde & Schwarz Firmengruppe).
7. Stecken Sie den Stecker nicht in verstaubte oder verschmutzte Steckdosen/-buchsen. Stecken Sie die Steckverbindung/-vorrichtung fest und vollständig in die dafür vorgesehenen Steckdosen/-buchsen. Missachtung dieser Maßnahmen kann zu Funken, Feuer und/oder Verletzungen führen.
8. Überlasten Sie keine Steckdosen, Verlängerungskabel oder Steckdosenleisten, dies kann Feuer oder elektrische Schläge verursachen.
9. Bei Messungen in Stromkreisen mit Spannungen U_{eff} > 30 V ist mit geeigneten Maßnahmen Vorsorge zu treffen, dass jegliche Gefährdung ausgeschlossen wird (z.B. geeignete Messmittel, Absicherung, Strombegrenzung, Schutztrennung, Isolierung usw.).
10. Bei Verbindungen mit informationstechnischen Geräten, z.B. PC oder Industrierechner, ist darauf zu achten, dass diese der jeweils gültigen IEC 60950-1 / EN 60950-1 oder IEC 61010-1 / EN 61010-1 entsprechen.
11. Sofern nicht ausdrücklich erlaubt, darf der Deckel oder ein Teil des Gehäuses niemals entfernt werden, wenn das Produkt betrieben wird. Dies macht elektrische Leitungen und Komponenten zugänglich und kann zu Verletzungen, Feuer oder Schaden am Produkt führen.

12. Wird ein Produkt ortsfest angeschlossen, ist die Verbindung zwischen dem Schutzleiteranschluss vor Ort und dem Geräteschutzleiter vor jeglicher anderer Verbindung herzustellen. Aufstellung und Anschluss darf nur durch eine Elektrofachkraft erfolgen.
13. Bei ortsfesten Geräten ohne eingebaute Sicherung, Selbstschalter oder ähnliche Schutzeinrichtung muss der Versorgungskreis so abgesichert sein, dass alle Personen, die Zugang zum Produkt haben, sowie das Produkt selbst ausreichend vor Schäden geschützt sind.
14. Jedes Produkt muss durch geeigneten Überspannungsschutz vor Überspannung (z.B. durch Blitzschlag) geschützt werden. Andernfalls ist das bedienende Personal durch elektrischen Schlag gefährdet.
15. Gegenstände, die nicht dafür vorgesehen sind, dürfen nicht in die Öffnungen des Gehäuses eingebracht werden. Dies kann Kurzschlüsse im Produkt und/oder elektrische Schläge, Feuer oder Verletzungen verursachen.
16. Sofern nicht anders spezifiziert, sind Produkte nicht gegen das Eindringen von Flüssigkeiten geschützt, siehe auch Abschnitt "Betriebszustände und Betriebslagen", Punkt 1. Daher müssen die Geräte vor Eindringen von Flüssigkeiten geschützt werden. Wird dies nicht beachtet, besteht Gefahr durch elektrischen Schlag für den Benutzer oder Beschädigung des Produkts, was ebenfalls zur Gefährdung von Personen führen kann.
17. Benutzen Sie das Produkt nicht unter Bedingungen, bei denen Kondensation in oder am Produkt stattfinden könnte oder ggf. bereits stattgefunden hat, z.B. wenn das Produkt von kalter in warme Umgebung bewegt wurde. Das Eindringen von Wasser erhöht das Risiko eines elektrischen Schlages.
18. Trennen Sie das Produkt vor der Reinigung komplett von der Energieversorgung (z.B. speisendes Netz oder Batterie). Nehmen Sie bei Geräten die Reinigung mit einem weichen, nicht fasernden Staublappen vor. Verwenden Sie keinesfalls chemische Reinigungsmittel wie z.B. Alkohol, Aceton, Nitroverdünnung.

Betrieb

1. Die Benutzung des Produkts erfordert spezielle Einweisung und hohe Konzentration während der Benutzung. Es muss sichergestellt sein, dass Personen, die das Produkt bedienen, bezüglich ihrer körperlichen, geistigen und seelischen Verfassung den Anforderungen gewachsen sind, da andernfalls Verletzungen oder Sachschäden nicht auszuschließen sind. Es liegt in der Verantwortung des Arbeitsgebers/Betreibers, geeignetes Personal für die Benutzung des Produkts auszuwählen.
2. Bevor Sie das Produkt bewegen oder transportieren, lesen und beachten Sie den Abschnitt "Transport".
3. Wie bei allen industriell gefertigten Gütern kann die Verwendung von Stoffen, die Allergien hervorrufen - so genannte Allergene (z.B. Nickel) - nicht generell ausgeschlossen werden. Sollten beim Umgang mit R&S-Produkten allergische Reaktionen, z.B. Hautausschlag, häufiges Niesen, Bindehautrötung oder Atembeschwerden auftreten, ist umgehend ein Arzt aufzusuchen, um die Ursachen zu klären und Gesundheitsschäden bzw. -belastungen zu vermeiden.
4. Vor der mechanischen und/oder thermischen Bearbeitung oder Zerlegung des Produkts beachten Sie unbedingt Abschnitt "Entsorgung", Punkt 1.

5. Bei bestimmten Produkten, z.B. HF-Funkanlagen, können funktionsbedingt erhöhte elektromagnetische Strahlungen auftreten. Unter Berücksichtigung der erhöhten Schutzwürdigkeit des ungeborenen Lebens müssen Schwangere durch geeignete Maßnahmen geschützt werden. Auch Träger von Herzschrittmachern können durch elektromagnetische Strahlungen gefährdet sein. Der Arbeitgeber/Betreiber ist verpflichtet, Arbeitsstätten, bei denen ein besonderes Risiko einer Strahlenexposition besteht, zu beurteilen und zu kennzeichnen und mögliche Gefahren abzuwenden.

6. Im Falle eines Brandes entweichen ggf. giftige Stoffe (Gase, Flüssigkeiten etc.) aus dem Produkt, die Gesundheitsschäden verursachen können. Daher sind im Brandfall geeignete Maßnahmen wie z.B. Atemschutzmasken und Schutzkleidung zu verwenden.

7. Falls ein Laser-Produkt in ein R&S-Produkt integriert ist (z.B. CD/DVD-Laufwerk), dürfen keine anderen Einstellungen oder Funktionen verwendet werden, als in der Produktdokumentation beschrieben, um Personenschäden zu vermeiden (z.B. durch Laserstrahl).

8. EMV Klassen (nach EN 55011 / CISPR 11; sinngemäß EN 55022 / CISPR 22, EN 55032 / CISPR 32)

   Gerät der Klasse A:
   Ein Gerät, das sich für den Gebrauch in allen anderen Bereichen außer dem Wohnbereich und solchen Bereichen eignet, die direkt an ein Niederspannungs-Versorgungsnetz angeschlossen sind, das Wohngebäude versorgt.
   Hinweis: Diese Einrichtung kann wegen möglicher auftretender leitungsgebundener als auch gestrahlten Störgrößen im Wohnbereich Funkstörungen verursachen. In diesem Fall kann vom Betreiber verlangt werden, angemessene Maßnahmen durchzuführen.
   Gerät der Klasse B:
   Ein Gerät, das sich für den Betrieb im Wohnbereich sowie in solchen Bereichen eignet, die direkt an ein Niederspannungs-Versorgungsnetz angeschlossen sind, das Wohngebäude versorgt.

Reparatur und Service

1. Das Produkt darf nur von dafür autorisiertem Fachpersonal geöffnet werden. Vor Arbeiten am Produkt oder Öffnen des Produkts ist dieses von der Versorgungsspannung zu trennen, sonst besteht das Risiko eines elektrischen Schlages.

2. Abgleich, Auswechseln von Teilen, Wartung und Reparatur darf nur von R&S-autorisierten Elektrofachkräften ausgeführt werden. Werden sicherheitsrelevante Teile (z.B. Netzschalter, Netztrafos oder Sicherungen) ausgewechselt, so dürfen diese nur durch Originalteile ersetzt werden. Nach jedem Austausch von sicherheitsrelevanten Teilen ist eine Sicherheitsprüfung durchzuführen (Sichtprüfung, Schutzleitertest, Isolationswiderstand-, Ableitstrommessung, Funktionstest). Damit wird sichergestellt, dass die Sicherheit des Produkts erhalten bleibt.

Batterien und Akkumulatoren/Zellen

Werden die Hinweise zu Batterien und Akkumulatoren/Zellen nicht oder unzureichend beachtet, kann dies Explosion, Brand und/oder schwere Verletzungen von Personen, unter Umständen mit Todesfolge, verursachen. Die Handhabung von Batterien und Akkumulatoren mit alkalischen Elektrolyten (z.B. Lithiumzellen) muss der EN 62133 entsprechen.

1. Zellen dürfen nicht zerlegt, geöffnet oder zerkleinert werden.

2. Zellen oder Batterien dürfen weder Hitze noch Feuer ausgesetzt werden. Die Lagerung im direkten Sonnenlicht ist zu vermeiden. Zellen und Batterien sauber und trocken halten. Verschmutzte Anschlüsse mit einem trockenen, sauberen Tuch reinigen.

3. Zellen oder Batterien dürfen nicht kurzgeschlossen werden. Zellen oder Batterien dürfen nicht gefahrbringend in einer Schachtel oder in einem Schubfach gelagert werden, wo sie sich gegenseitig kurzschließen oder durch andere leitende Werkstoffe kurzgeschlossen werden können. Eine Zelle oder Batterie darf erst aus ihrer Originalverpackung entnommen werden, wenn sie verwendet werden soll.
4. Zellen oder Batterien dürfen keinen unzulässig starken, mechanischen Stößen ausgesetzt werden.
5. Bei Undichtheit einer Zelle darf die Flüssigkeit nicht mit der Haut in Berührung kommen oder in die Augen gelangen. Falls es zu einer Berührung gekommen ist, den betroffenen Bereich mit reichlich Wasser waschen und ärztliche Hilfe in Anspruch nehmen.
6. Werden Zellen oder Batterien, die alkalische Elektrolyte enthalten (z.B. Lithiumzellen), unsachgemäß ausgewechselt oder geladen, besteht Explosionsgefahr. Zellen oder Batterien nur durch den entsprechenden R&S-Typ ersetzen (siehe Ersatzteilliste), um die Sicherheit des Produkts zu erhalten.
7. Zellen oder Batterien müssen wiederverwertet werden und dürfen nicht in den Restmüll gelangen. Akkumulatoren oder Batterien, die Blei, Quecksilber oder Cadmium enthalten, sind Sonderabfall. Beachten Sie hierzu die landesspezifischen Entsorgungs- und Recycling-Bestimmungen.

Transport

1. Das Produkt kann ein hohes Gewicht aufweisen. Daher muss es vorsichtig und ggf. unter Verwendung eines geeigneten Hebemittels (z.B. Hubwagen) bewegt bzw. transportiert werden, um Rückenschäden oder Verletzungen zu vermeiden.
2. Griffe an den Produkten sind eine Handhabungshilfe, die ausschließlich für den Transport des Produkts durch Personen vorgesehen ist. Es ist daher nicht zulässig, Griffe zur Befestigung an bzw. auf Transportmitteln, z.B. Kränen, Gabelstaplern, Karren etc. zu verwenden. Es liegt in Ihrer Verantwortung, die Produkte sicher an bzw. auf geeigneten Transport- oder Hebemitteln zu befestigen. Beachten Sie die Sicherheitsvorschriften des jeweiligen Herstellers eingesetzter Transport- oder Hebemittel, um Personenschäden und Schäden am Produkt zu vermeiden.
3. Falls Sie das Produkt in einem Fahrzeug benutzen, liegt es in der alleinigen Verantwortung des Fahrers, das Fahrzeug in sicherer und angemessener Weise zu führen. Der Hersteller übernimmt keine Verantwortung für Unfälle oder Kollisionen. Verwenden Sie das Produkt niemals in einem sich bewegenden Fahrzeug, sofern dies den Fahrzeugführer ablenken könnte. Sichern Sie das Produkt im Fahrzeug ausreichend ab, um im Falle eines Unfalls Verletzungen oder Schäden anderer Art zu verhindern.

Entsorgung

1. Batterien bzw. Akkumulatoren, die nicht mit dem Hausmüll entsorgt werden dürfen, darf nach Ende der Lebensdauer nur über eine geeignete Sammelstelle oder eine Rohde & Schwarz-Kundendienststelle entsorgt werden.
2. Am Ende der Lebensdauer des Produktes darf dieses Produkt nicht über den normalen Hausmüll entsorgt werden, sondern muss getrennt gesammelt werden.
   Rohde & Schwarz GmbH & Co.KG ein Entsorgungskonzept entwickelt und übernimmt die Pflichten der Rücknahme- und Entsorgung für Hersteller innerhalb der EU in vollem Umfang. Wenden Sie sich bitte an Ihre Rohde & Schwarz-Kundendienststelle, um das Produkt umweltgerecht zu entsorgen.

3. Werden Produkte oder ihre Bestandteile über den bestimmungsgemäßen Betrieb hinaus mechanisch und/oder thermisch bearbeitet, können ggf. gefährliche Stoffe (schwermetallhaltiger Staub wie z.B. Blei, Beryllium, Nickel) freigesetzt werden. Die Zerlegung des Produkts darf daher nur von speziell geschultem Fachpersonal erfolgen. Unsachgemäßes Zerlegen kann Gesundheitsschäden hervorrufen. Die nationalen Vorschriften zur Entsorgung sind zu beachten.
4. Falls beim Umgang mit dem Produkt Gefahren- oder Betriebsstoffe entstehen, die speziell zu entsorgen sind, z.B. regelmäßig zu wechselnde Kühlmittel oder Motorenöle, sind die Sicherheitshinweise des Herstellers dieser Gefahren- oder Betriebsstoffe und die regional gültigen Entsorgungsvorschriften einzuhalten. Beachten Sie ggf. auch die zugehörigen speziellen Sicherheitshinweise in der Produktdokumentation. Die unsachgemäße Entsorgung von Gefahren- oder Betriebsstoffen kann zu Gesundheitsschäden von Personen und Umweltschäden führen.

Weitere Informationen zu Umweltschutz finden Sie auf der Rohde & Schwarz Home Page.

Consignes de sécurité fondamentales

Lisez et respectez impérativement les instructions et consignes de sécurité suivantes

Les usines et sites du groupe Rohde & Schwarz veillent à la conformité des produits du groupe avec les normes de sécurité en vigueur dans un souci constant de garantir aux clients le plus haut niveau de sécurité possible. Nos produits ainsi que les accessoires nécessaires sont fabriqués et testés conformément aux règles de sécurité en vigueur. Le respect de ces règles est vérifié régulièrement par notre système d'assurance qualité. Le présent produit a été fabriqué et contrôlé conformément au certificat de conformité CE ci-joint et a quitté l'usine dans un parfait état de sécurité. Pour le maintenir dans cet état et en garantir une utilisation sans danger, l'utilisateur doit respecter l'ensemble des consignes, remarques de sécurité et avertissements qui se trouvent dans ce manuel. Le groupe Rohde & Schwarz se tient à votre disposition pour toutes questions relatives aux présentes consignes de sécurité.

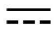
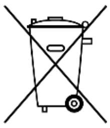
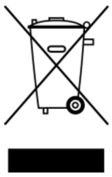
Il incombe à l'utilisateur d'employer ce produit de manière appropriée. Le produit est exclusivement destiné à l'utilisation en industrie et en laboratoire et/ou, si cela a été expressément autorisé, également aux travaux extérieurs ; il ne peut en aucun cas être utilisé à des fins pouvant causer des dommages corporels ou matériels. L'exploitation du produit en dehors de son utilisation prévue ou le non-respect des consignes du fabricant se font sous la responsabilité de l'utilisateur. Le fabricant décline toute responsabilité en cas d'utilisation non conforme du produit.

Le produit est présumé faire l'objet d'une utilisation conforme lorsqu'il est utilisé conformément aux consignes de la documentation produit correspondante et dans la limite de ses performances (voir fiche technique, documentation, consignes de sécurité ci-après). L'utilisation du produit exige des compétences en la matière et des connaissances de base de l'anglais. Par conséquent, le produit ne devra être utilisé que par un personnel qualifié ou des personnes formées de manière approfondie et possédant les compétences requises. Si, pour l'utilisation des produits Rohde & Schwarz, l'emploi d'un équipement personnel de protection s'avère nécessaire, il en est fait mention dans la documentation produit à l'emplacement correspondant. Conservez les consignes de sécurité fondamentales et la documentation produit dans un lieu sûr et transmettez ces documents aux autres utilisateurs du produit.

La stricte observation des consignes de sécurité a pour but d'exclure des blessures ou dommages causés par des dangers de toutes sortes. A cet effet, il est nécessaire de lire avec soin et de bien comprendre les consignes de sécurité ci-dessous avant l'utilisation du produit et de les respecter lors de l'utilisation du produit. Toutes les autres consignes de sécurité présentées à l'emplacement correspondant de la documentation produit, par exemple, celles concernant la protection des personnes, doivent également être impérativement respectées. Dans les présentes consignes de sécurité, toutes les marchandises commercialisées par le groupe Rohde & Schwarz, notamment les appareils, les systèmes ainsi que les accessoires, sont dénommés « produit ».

Consignes de sécurité fondamentales

Symboles et marquages de sécurité

Symbole	Signification	Symbole	Signification
	Avis, source générale de danger Se référer à la documentation produit		MARCHE / ARRET (tension d'alimentation)
	Attention lors de la manipulation d'appareils ayant un poids élevé		Indicateur de veille
	Risque de choc électrique		Courant continu (CC)
	Avertissement, surface chaude		Courant alternatif (CA)
	Borne de conducteur de protection		Courant continu/alternatif (CC/CA)
	Borne de mise à la terre		L'appareil est conforme aux exigences de sécurité du degré de protection II (appareil entièrement protégé par isolation double/renforcée).
	Borne de mise à la masse du bâti ou du boîtier		Marquage UE pour batteries et accumulateurs. L'appareil contient une batterie ou un accumulateur. Ces pièces ne peuvent pas être éliminées avec les déchets urbains non triés, mais doivent faire l'objet d'une collecte séparée. Pour plus d'informations, voir la page 7.
	Avis : prudence lors de la manipulation de composants sensibles aux décharges électrostatiques		Marquage UE pour la collecte séparée d'équipements électriques et électroniques. Les déchets d'équipements électriques et électroniques ne peuvent pas être éliminés avec les déchets urbains non triés, mais doivent faire l'objet d'une collecte séparée. Pour plus d'informations, voir la page 7.
	Avertissement, rayon laser Les produits laser sont munis d'avertissements normalisés d'après leur catégorie laser. En raison des caractéristiques de leur rayonnement ainsi que de leur puissance électromagnétique extrêmement concentrée, les lasers peuvent causer des dommages biologiques. Pour plus d'informations, voir le chapitre « Fonctionnement »", point 7.		

Mots d’alerte et significations

Les mots d’alerte suivants sont utilisés dans la documentation produit pour avertir des risques et dangers.

DANGER	Indique une situation dangereuse immédiate qui, si elle n’est pas évitée, comporte un risque élevé de blessures graves ou mortelles.
AVERTISSEMENT	Indique une situation dangereuse possible qui, si elle n’est pas évitée, comporte un risque modéré de blessures (graves) ou mortelles.
ATTENTION	Indique une situation dangereuse qui, si elle n’est pas évitée, comporte un risque faible de blessures mineures ou modérées.
AVIS	Indique la possibilité d’une fausse manœuvre susceptible d’endommager le produit.

Ces mots d’alerte correspondent à la définition habituelle utilisée pour des applications civiles dans l’espace économique européen. Des définitions divergentes peuvent cependant exister dans d’autres espaces économiques ou dans le cadre d’applications militaires. Il faut donc veiller à ce que les mots d’alerte décrits ici ne soient utilisés qu’en relation avec la documentation produit correspondante et seulement avec le produit correspondant. L’utilisation des mots d’alerte en relation avec des produits ou des documentations non correspondants peut conduire à des erreurs d’interprétation et par conséquent à des dommages corporels ou matériels.

États et positions de fonctionnement

L’appareil ne doit être utilisé que dans les états et positions de fonctionnement indiqués par le fabricant. Tout obstacle à la ventilation doit être empêché. Le non-respect des indications du fabricant peut provoquer des chocs électriques, des incendies et/ou des blessures graves pouvant éventuellement entraîner la mort. Pour tous les travaux, les règles locales et/ou nationales de sécurité et de prévention des accidents doivent être respectées.

1. Sauf stipulations contraires, les produits Rohde & Schwarz répondent aux exigences ci-après :
faire fonctionner le produit avec le fond du boîtier toujours en bas, degré de protection IP 2X, degré de pollution 2, catégorie de surtension 2, utilisation uniquement à l’intérieur, fonctionnement à une altitude max. de 2000 m au-dessus du niveau de la mer, transport à une altitude max. de 4500 m au-dessus du niveau de la mer, tolérance de ±10 % pour la tension nominale et de ±5 % pour la fréquence nominale.
2. Ne jamais placer le produit sur des surfaces, véhicules, dépôts ou tables non appropriés pour raisons de stabilité ou de poids. Suivre toujours strictement les indications d’installation du fabricant pour le montage et la fixation du produit sur des objets ou des structures (par exemple parois et étagères). En cas d’installation non conforme à la documentation produit, il y a risque de blessures, voire de mort.
3. Ne jamais placer le produit sur des dispositifs générant de la chaleur (par exemple radiateurs et appareils de chauffage soufflants). La température ambiante ne doit pas dépasser la température maximale spécifiée dans la documentation produit ou dans la fiche technique. Une surchauffe du produit peut provoquer des chocs électriques, des incendies et/ou des blessures graves pouvant éventuellement entraîner la mort.

Sécurité électrique

Si les consignes relatives à la sécurité électrique ne sont pas ou sont insuffisamment respectées, il peut s'ensuivre des chocs électriques, des incendies et/ou des blessures graves pouvant éventuellement entraîner la mort.

1. Avant chaque mise sous tension du produit, il faut s'assurer que la tension nominale réglée sur le produit correspond à la tension nominale du réseau électrique. S'il est nécessaire de modifier le réglage de la tension, il faut remplacer le fusible du produit, le cas échéant.
2. L'utilisation des produits du degré de protection I pourvus d'un câble d'alimentation mobile et d'un connecteur n'est autorisée qu'avec des prises munies d'un contact de protection et d'un conducteur de protection raccordé.
3. Toute déconnexion intentionnelle du conducteur de protection, dans le câble ou dans le produit lui-même, est interdite. Elle entraîne un risque de choc électrique au niveau du produit. En cas d'utilisation de câbles prolongateurs ou de multiprises, ceux-ci doivent être examinés régulièrement quant à leur état de sécurité technique.
4. Si le produit n'est pas doté d'un interrupteur d'alimentation pour le couper du réseau électrique ou si l'interrupteur d'alimentation disponible n'est pas approprié pour couper le produit du réseau électrique, le connecteur mâle du câble de raccordement est à considérer comme dispositif de séparation.
   Le dispositif de séparation doit être à tout moment facilement accessible. Si, par exemple, le connecteur d'alimentation sert de dispositif de séparation, la longueur du câble de raccordement ne doit pas dépasser 3 m.
   Les commutateurs fonctionnels ou électroniques ne sont pas appropriés pour couper l'appareil du réseau électrique. Si des produits sans interrupteur d'alimentation sont intégrés dans des bâtis ou systèmes, le dispositif de séparation doit être reporté au niveau du système.
5. Ne jamais utiliser le produit si le câble d'alimentation est endommagé. Vérifier régulièrement le parfait état du câble d'alimentation. Prendre les mesures préventives appropriées et opter pour des types de pose tels que le câble d'alimentation ne puisse pas être endommagé et que personne ne puisse subir de préjudice, par exemple en trébuchant sur le câble ou par des chocs électriques.
6. L'utilisation des produits est uniquement autorisée sur des réseaux d'alimentation de type TN/TT protégés par des fusibles d'une intensité max. de 16 A (pour toute intensité supérieure, consulter le groupe Rohde & Schwarz).
7. Ne pas brancher le connecteur dans des prises d'alimentation sales ou poussiéreuses. Enfoncer fermement le connecteur jusqu'au bout de la prise. Le non-respect de cette mesure peut provoquer des étincelles, incendies et/ou blessures.
8. Ne pas surcharger les prises, les câbles prolongateurs ou les multiprises, cela pouvant provoquer des incendies ou chocs électriques.
9. En cas de mesures sur les circuits électriques d'une tension efficace > 30 V, prendre les précautions nécessaires pour éviter tout risque (par exemple équipement de mesure approprié, fusibles, limitation de courant, coupe-circuit, isolation, etc.).
10. En cas d'interconnexion avec des équipements informatiques comme par exemple un PC ou un ordinateur industriel, veiller à ce que ces derniers soient conformes aux normes IEC 60950-1 / EN 60950-1 ou IEC 61010-1 / EN 61010-1 en vigueur.
11. Sauf autorisation expresse, il est interdit de retirer le couvercle ou toute autre pièce du boîtier lorsque le produit est en cours de service. Les câbles et composants électriques seraient ainsi accessibles, ce qui peut entraîner des blessures, des incendies ou des dégâts sur le produit.

12. Si un produit est connecté de façon stationnaire, établir avant toute autre connexion le raccordement du conducteur de protection local et du conducteur de protection du produit. L'installation et le raccordement ne peuvent être effectués que par un électricien ou électronicien qualifié.
13. Sur les appareils stationnaires sans fusible ni disjoncteur automatique ou dispositif de protection similaire intégrés, le circuit d'alimentation doit être sécurisé de sorte que toutes les personnes ayant accès au produit et le produit lui-même soient suffisamment protégés contre tout dommage.
14. Chaque produit doit être protégé de manière appropriée contre les éventuelles surtensions (par exemple dues à un coup de foudre). Sinon, les utilisateurs sont exposés à des risques de choc électrique.
15. Ne jamais introduire d'objets non prévus à cet effet dans les ouvertures du boîtier, étant donné que cela peut entraîner des courts-circuits dans le produit et/ou des chocs électriques, incendies ou blessures.
16. Sauf spécification contraire, les produits ne sont pas protégés contre l'infiltration de liquides, voir aussi la section « États et positions de fonctionnement », point 1. Il faut donc protéger les produits contre l'infiltration de liquides. La non-observation de cette consigne entraîne le risque de choc électrique pour l'utilisateur ou d'endommagement du produit, ce qui peut également mettre les personnes en danger.
17. Ne pas utiliser le produit dans des conditions pouvant occasionner ou ayant déjà occasionné, le cas échéant, des condensations dans ou sur le produit, par exemple lorsque celui-ci est déplacé d'un environnement froid dans un environnement chaud. L'infiltration d'eau augmente le risque de choc électrique.
18. Avant le nettoyage, débrancher le produit de l'alimentation (par exemple réseau électrique ou batterie). Pour le nettoyage des appareils, utiliser un chiffon doux non pelucheux. N'utiliser en aucun cas de produit de nettoyage chimique, tel que de l'alcool, de l'acétone ou un diluant nitrocellulosique.

Fonctionnement

1. L'utilisation du produit exige une formation spécifique ainsi qu'une grande concentration. Il est impératif que les personnes qui utilisent le produit présent les aptitudes physiques, mentales et psychiques requises, vu qu'autrement des dommages corporels ou matériels ne peuvent pas être exclus. Le choix du personnel qualifié pour l'utilisation du produit est sous la responsabilité de l'employeur/l'exploitant.
2. Avant de déplacer ou de transporter le produit, lire et respecter la section « Transport ».
3. Comme pour tous les biens produits de façon industrielle, l'utilisation de matériaux pouvant causer des allergies (allergènes, comme par exemple le nickel) ne peut être totalement exclue. Si, lors de l'utilisation de produits Rohde & Schwarz, des réactions allergiques surviennent, telles qu'éruption cutanée, éternuements fréquents, rougeur de la conjonctive ou difficultés respiratoires, il faut immédiatement consulter un médecin pour en clarifier la cause et éviter toute atteinte à la santé.
4. Avant le traitement mécanique et/ou thermique ou le démontage du produit, il faut impérativement observer la section « Élimination des déchets », point 1.

5. Selon les fonctions, certains produits, tels que des systèmes de radiocommunication RF, peuvent produire des niveaux élevés de rayonnement électromagnétique. Étant donné la vulnérabilité de l'enfant à naître, les femmes enceintes doivent être protégées par des mesures appropriées. Les porteurs de stimulateurs cardiaques peuvent également être menacés par les rayonnements électromagnétiques. L'employeur/l'exploitant est tenu d'évaluer et de repérer les lieux de travail soumis à un risque particulier d'exposition aux rayonnements et de prévenir les dangers éventuels.
6. En cas d'incendie, il se peut que le produit dégage des matières toxiques (gaz, liquides, etc.) susceptibles de nuire à la santé. Il faut donc, en cas d'incendie, prendre des mesures adéquates comme par exemple le port de masques respiratoires et de vêtements de protection.
7. Si un produit laser est intégré dans un produit Rohde & Schwarz (par exemple lecteur CD/DVD), il ne faut pas utiliser de réglages ou fonctions autres que ceux décrits dans la documentation produit pour éviter tout dommage corporel (par exemple causé par rayon laser).
8. Classes CEM (selon EN 55011 / CISPR 11 ; selon EN 55022 / CISPR 22, EN 55032 / CISPR 32 par analogie)
   - Appareil de la classe A :
     Appareil approprié à un usage dans tous les environnements autres que l'environnement résidentiel et les environnements raccordés directement à un réseau d'alimentation basse tension qui alimente des bâtiments résidentiels.
     Remarque : ces appareils peuvent provoquer des perturbations radioélectriques dans l'environnement résidentiel en raison de perturbations conduites ou rayonnées. Dans ce cas, on peut exiger que l'exploitant mette en œuvre de mesures appropriées pour éliminer ces perturbations.
   - Appareil de la classe B :
     Appareil approprié à un usage dans l'environnement résidentiel ainsi que dans les environnements raccordés directement à un réseau d'alimentation basse tension qui alimente des bâtiments résidentiels.

Réparation et service après-vente

1. Le produit ne doit être ouvert que par un personnel qualifié et autorisé. Avant de travailler sur le produit ou de l'ouvrir, il faut le couper de la tension d'alimentation ; sinon il y a risque de choc électrique.
2. Les travaux d'ajustement, le remplacement des pièces, la maintenance et la réparation ne doivent être effectués que par des électroniciens qualifiés et autorisés par Rohde & Schwarz. En cas de remplacement de pièces concernant la sécurité (notamment interrupteur d'alimentation, transformateur d'alimentation réseau ou fusibles), celles-ci ne doivent être remplacées que par des pièces d'origine. Après chaque remplacement de pièces concernant la sécurité, une vérification de sécurité doit être effectuée (contrôle visuel, vérification du conducteur de protection, mesure de la résistance d'isolement et du courant de fuite, essai de fonctionnement). Cela permet d'assurer le maintien de la sécurité du produit.

Batteries et accumulateurs/cellules

Si les instructions concernant les batteries et accumulateurs/cellules ne sont pas ou sont insuffisamment respectées, cela peut provoquer des explosions, des incendies et/ou des blessures graves pouvant entraîner la mort. La manipulation de batteries et accumulateurs contenant des électrolytes alcalins (par exemple cellules de lithium) doit être conforme à la norme EN 62133.

1. Les cellules ne doivent être ni démontées, ni ouvertes, ni réduites en morceaux.
2. Ne jamais exposer les cellules ou batteries à la chaleur ou au feu. Ne pas les stocker dans un endroit où elles sont exposées au rayonnement direct du soleil. Tenir les cellules et batteries au sec. Nettoyer les raccords sales avec un chiffon sec et propre.
3. Ne jamais court-circuiter les cellules ou batteries. Les cellules ou batteries ne doivent pas être gardées dans une boîte ou un tiroir où elles peuvent se court-circuiter mutuellement ou être court-circuitées par d'autres matériaux conducteurs. Une cellule ou batterie ne doit être retirée de son emballage d'origine que lorsqu'on l'utilise.
4. Les cellules ou batteries ne doivent pas être exposées à des chocs mécaniques de force non admissible.
5. En cas de manque d'étanchéité d'une cellule, le liquide ne doit pas entrer en contact avec la peau ou les yeux. S'il y a contact, rincer abondamment à l'eau l'endroit concerné et consulter un médecin.
6. Il y a danger d'explosion en cas de remplacement ou chargement incorrect des cellules ou batteries qui contiennent des électrolytes alcalins (par exemple cellules de lithium). Remplacer les cellules ou batteries uniquement par le type Rohde & Schwarz correspondant (voir la liste des pièces de rechange) pour maintenir la sécurité du produit.
7. Il faut recycler les cellules ou batteries et il est interdit de les éliminer comme déchets normaux. Les accumulateurs ou batteries qui contiennent du plomb, du mercure ou du cadmium sont des déchets spéciaux. Observer les règles nationales d'élimination et de recyclage.

Transport

1. Le produit peut avoir un poids élevé. Il faut donc le déplacer ou le transporter avec précaution et en utilisant le cas échéant un moyen de levage approprié (par exemple, chariot élévateur) pour éviter des dommages au dos ou des blessures.
2. Les poignées des produits sont une aide de manipulation exclusivement réservée au transport du produit par des personnes. Il est donc proscrit d'utiliser ces poignées pour attacher le produit à ou sur des moyens de transport, tels que grues, chariots et chariots élévateurs, etc. Vous êtes responsable de la fixation sûre des produits à ou sur des moyens de transport et de levage appropriés. Observer les consignes de sécurité du fabricant des moyens de transport ou de levage utilisés pour éviter des dommages corporels et des dégâts sur le produit.
3. L'utilisation du produit dans un véhicule se fait sous l'unique responsabilité du conducteur qui doit piloter le véhicule de manière sûre et appropriée. Le fabricant décline toute responsabilité en cas d'accidents ou de collisions. Ne jamais utiliser le produit dans un véhicule en mouvement si cela pouvait détourner l'attention du conducteur. Sécuriser suffisamment le produit dans le véhicule pour empêcher des blessures ou dommages de tout type en cas d'accident.

Élimination des déchets

1. Au terme de leur durée de vie, les batteries ou accumulateurs qui ne peuvent pas être éliminés avec les déchets ménagers peuvent uniquement être éliminés par des points de collecte appropriés ou par un centre de service après-vente Rohde & Schwarz.

2. Au terme de sa durée de vie, un produit ne peut pas être éliminé avec les déchets ménagers normaux, mais doit être collecté séparément.
   Rohde & Schwarz GmbH & Co. KG a développé un concept d'élimination des déchets et assume toutes les obligations en matière de reprise et d'élimination, valables pour les fabricants au sein de l'UE. Veuillez vous adresser à votre centre de service après-vente Rohde & Schwarz pour éliminer le produit de manière écologique.
3. Si les produits ou leurs composants sont travaillés mécaniquement et/ou thermiquement au-delà de l'utilisation prévue, ils peuvent, le cas échéant, libérer des substances dangereuses (poussières contenant des métaux lourds comme par exemple du plomb, du béryllium ou du nickel). Le démontage du produit ne doit donc être effectué que par un personnel qualifié et spécialement formé. Le démontage inadéquat peut nuire à la santé. Les règles nationales concernant l'élimination des déchets doivent être observées.
4. Si, lors de l'utilisation du produit, des substances dangereuses ou combustibles exigeant une élimination spéciale sont dégagées, comme par exemple liquides de refroidissement ou huiles moteurs qui sont à changer régulièrement, les consignes de sécurité du fabricant de ces substances dangereuses ou combustibles ainsi que les règles sur l'élimination en vigueur au niveau régional doivent être respectées. Les consignes de sécurité spéciales correspondantes dans la documentation produit doivent également être respectées, le cas échéant. L'élimination non conforme des substances dangereuses ou combustibles peut provoquer des atteintes à la santé et des dommages écologiques.

Pour plus d'informations concernant la protection de l'environnement, voir la page d'accueil de Rohde & Schwarz.

Customer Support

Technical support – where and when you need it

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

Up-to-date information and upgrades

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

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

ROHDE&SCHWARZ

Contents

1 Preface

The R&S SGT is a signal generator intended for the generation of IQ-modulated signals and the playback and output of externally calculated modulation signals in the form of waveforms.

Optimized for use in automated test equipment (ATE), the instrument offers fast settling times in an exceptionally small form factor and low power consumption. The R&S SGT is equipped with an active electronic step attenuator and can be equipped optionally with a high stability reference oscillator.

1.1 Key Features

The key features of the R&S SGT include the following:

- Compact size and low power consumption
- Remote connection via PCI Express, minimizing the setup time
  Alternatively, LAN or USB connections available
- Coherent LO input and output connectors, also usable as MIMO input/output and phase coherent I/Q demodulation
- Linux operating system
- Graphical user interface R&S SGMA-GUI to set up and control one or more R&S SGT instruments simultaneously from one remote computer, available for Windows and Linux systems

1.2 Documentation Overview

This section provides an overview of the R&S SGT user documentation. You find it on the product page at:

www.rohde-schwarz.com/manual/sgt100a

Getting started manual

Introduces the R&S SGT 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. A printed version is delivered with the instrument.

Online help

Embedded in the R&S SGMA-GUI software, it offers quick, context-sensitive access to the complete information.

User manual

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

- Base unit manual
  Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the quick start guide manual.
- Software option manual
  Contains the description of the specific functions of an option. Basic information on operating the R&S SGT is not included.

The **online version** of the operating manual provides the complete contents 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.

Instrument security procedures manual

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

Basic safety instructions

Contains safety instructions, operating conditions and further important information. The printed document is delivered with the instrument.

Data sheet and brochure

The data sheet contains the technical specifications of the R&S SGT. It also lists the options and their order numbers as well as optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

Release notes and open source acknowledgment (OSA)

The release notes list new features, improvements and known issues of the current firmware version, and describe the firmware installation.

The open source acknowledgment document provides verbatim license texts of the used open source software.

See www.rohde-schwarz.com/firmware/sgt100a

Application notes, application cards, white papers, etc.

These documents deal with special applications or background information on particular topics, see www.rohde-schwarz.com/application/sgt100a.

1.3 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.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

2 Preparing for Use

2.1 Putting into Operation

This section describes the basic steps to be taken when setting up the R&S SGT 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" delivered as a printed brochure with the instrument.
  In addition, read and observe 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 prevent damage to the instrument. The instrument's data sheet can contain additional operating conditions.

NOTICE

Risk of electrostatic discharge (ESD)

Electrostatic discharge (ESD) can damage 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 damage the instrument and 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.

2.1.1 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

2.1.2 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.

2.1.3 Accessory List

The instrument comes with the following accessories:

- Power cable
- Getting started printed manual

2.1.4 Placing or Mounting the Instrument

The R&S SGT is designed for use under laboratory conditions, either on a bench top or in a rack using a rack adapter kit (order number see data sheet).

Bench top operation

If the R&S SGT is operated on a bench top, the surface should be flat. The instrument can be used in horizontal position, standing on its feet.

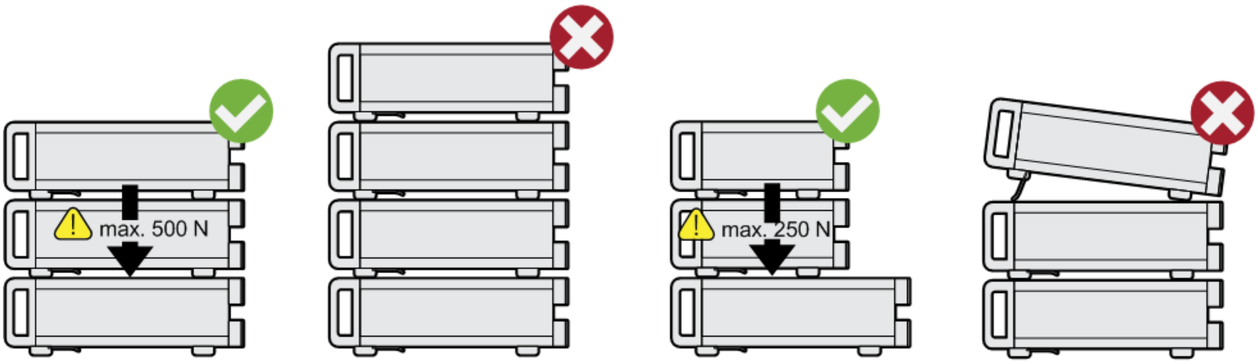
CAUTION

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.



Correct Too many instruments Different dimensions Feet folded out

Rack mounting

The R&S SGT 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.

2.1.5 Switching the Instrument On and Off

The R&S SGT is automatically adapted to the AC voltage supplied. 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.

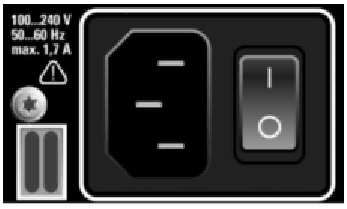
To connect the AC supply

► Connect the R&S SGT to the AC power source using the AC power cable delivered with the instrument.

Note: The instrument is in compliance with safety class EN61010-1.
Connect the instrument only to a socket with earthing 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).

To switch between standby and ready state

► Press the POWER ON/STAND BY key briefly to switch the instrument from the standby to ready state or vice versa.

In ready state, the button is green. The instrument is ready for operation. All modules are power-supplied and the R&S SGT initiates its startup procedure.
In standby state, the button is orange. The standby power only supplies the power switch circuits and built-in oscillator to keep it at its operating temperature. The remote control system is **not** active.

Start-up and booting

The instrument boots the operating system and starts the instrument firmware. During the booting process, the green POWER ON/STAND BY key blinks. If the previous session was terminated regularly, the instrument uses the last setup with the relevant instrument settings.

Once the startup procedure has been terminated, the instrument is ready for operation.

In the R&S SGMA-GUI, select "Instrument > Preset" function to return the instrument to its defined reset/preset state, if the current setup is no longer relevant.

To customize the start settings, use the "SGMA-GUI > File > Save As/Open" function.

To shut down the instrument

To shut down the R&S SGT, proceed as described below.

► To turn the power off, press the main power switch to position 0 (Off).

None of the front-panel LEDs should be on.

2.1.6 Function Check

The instrument automatically monitors the main functions when it is switched on and monitors them continuously during operation.

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

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

- Internal Adjustments
  In the R&S SGMA-GUI, select the "Instrument > Setup > Internal Adjustments" dialog to access the dialog for performing and configuring the adjustments settings. A maximum level accuracy can be obtained, for instance.
- Selftest
  A selftest is provided for service purposes ("SGMA-GUI > Instrument > Diagnostic/Test > Self Test").

2.1.7 Default Settings

When the instrument is switched on, it is not the preset state that is active, but rather the instrument state that was set before the instrument was switched off. It is recommended that you use the "SGMA-GUI > Instrument > 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 SGT offers a two-stage preset concept:

- Preset the instrument to a predefined state
  The "SGMA-GUI > Instrument Name > Preset" function calls up a defined instrument setup. All parameters and switching states are preset (also these of inactive operating modes). The default instrument settings provide a reproducible initial basis for all other settings. However, functions that concern the integration of the instrument into a measurement setup are not changed.
- Preset the instrument to its factory settings
  The instrument can also be forced to load its default factory settings. To access the corresponding dialog box, select the "SGMA-GUI > Instrument Name > Setup > Factory Preset" function.
  For more information and an overview of the settings affected by the factory preset function, see the "Factory Preset" section in the user manual.

For more information and an overview of the settings affected by the factory preset function, see Chapter 8.13, "Factory Preset", on page 262.

User-defined instrument states can be stored and called up using the functions "SGMA-GUI > File > Save As/Open".

2.2 Linux Operating System

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

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.

2.3 Connecting an External PC and Devices

As a rule, the R&S SGT is operated exclusively via remote control on a connected PC. Another way to control the instrument is the manual operation via the R&S SGMA-GUI software on the connected PC.

Both the remote control and the manual operation of the instrument require an external controller. For the prerequisites and the instructions on how to configure an external controller for remote control, refer to the user manual. A brief introduction to the remote control capabilities is provided in Chapter 10, "Network and Remote Control Operation", on page 276.

This section gives an introduction on how to configure the external PC for manual operation (see Chapter 2.3.1, "Installing the R&S SGMA-GUI Software on an External PC", on page 25).

In addition to connecting an external controller, it may be useful to connect other external devices, e.g. a memory stick. The following interfaces are provided on the rear panel of the instrument, see also Chapter 3.2, "Rear Panel Tour", on page 32:

- PCI Express (refer to Chapter 2.3.3, "Connecting a Controller via PCI Express", on page 28
- USB interface (refer to Chapter 2.3.4, "Connecting a Controller or a USB Device via USB", on page 28)
- LAN interface (refer to Chapter 2.3.2, "Connecting a Remote PC via LAN", on page 26)

2.3.1 Installing the R&S SGMA-GUI Software on an External PC

The R&S SGMA-GUI software is a graphical user interface program for one or more instruments. It runs on a remote PC.

The R&S SGMA-GUI software is provided as separate installation package for the different operating systems. The latest version of the software together with the relese notes is available for download at:

http://www.rohde-schwarz.com/product/SGT100A.html > "Downloads" > "Software"

This page always offers the latest information on your R&S SGMA-GUI.

This description focuses on the handling of the Windows-32 version. The file naming conventions and the installation instructions for the other operating systems are analogous.

The R&S SGMA-GUI installation package for Windows-32 operating system consists of the file `SGMA-GUI_<V.VV.VVV.VVV>.exe`. The version numbers in the file names vary with each update. To install the R&S SGMA-GUI, the following hardware and software requirements have to be met.

Table 2-1: Hardware and software requirements

Requirement	Remark
One of the following operating systems: ● Windows XP SP2 ● Windows Vista ● Windows 7 ● Windows 8/ 8.1 ● Windows 10 ● Linux	R&S SGMA-GUI has to be installed on one of the supported operating systems. **Note:** Any other Windows version or other operating systems are not supported. Windows installer version 4.5 or higher is needed for the installation of the software on a Windows XP computer. During installation, the operation system is checked. The installation is terminated if this requirement is not fulfilled.
R&S VISA	VISA drivers can be obtained on the Rohde & Schwarz website: http://www.rohde-schwarz.com/rsvisa
CPU	At least Pentium or compatible, as from 1 GHz (recommended).
VGA color display resolution	At least 800*600 pixels

Installing a new software version

Administrator rights are necessary for installation and starting.

1. Download the R&S SGMA-GUI software
2. In Windows Explorer, double-click `SGMA-GUI_V.VV.VVV.VVV.exe`. Follow the instructions.

Uninstalling an old software version

An uninstallation of a previous version of the SW can be performed before the installation of the new one, but this is not mandatory.

► To uninstall this version, go to "Start > Settings > Control Panel > Add/Remove Programs" and select the entry `SGMA-GUI_V.VV.VVV.VVV`.

  The script file identifies and removes all currently installed R&S SGMA-GUI software items.

2.3.2 Connecting a Remote PC via LAN

The R&S SGT is equipped with a network interface and can be connected to an Ethernet LAN (local area network). The interface can be used, for example:

- To connect an external computer for manual control of the instrument by the R&S SGMA-GUI software.
- To operate the device by a remote control program.
  See Chapter 10, "Network and Remote Control Operation", on page 276.

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

- Chapter 2.3.2.1, "Connecting the Instrument to the Network", on page 26
- Chapter 2.3.2.2, "Assigning the IP Address", on page 27
- Chapter 2.3.2.3, "Automatically Adding Instruments to the SGMA-GUI ", on page 27

2.3.2.1 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, an IP address has to be assigned to the instrument and the computer, see Chapter 2.3.2.2, "Assigning the IP Address", on page 27.

Setting 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 obtain all address information automatically.

2.3.2.2 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), all 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.

The R&S SGT uses the Zeroconf IP addresses 169.254.xxx.yyy., where xxx takes values between 1...254 and yyy the values in the value range 1...255; the subnet mask is always 255.255.0.0. The IP address of the host must be within the same address area for Zeroconf.

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

2.3.2.3 Automatically Adding Instruments to the SGMA-GUI

For information on how to install the R&S SGMA-GUI software, refer to Chapter 2.3.1, "Installing the R&S SGMA-GUI Software on an External PC", on page 25.

1. For each new instrument perform the following steps:
   a) Connect the instrument to the network.
   b) Press the POWER ON/STAND BY key to switch on the instrument.
   c) Wait until the POWER ON/STAND BY LED is green and not blinking.
   d) Press the ID key on the front panel of the instrument.
2. Start the SGMA-GUI on a computer connected to the same network.
3. Open the "Instruments" dialog and click "Scan".

   Note: This step is performed automatically on the first start and can also be omitted for instruments with a direct LAN connection to the computer.

   All instruments are added automatically to the main panel of the SIGMA-GUI.

2.3.3 Connecting a Controller via PCI Express

A PCI Express connector is provided on the rear panel of the instrument, see Chapter 3.2, "Rear Panel Tour", on page 32.

NOTICE

Risk of device failure

The R&S SGT is equipped with a single lane PCIe interface that supports hot plugging.

Do not connect an external PC to the PCIe connector of the instrument during operation if this external PC does not support hot-plugging!

Using the PCIe interface for remote control of the instrument requires extended knowledge. Refer to Chapter 10.3, "Advanced Remote Control Using PCIe", on page 286 for detailed information.

2.3.4 Connecting a Controller or a USB Device via USB

The USB interface on the rear panel of the R&S SGT allows you to connect either a USB device or use the R&S SGT as a device and connect it to a controller.

Connecting a controller (host PC or compatible signal generator)

If you connect a controller (host PC or compatible signal generator) to the R&S SGT, the R&S SGT acts as a USB device.

To connect the controller to the USB interface of the R&S SGT, always connect the **USB type Micro-B** connector to the R&S SGT. Refer to the documentation of the controller to find out which USB connector type you can connect to the controller.

The Figure 2-1 illustrates schematically the required connector type to emphasize on the different connector shape.

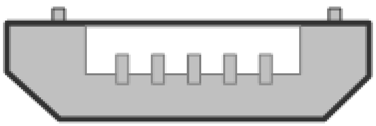


Figure 2-1: USB type Micro-B connectors

An external PC with installed R&S SGMA-GUI is required for manual operation of the R&S SGT.

On the remote PC, perform the steps as described in Chapter 2.3.2.3, "Automatically Adding Instruments to the SGMA-GUI ", on page 27.

Connecting a USB device

If you connect a USB device (memory stick, CD-ROM, an instrument) to the R&S SGT, the R&S SGT acts as a host.

To connect a USB device to the interface of the R&S SGT, always connect the **USB type Micro-A** connector to the R&S SGT. Refer to the documentation of the USB device to find out which USB connector type you can connect to the USB device.

The Figure 2-2 illustrates schematically the required connector type to emphasize on the different connector shape.

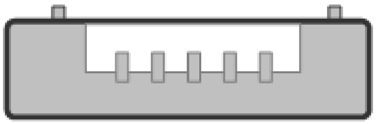


Figure 2-2: USB type Micro-A connectors

3 Instrument Tour

The following topics 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 SGT with the aid of the front and rear views. Specifications of interfaces can be found in the data sheet.

3.1 Front Panel Tour

This section provides an overview of control elements on the front panel of the R&S SGT. The connectors of the R&S SGT are placed on the rear panel and are described in Chapter 3.2, "Rear Panel Tour", on page 32. As the R&S SGT is intended to be remote-controlled, the front panel of the R&S SGT contains no display but mostly LEDs to inform you about the status of the instrument. The user interface can be displayed on a remote PC station used to manually remote control the instrument.

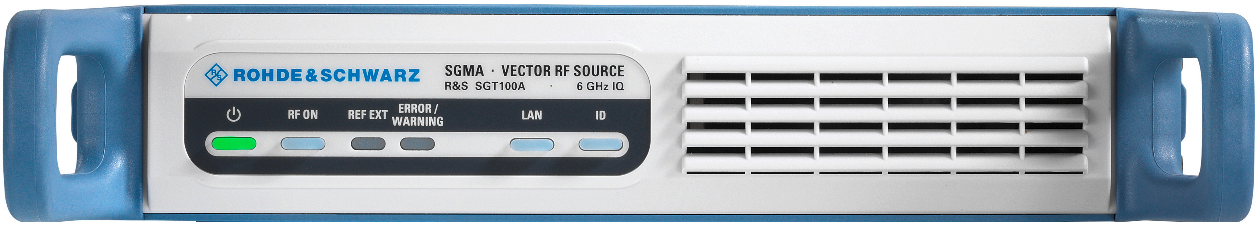


Figure 3-1: Front panel view

POWER ON/STAND BY

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

In ready state, the button is green. The instrument is ready for operation.

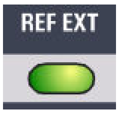
In standby state, the button is orange. In this state, it is safe to switch off the AC power and disconnect the instrument from the power supply.

A blinking green color indicates that a booting operation is in process.

RF ON

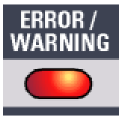
The RF ON key switches the RF signal on or off. If activated, the button is green.

REF EXT



The REF EXT LED indicates the status of the external reference.
- Green indicates that the instrument can synchronize to the external clock.
- Red indicates that the instrument cannot synchronize to the external clock.
- No light indicates that the internal reference is used.

ERROR / WARNING

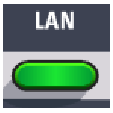


The ERROR / WARNING LED indicates the status of the R&S SGT.
- Red indicates that an error has occurred, e.g. temperature exceeded or power failure.
- Blinking orange indicates a running process (e.g calibration, self test).
- No light indicates that no errors or warnings have occurred.

For details on errors or warnings, refer to the graphical user interface on a remote PC ("SGMA-GUI > Info").

For more information, refer to the "Error Messages" section in the user manual.

LAN



Pressing the key for more than 3 s resets the LAN interface settings, i.e the "IP Adress Mode" is reset to DHCP.

ID

Pressing the ID key while the instrument is active, opens the "SGMA-GUI > Setup > Instruments > Configure Instruments > Edit Instrument" dialog of the corresponding instrument on the remote controller.

Pressing the ID key of an inactive instrument and starting "SGMA-GUI > Setup > Instruments > Scan", leads to an automatic activation of the instrument in the SGMA-GUI.

3.2 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.

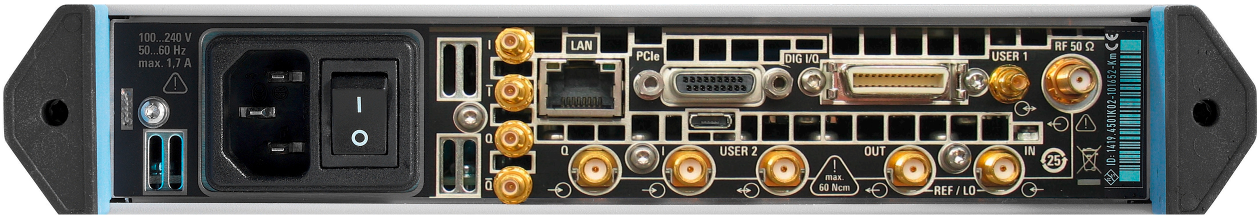


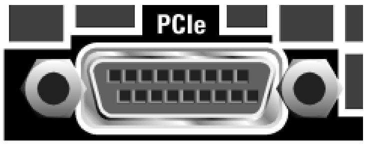
Figure 3-2: Rear panel view

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.

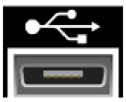
PCI EXPRESS CONNECTOR



The PCIe (Peripheral Component Interconnect Express) single lane interface allows remote control with optimized speed.

For details, see Chapter 2.3.3, "Connecting a Controller via PCI Express", on page 28.

USB CONNECTOR

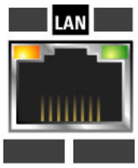


The USB (universal serial bus) interface, type micro, allows you to connect various external devices, e.g.:

- If the interface is configured as a device interface, the R&S SGT can be connected to other devices like a remote computer. On the computer, you can perform a firmware update, manual operation via the R&S SGMA-GUI software or for remote control of the instrument.

For details, see Chapter 2.3.4, "Connecting a Controller or a USB Device via USB", on page 28.

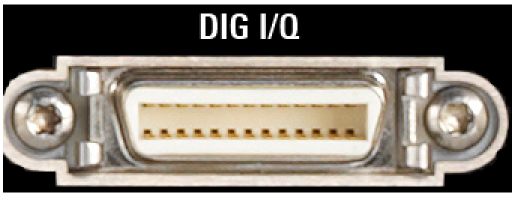
LAN CONNECTOR



The LAN (Ethernet) interface allows you to connect the R&S SGT to other devices like a remote computer. On the computer, you can perform a firmware update, manual operation via the R&S SGMA-GUI software or for remote control of the instrument. The connection to the remote computer can be direct or via a network.

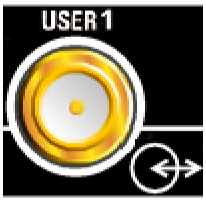
For details, see Chapter 2.3.2, "Connecting a Remote PC via LAN", on page 26.

DIGITAL I/Q



Input of a digital I/Q signal.

USER 1/2



Multi-purpose connectors. The input/output signal has to be defined, e.g. "Trigger", "Marker 1/2", "Clock In/Out", "Sync In/Out".

USER 1 is an SMB connector while USER 2 is an SMA female connector.

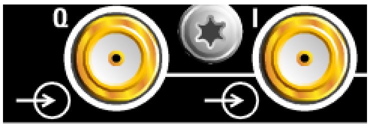
Connector USER 2 can be also used as an input for external pulse modulator sources.

RF OUT

Provides an RF 50 Ohm signal output.

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

I , Q



SMA female type connectors that are inputs of the I/Q modulator, provided for feeding of external signal.

NOTICE! Maximum input levels. Do not overload the I and Q inputs. The maximum permissible voltage is 1V. For details, refer to the data sheet.

I, Q OUT

The I OUT/I BAR OUT and Q OUT/Q BAR OUT connectors are SMB male connectors for direct output of the analog I/Q signal.

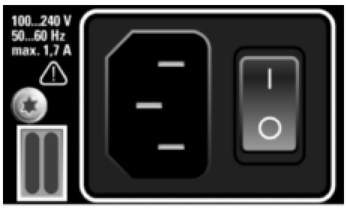
REF / LO IN, REF / LO OUT

SMA female type connectors, for reference or local oscillator signals, and alternatively also in MIMO setups.

Reference input and output:
- REF IN: Input for external reference signal.
- REF OUT: Output of internal reference signal.

Local oscillator input and output:
- LO IN: Input for external LO signals
- LO OUT: Output of internal LO signals.

AC SUPPLY AND POWER SWITCH



The AC supply and power switch allow you to connect the R&S SGT to the power supply and switch on the instrument.

For details, see "To connect the AC supply" on page 22.

3.3 Connector Extension Unit (R&S SGT-B88)

The R&S SGT connector extension unit can be ordered together with an R&S SGT. The extension unit provides a front panel N-connector for the RF output and rear panel BNC connectors for the I , Q IN, REF / LO IN, REF / LO OUT and the USER 2 connectors.

The R&S SGT- B88 cannot be retrofitted on an already existing R&S SGT unit. It is only available as a set together with a new R&S SGT instrument.

3.3.1 Front Panel

This section provides an overview of the connectors on the front panel of the extension unit.

For an overview of the front panel connectors of the R&S SGT, refer to Chapter 3.1, "Front Panel Tour", on page 30.

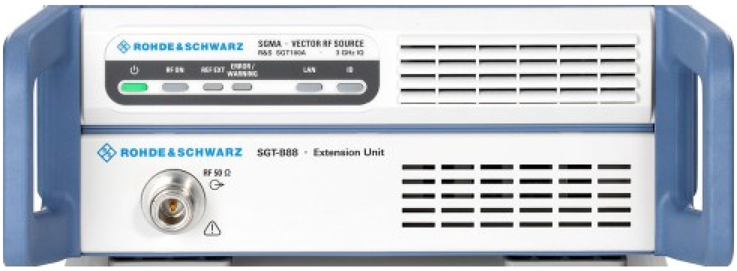


Figure 3-3: Front panel view of the R&S SGT and the connector extension unit

RF OUT
An N-connector, that provides an RF 50 Ohm signal output.

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

3.3.2 Rear Panel

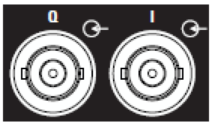
This section provides an overview of the connectors on the rear panel of the extension unit.

For an overview of the connectors of the rear panel of R&S SGT, refer to Chapter 3.2, "Rear Panel Tour", on page 32.

Figure 3-4: Rear panel view of the R&S SGT and the connector extension unit

1 = Rear view of the R&S SGT
2 = Rear view of the connector extension unit

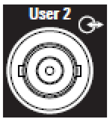
I , Q



BNC type connectors that are inputs of the I/Q modulator, provided for feeding of external signal.

NOTICE! Maximum input levels. Do not overload the I and Q inputs. For details on the maximum permissible voltage, refer to the data sheet.

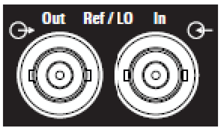
USER 2



A BNC multi-purpose connector. The input/output signal has to be defined, e.g. "Trigger", "Marker 1/2", "Clock In/Out", "Sync In/Out".

Connector USER 2 can be also used as an input for external pulse modulator sources.

REF / LO IN, REF / LO OUT



BNC type connectors, for reference or local oscillator signals, and alternatively also in MIMO setups.

Reference input and output:
- REF IN: Input for external reference signal.
- REF OUT: Output of internal reference signal.

Local oscillator input and output:
- LO IN: Input for external LO signals
- LO OUT: Output of internal LO signals.

4 First Steps with the Instrument

This chapter introduces the most important functions and settings of the R&S SGT step by step.

Prerequisites

As a prerequisite for these examples, the R&S SGT has to be connected to a remote PC. The R&S SGMA-GUI software has to be installed on this remote PC and the instrument is added to the list of "Available Instruments".

For information on how to fulfill these requirements, refer to:

- Chapter 2.3.2.1, "Connecting the Instrument to the Network", on page 26
- Chapter 2.3.1, "Installing the R&S SGMA-GUI Software on an External PC", on page 25
- Chapter 2.3.2.3, "Automatically Adding Instruments to the SGMA-GUI ", on page 27

4.1 How to Generate a CW Signal

Configuring the R&S SGT to generate a CW signal

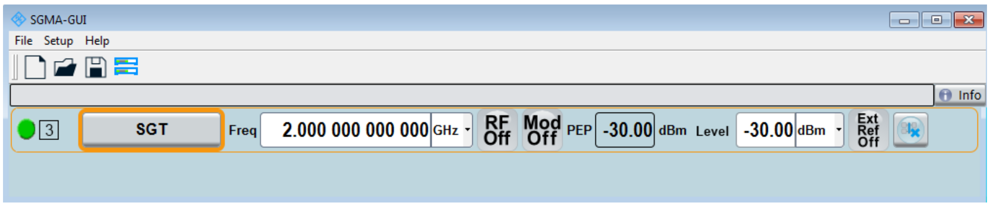
Figure 4-1: Example of the setup

1. Check the front panel of the R&S SGT.

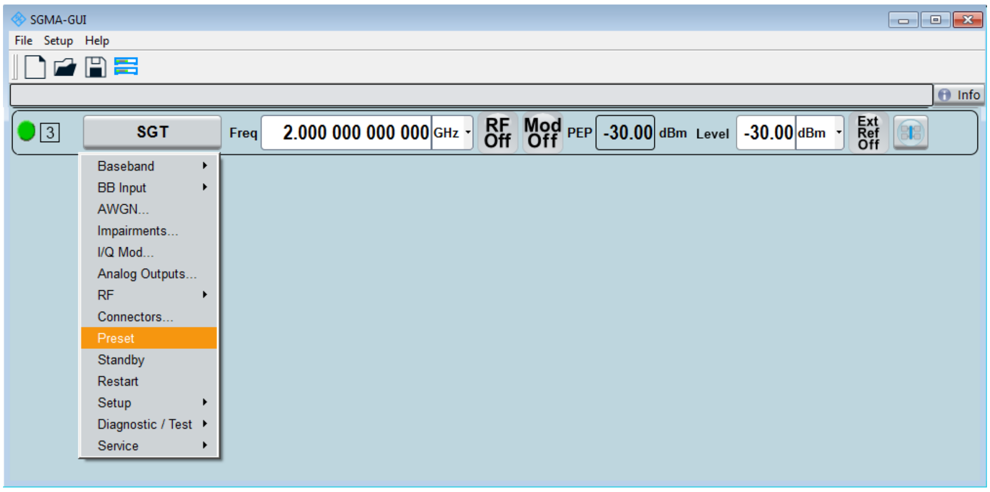
   The POWER ON/STAND BY key has to be **green**.

2. On the connected remote PC, start the R&S SGMA-GUI software application.

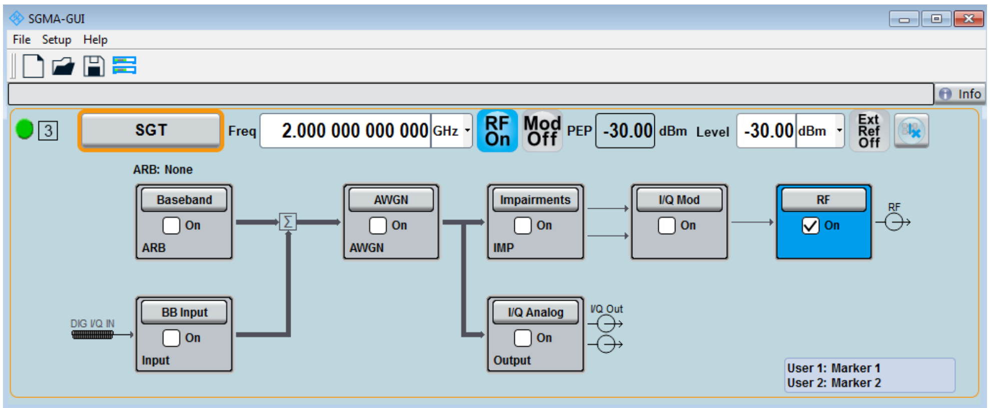
The main panel of the application opens. The panel provides a quick access to the main settings of the configured and activated instruments. The display shows one row per instrument with the instrument-specific settings. The rows comprise the instrument, the connection state, the used frequency and power level, the state of the RF output and the modulator and the used reference frequency source.



3. In the R&S SGMA-GUI main panel, the green indicator in front of the instrument's name confirms that there is a connection between the instrument and the remote PC and that the instrument is recognized by the software.
4. In the R&S SGMA-GUI main panel, select the row corresponding to the instrument to be configured and select "Instrument Name > Preset" to restore the predefined instrument's settings.



5. In the R&S SGMA-GUI main panel, select the row corresponding to the instrument to be configured and adjust the "Frequency" as required.
6. Select "SGMA-GUI > RF On" to enable the output of the CW signal.



The 2 GHz signal is output at the RF OUT connector at the rear panel of the R&S SGT.

4.2 How to Create a Waveform File with R&S WinIQSIM2 and Load it in the ARB

The following is an example on how to use the R&S WinIQSIM2 to generate a waveform and load it in the ARB of the R&S SGT.

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 SGT.
- Generating a waveform file with the required settings.
- Transferring the waveform file and playing it with the R&S SGT.

This section does not describe the R&S WinIQSIM2 but focuses only the task-related settings.

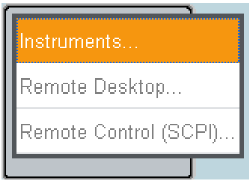
For more information on configuration and working with the R&S WinIQSIM2, refer to description "software manual R&S WinIQSIM2".

To configure the R&S SGT 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 SGT.

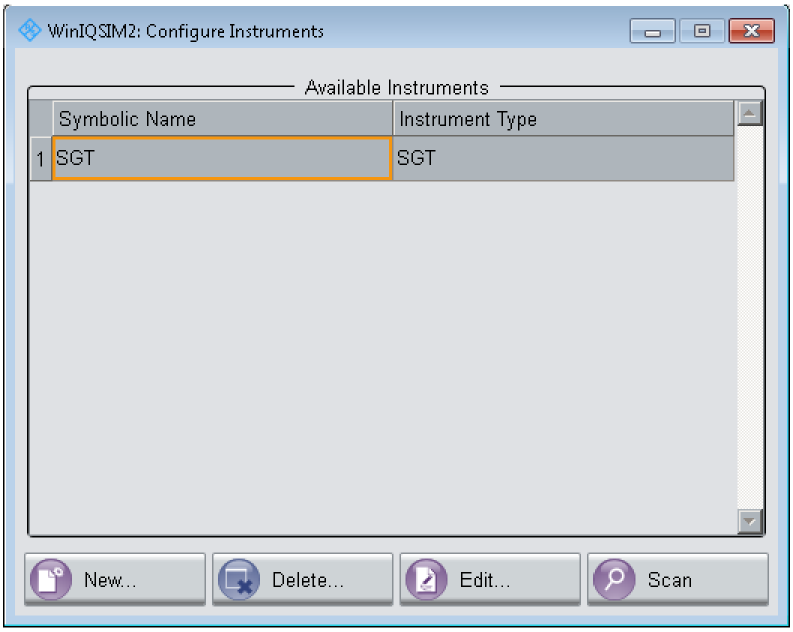
The general instrument settings of the destination instrument affect various functions, like, the maximum size of the file the waveform is stored in. It is recommended that you configure the destination instrument before you generate the waveform with the R&S WinIQSIM2.

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".

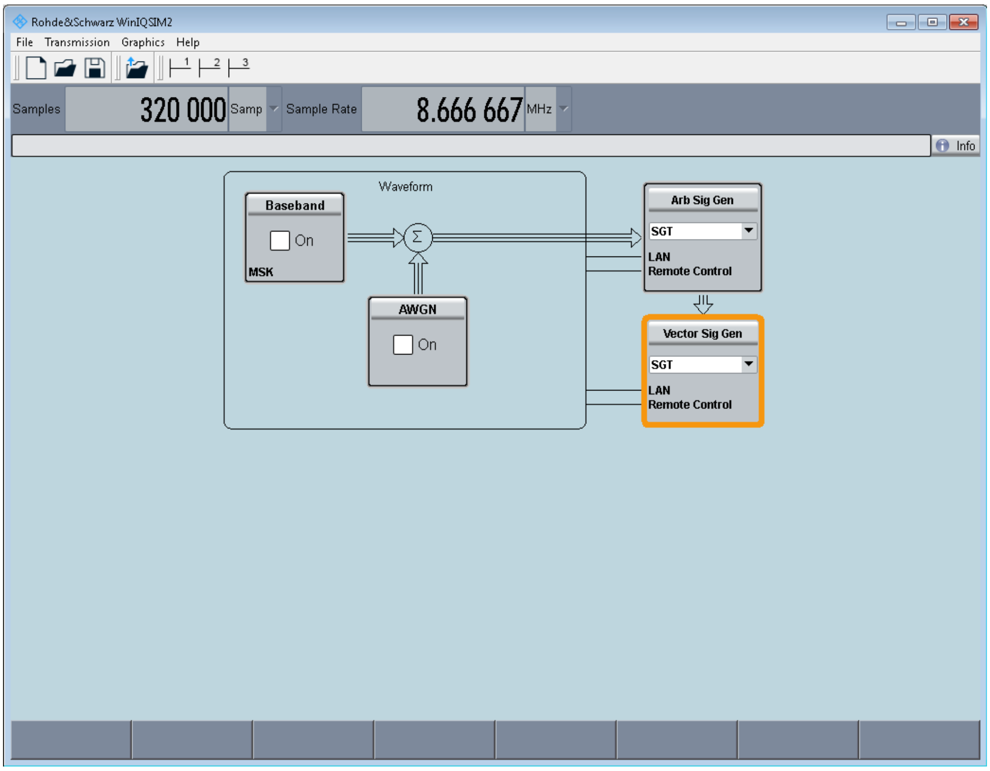


The software scans the network for connected and active instruments. Alternatively, use the "New" function to add the R&S SGT manually to the list of instruments.

4. Close the dialog.

5. In the block diagram, select "Vector Sig Gen" block and select the R&S SGT form the list.

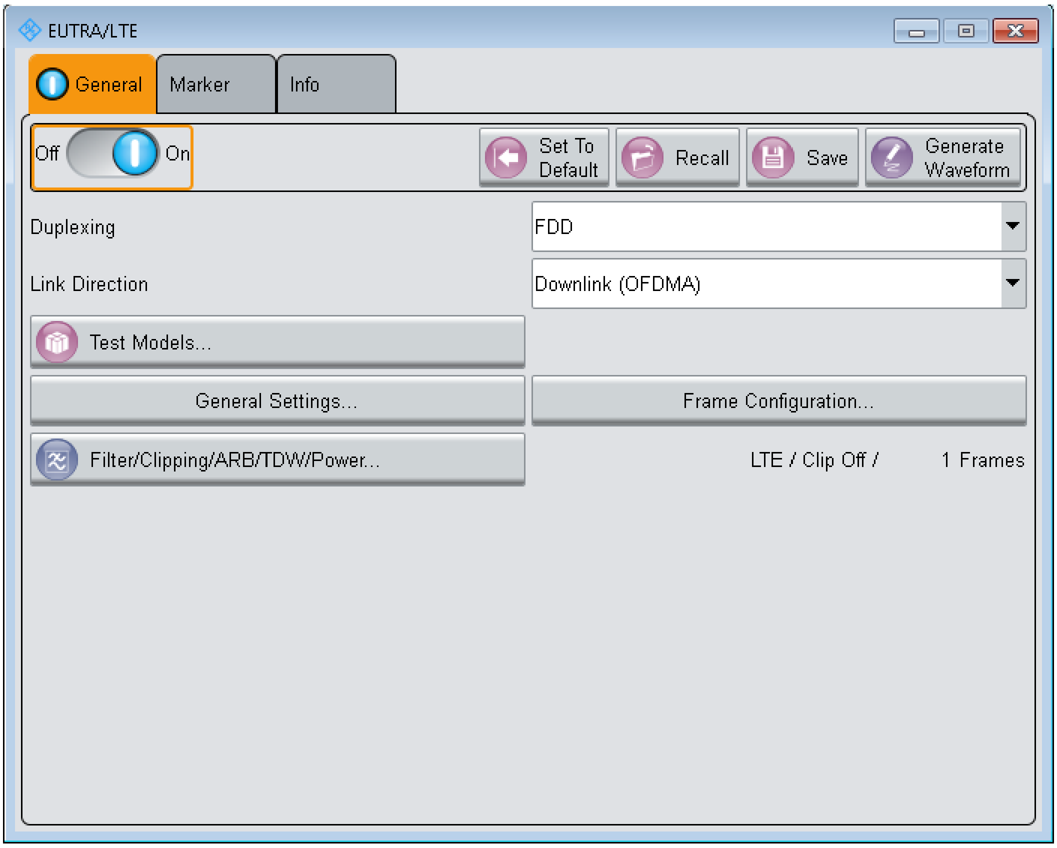
6. In the block diagram, select "Arb Sig Gen" block and select the R&S SGT form the list.



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 SGT is established.

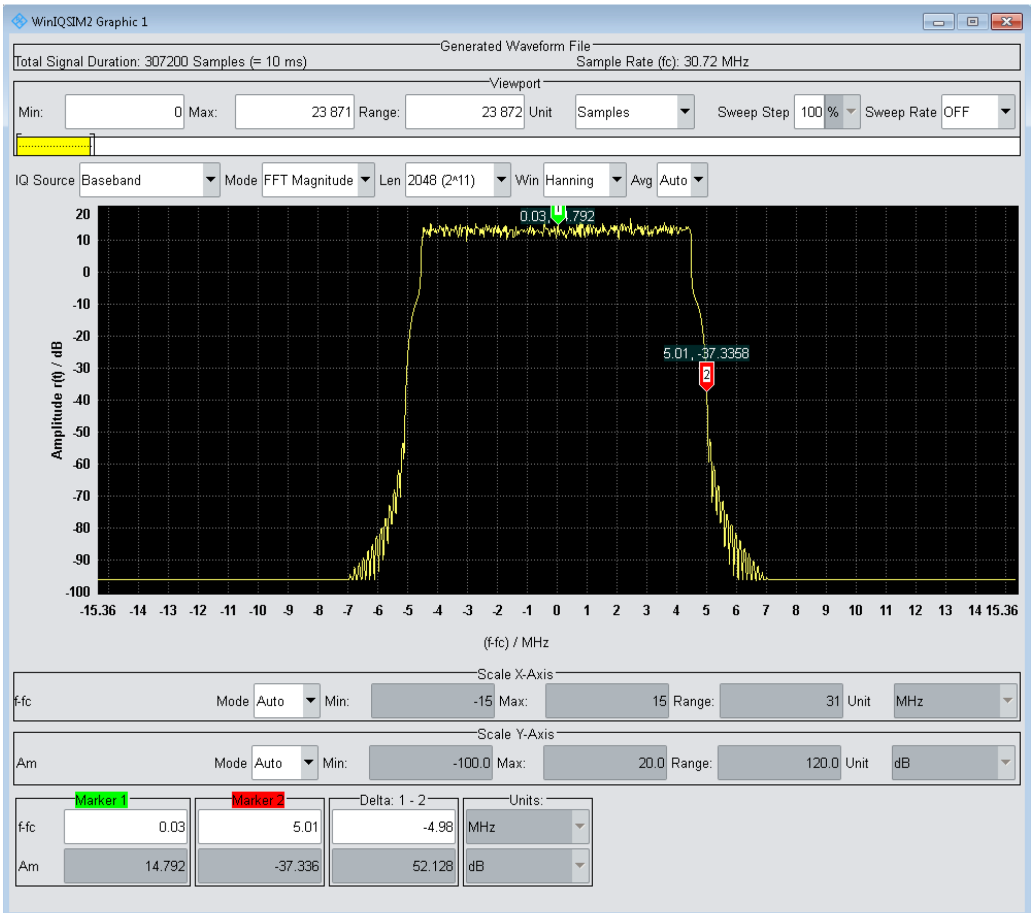
To generate an LTE example waveform file with the R&S WinIQSIM2

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".

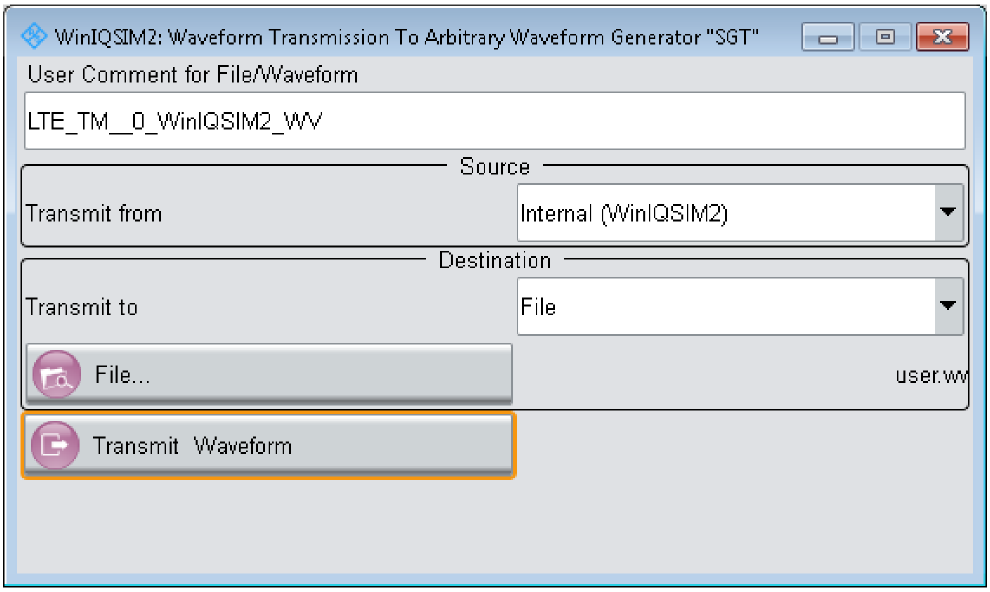
Use "Graphics > Graphic 1 (Complete)" view to retrieve more information on the generated signal.



The display confirms the expected EUTRA/LTE 10 MHz spectrum.

To transfer the generated file to the R&S SGT

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 for the transmitted file.
   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".



The waveform is transmitted to the default directory of the R&S SGT.

3. In the R&S SGT, select "Baseband > ARB".

   The dialog confirms that the ARB is enabled and plays the transmitted waveform.

5 System Overview

The R&S SGT RF Source is a vector signal generator intended for the generation of IQ-modulated signals as well as the playback and output of externally calculated modulation signals in the form of waveforms.

Optimized for use in automated test equipment (ATE), the instrument offers very fast settling times in an exceptionally small formfactor and low power consumption. The R&S SGT is equipped with an active electronic step attenuator and can be equipped optionally with a high stability reference oscillator.

5.1 Setups for Instrument Control

The R&S SGT is an instrument designed for the automated test equipment (ATE) needs. To maintain the small size, the instrument is not equipped with a display and hence additional equipment is required to control the instrument.

This section provides an overview of the possible configuration setups for controlling the R&S SGT.

5.1.1 Manual Operation from the R&S SGMA-GUI

The following example represents a basic configuration of the R&S SGT, operated manually by the configuration software R&S SGMA-GUI. The configuration software is installed on a remote PC and controls several instruments. The instruments are connected to the remote PC over different remote control interfaces. Any combination of the used interfaces is possible.

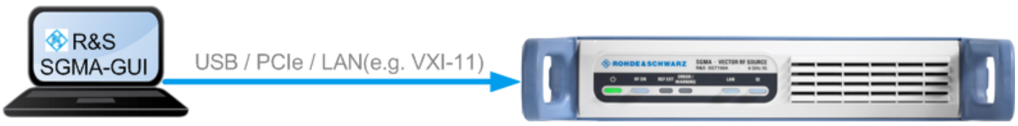


Figure 5-1: Configuration example: manual control from R&S SGMA-GUI

For information about the manual control, refer to:
- Chapter 6, "Understanding the R&S SGMA-GUI Software", on page 48
- Chapter 7, "Signal Generator Settings", on page 75
- Chapter 8, "General Instrument Settings and Instrument Setup", on page 243

5.1.2 Remote Control from a Controller

The remote control provides access to the instrument's settings from a remote computer (external controller) by means of remote commands. To automate often repeating settings and settings sequences, these are grouped in the remote control programs, i.e. application programs.

An instrument may be connected to the controller via any of the supported interfaces LAN, USB or PCIe.

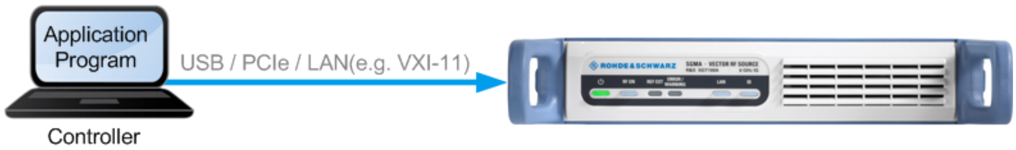


Figure 5-2: Configuration example: remote control from a controller

For information about remote control, refer to:

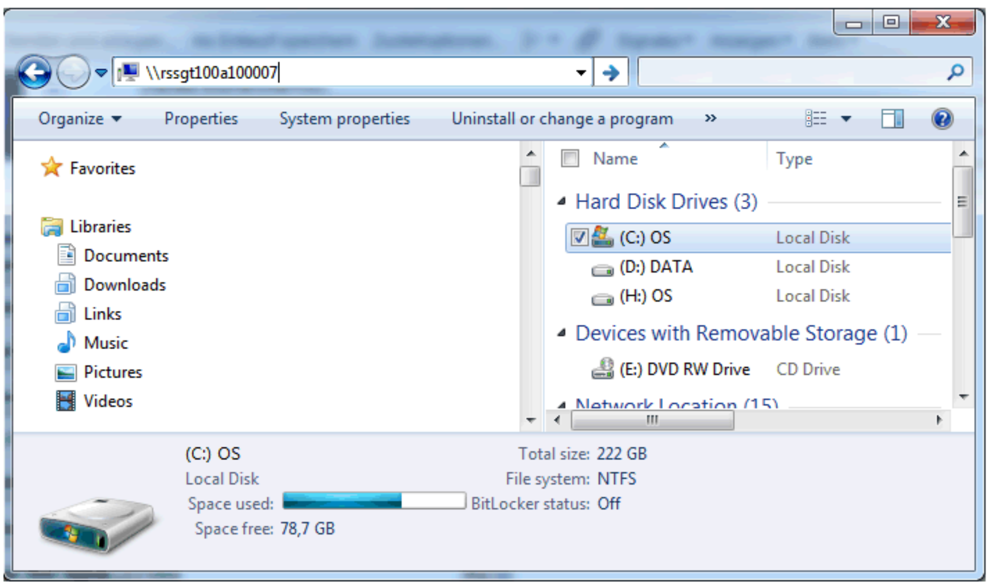
- Chapter 10, "Network and Remote Control Operation", on page 276
- Chapter 15.1, "Remote Control Basics", on page 525

5.2 Managing Files on the R&S SGT

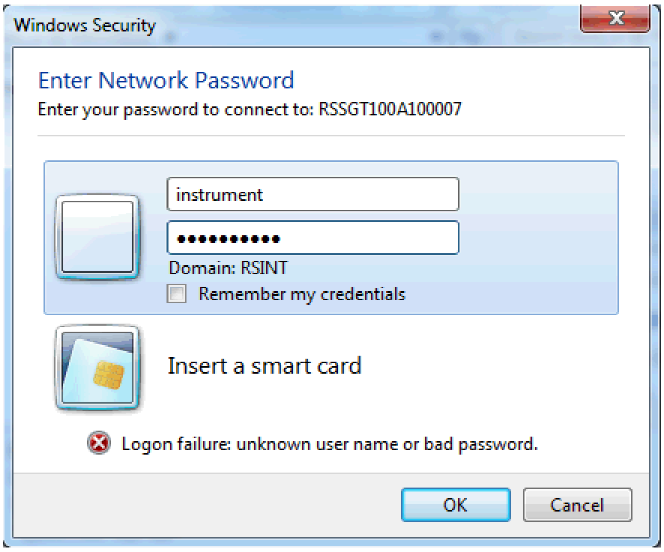
The R&S SGT has internal memory, where you can store waveforms, lists etc. You can also access these files and manage them as required.

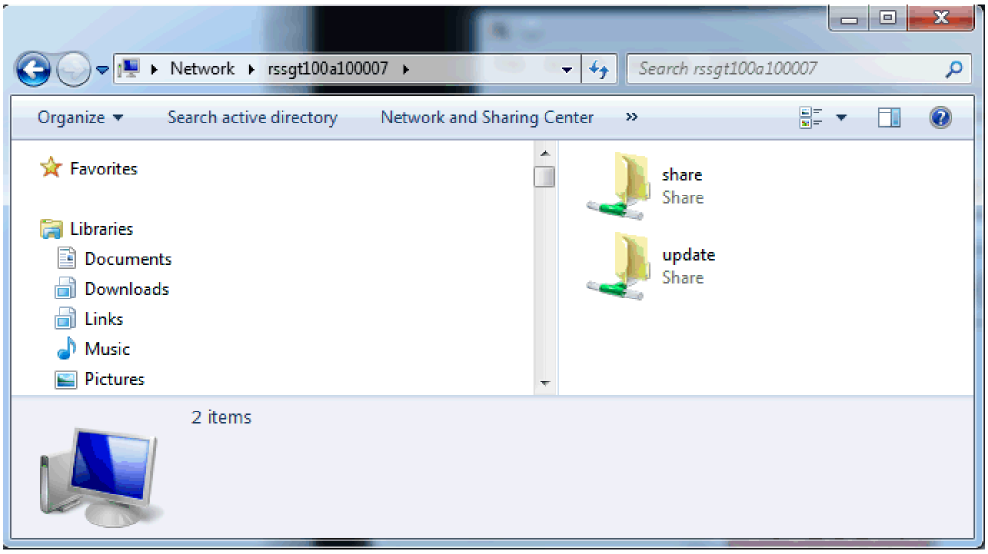
To access files on the R&S SGT

1. Connect the R&S SGT and a Windows PC to the same network.
2. On the PC, open a Windows Explorer window.
3. To connect to the R&S SGT, enter the name of the instrument or its IP address in the Windows address bar.



4. Enter the user name and password to connect to the R&S SGT. The default user name is *instrument* and the password is *instrument*.

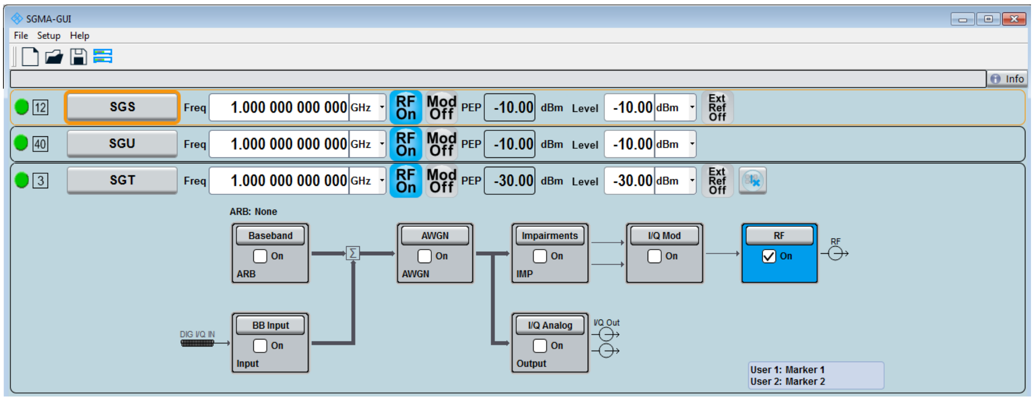




A folder opens, containing the `share` and the `update` folder.
The `share` folder contains the user files, e.g. waveforms, lists. You can copy, delete and rename the files contained in this folder.
The `update` folder allows you to start an update of the instrument's firmware. If you copy a firmware update file in this folder, the update will start automatically.

6 Understanding the R&S SGMA-GUI Software

This section gives a detailed description of the R&S SGMA-GUI user interface and information on how to work with it. The main panel with the overview of the configured instruments is the operating and control interface for the whole program. From here, all program functions are accessible. This panel is displayed after the start of R&S SGMA-GUI. The program always loads the previously used settings so you can continue your work in the next session.



6.1 Operating Menu and Toolbar

On the top of the main panel, there are the menu bar, the toolbar and the info bar with the corresponding "Info" button. Some of the functions are accessible via the toolbar with its icons below the menu selection line.

The dialogs are built using elements, e.g., selection lists, checkboxes, and entry fields. A blue frame indicates that the selected item is active. In a highlighted element, entries can be made.

Table 6-1: Content of the operating menu

File	Setup	Help
New	Instruments	About
Open	Software	Contents
Save	Reset SGMA-GUI	Index
Save as	Protection	
Exit		
Shut down instruments and exit		

6.1.1 File Menu

The R&S SGMA-GUI employs the standard Save/Recall file management function and allows you to store and reload settings in/to a file with a user-defined name and location (see also Chapter 6.5.1, "Storing and Loading Settings", on page 62).

In the following, the "File" menu of the R&S SGMA-GUI is described in detail. It incorporates standard functions.

New
Resets R&S SGMA-GUI and all connected instruments to their preset settings.

Open
Opens the standard file open browser for loading a saved R&S SGMA-GUI file (`*.savrcl`). The file contains the user-specific settings of a session, such as instruments configured in the software, etc. The complete settings of a session can be saved and loaded.

Only files of this type are selectable.

Note: Instrument-specific settings, e.g. frequency and level settings, are stored locally on the particular instrument itself. These instruments settings are saved automatically in a predefined directory and loaded by default when starting the instrument again. The files with instrument settings are not accessible.

Save
Standard quick save of the settings of the current session if a filename previously has been applied. If not, the "Save As" dialog is opened.

Save as
Opens the standard file save browser for saving the settings of the current session. R&S SGMA-GUI files have the file extension `.savrcl` so the name typed in is equipped with this extension. The complete settings of a session are saved.

Exit
Quits the R&S SGMA-GUI. The current settings of the instrument's session are saved and loaded by default when starting the software again.

Note: The instruments configured in the R&S SGMA-GUI are not shut down.

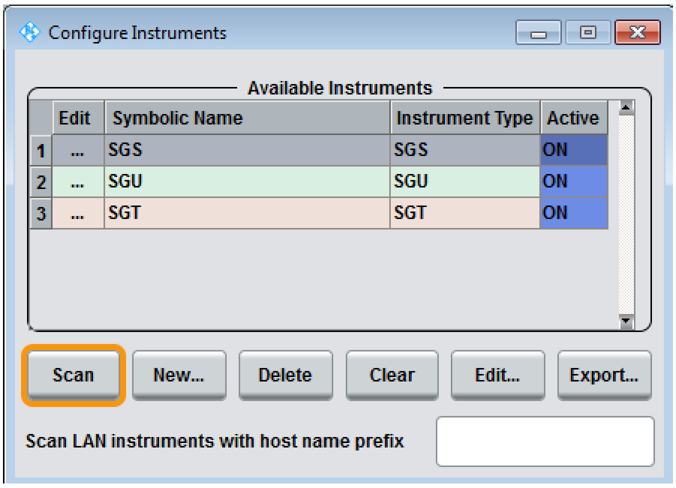
Shut down instruments and exit
Quits the R&S SGMA-GUI and switches the connected instruments to the standby state (see alsoChapter 9.7, "How to Switch between the Operating States", on page 270).

6.1.2 Setup Menu

The setup menu provides access to dialogs for setting the general settings of the software, like dialogs for managing the connected instruments or dialogs providing information about the installed options.

6.1.2.1 Configure Instruments

This dialog is the central point for managing the instrument that will be configured and operated via the R&S SGMA-GUI. New instruments can be created and appended to the list of available instruments, connection settings can be edited, instruments can be removed from the list or they can be deactivated, but kept in the list for further use.



Refer to Chapter 6.5.2, "Handling Instruments in the R&S SGMA-GUI", on page 63 for information on how to configure and manage instruments in R&S SGMA-GUI.

Available Instruments

This section comprises a list of configured instruments. Each instrument is represented by a "Symbolic Name" which is also displayed in the main panel and an "Instrument Type". It is also displayed whether the instrument is activated in the R&S SGMA-GUI and hence displayed in the main panel or not.

Remote command:

`:INSTruments:COUNt?` on page 71
`:INSTruments:NAME` on page 71
`:INSTruments:TYPE` on page 73
`:INSTruments:ACTive[:STATe]` on page 70

Scan

Triggers a scan function and searches for instruments connected to the remote computer via all the available interfaces. During the scan process, a progress bar is displayed.

Tip: The first initialization of a newly connected instrument in a network and the instrument's request to the DHCP server for an IP address may take some time. During this time, the instrument does not respond to the query sent by the scan function. If the instrument does not appear in the list of "Available Instruments", trigger the scan function again after some minutes.

Remote command:

`:INSTruments:SCAN` on page 73

New Instrument
Calls the Add/Edit Instruments dialog.

Delete Instrument
Removes the selected instrument from the list of Available Instruments.

Edit Instrument
Calls the Add/Edit Instruments dialog.

Clear Instrument
Removes all instruments from the list of Available Instruments.

Export
Opens the standard file save browser for saving the list of the available instruments in a mapping file. The mapping files have the file extension `.map` so the filename typed in is automatically equipped with this extension.

A mapping file provides a cross-reference between the instruments' symbolic names and their respective remote control parameters. The information in the mapping file is grouped in rows, where one row corresponds to one configured instrument. The rows have the following structure:

```
<InstrumentType> <SymbolicName> <IP_Address/Hostname>
<RemoteChannel> <SerialNumber>
```

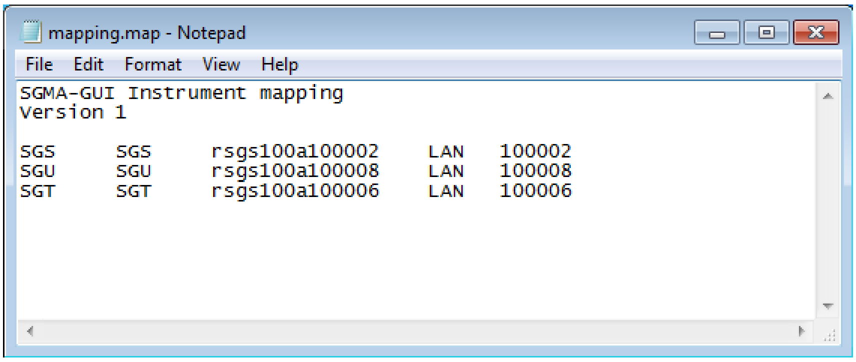


Figure 6-1: Mapping file example

Tip: In a remote control application program, address the instruments by their symbolic names and retrieve the remain required settings from the mapping file. This workflow is especially useful for frequent exchange of instruments.

Remote command:
`:INSTruments:MAPPing:FILE` on page 71

Scan LAN instruments with host name prefix
Sets the prefix the searched host names begin with. Use this function to limit the amount of the searched instruments and to speed up the scan process.

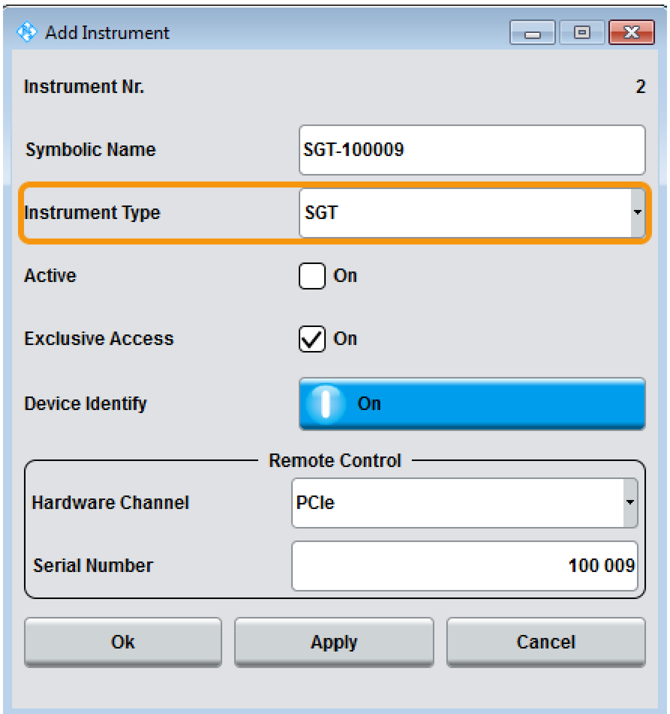
For example, set this field to "RsSGS, RsSGU, RsSGT", if you want to search for all available instruments.

Tip: If you start a scan for an instrument with a set IP address and it doesn't appear in the list of available instruments it may be due to the prefixes written in this field. You can perform another scan while leaving this field empty.

Remote command:
`:INSTruments:SCAN:HNPRefix` on page 73

6.1.2.2 Add/Edit Instruments

The dialog provides access to the main instrument's settings, such as "Symbolic Name", "Instrument Type" and connection settings.



Refer to Chapter 6.5.2, "Handling Instruments in the R&S SGMA-GUI", on page 63 for information on how to configure and manage instruments in R&S SGMA-GUI.

Instrument Nr.
Automatically assigned number that indicates the instrument's index in the list of "Available Instruments".

Symbolic Name
Selects the alias name of the instrument.

Remote command:
`:INSTruments:NAME` on page 71

Instrument Type
Selects the instrument's family.

Remote command:
:INSTruments:TYPE on page 73

Active
Activates/deactivates the display of the instrument's settings in the main panel.

Note: Only instruments in an active state can be controlled from the R&S SGMA-GUI!

Remote command:
:INSTruments:ACTive[:STATe] on page 70

Exclusive Access
Checks whether the instrument is locked by another user and if not locks the instrument. When an instrument is locked, it is reserved and can be operated manually or remote **exclusively** from the remote PC on which the R&S SGMA-GUI is running or from which the SCPI command is sent.

For interfaces using VISA, i.e. for LAN and USB, enabling the "Exclusive Access" triggers the standard `viLock` request. For remote control over PCIe or Socket, the lock request is performed on a higher application level.

Note: It is recommended to lock the instrument prior to further configuration.
Locked instruments will not be found by the scan function.

The instrument has to be unlocked to allow operation from another remote PC.

Note: The two functions "Exclusive Access" and monitoring are mutually exclusive.
Disable "Exclusive Access" if the instrument is monitored by an external PC.

Remote command:
:INSTruments:EACCess[:STATe] on page 71
:LOCK? on page 309
:UNLock on page 310

Device Identity
Triggers the device identification function. The LAN LED on the front panel of the selected instrument blinks.

See also Chapter 6.5.4, "Bidirectional Instrument Identification ", on page 66.

Hardware Channel
Selects the hardware interface used by the remote channel.

Remote command:
:INSTruments:REMote:CHANnel on page 72

Instrument Name / IP Address
Enters the IP address or the host name of the connected instrument.

See also Chapter 6.5.3, "Finding Out the Default Hostname of the Instrument", on page 65.

Remote command:
:INSTruments:REMote:NAME on page 72

GPIB Address
Enters the GPIB address of the connected instrument.

See also Chapter 10.1.5, "GPIB Interface (IEC/IEEE Bus Interface)", on page 284.

Remote command:
`:INSTruments:GPIB:ADDRess` on page 72

Board Number
Identifies the GPIB bus card of the controller to that the adapter is connected.

See also Chapter 10.1.5, "GPIB Interface (IEC/IEEE Bus Interface)", on page 284.

Remote command:
`:INSTruments:GPIB:BOARd` on page 72

Serial Number
Enters the serial number as instrument's identification while using the USB or PCIe interfaces for remote control.

Remote command:
`:INSTruments:SERial` on page 73

OK
Confirms the settings and closes the dialog.

Apply
Confirms the settings.

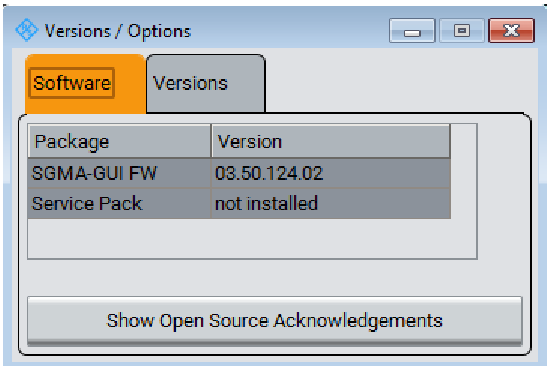
Cancel
Discards settings and closes the dialog.

6.1.2.3 Versions/Options Dialog

Querying information about the installed options and software version

► Select "Setup > Software".

An info dialog opens, showing program information.



Software
Displays information on:

"Package" Installed software packages.

"Version" Release of the software package.

Show Open Source Acknowledgments
Accesses the list of the used open source software packages and the corresponding verbatim license texts.

Versions
Shows the installed software platform and its version.

6.1.2.4 Protection

The "Protection" dialog provides access to the unlocking of protected service functions (authorized personnel of Rohde & Schwarz service departments only).

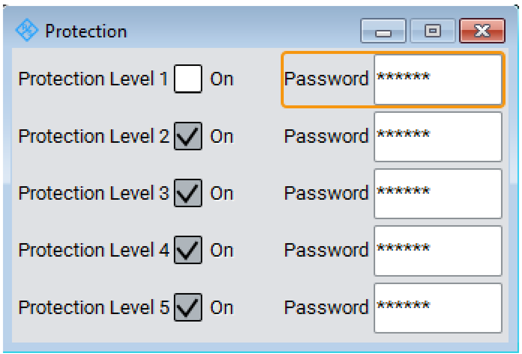
Unlocking of protected service functions

1. Select "SGMA-GUI > Setups > Protection".

   After the instrument has been switched on, the protection levels 1 to 4 are automatically activated.

2. To deactivate the protection, enter the correct password.
   Enter "Protection Level 1 > Password > 123456".

   Protection Level 1 is activated.



Protection Level / Password
"Protection Level 1" can be activated to expand the functionality of the internal adjustment. The password is *123456*.

The other protection levels 2 to 4 provide access to protected service functions. Only the authorized personnel of Rohde & Schwarz service departments can access these functions.

6.1.2.5 Reset SGMA-GUI

Resets R&S SGMA-GUI to its factory preset settings.

The connected instruments are not affected by this preset.

To preset one specific instrument to its factory preset settings, select "SGMA-GUI > Instrument Name > Setup > Factory Preset". Refer to Chapter 8.13, "Factory Preset", on page 262 for an overview of the settings affected by this function.

6.1.3 Help

The R&S SGMA-GUI is equipped with a context-sensitive help function. A help page can be called any time during software operation.

The context-sensitive page which is opened with the F1 button is part of a comprehensive help system.

It is possible to move from this context-sensitive page to any page of the help system. An overview of the contents of the online help can be reached via the menu "SGMA-GUI > Help > Contents".

A search for keywords within the help function is available via menu item "SGMA-GUI > Help > Index".

6.2 Info Dialog and Messages in the Info Bar

A few operating states and the current messages are displayed in the info line. For information on messages in greater detail and their management, an "Info" dialog can be opened.

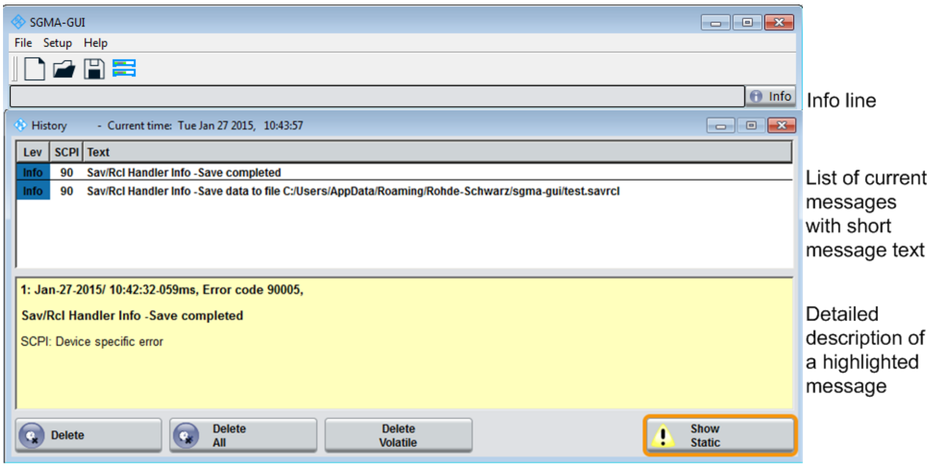
6.2.1 Info Dialog

The "Info" dialog provides a list of currently active permanent messages and a detailed description of each message. The messages are color-coded according to their level.

Accessing the info dialog

► In the "R&S SGMA-GUI main panel", select the "Info" button.

The "Info" dialog opens.



The upper part of the "Info" dialog lists the currently active permanent messages. See the following table for explanation of the displayed information.

Parameter	Description
"LEV"	Message level. Messages referring to a logical component of R&S SGMA-GUI, e.g., Unicode, are marked in red color, info messages are marked in black color. The following levels might occur: ● Err: Error message ● Info: Information message ● Sys: System message ● Crit: Critical message For detailed information on the message types, see Chapter 6.2.2, "Understanding the Messages in the Info Bar", on page 58.
"SCPI"	Indicates the SCPI error code.
Text	A list of all currently permanent messages in the order of their occurrence, i.e., the most recent message is displayed first.

The buttons in the lower part of the "Info" dialog provide quick access to some functions for managing these messages. For a detailed description on how to clear error messages or display a history of all messages, refer to Chapter 6.5.5, "Managing Messages in the Info Dialog", on page 67.

Function	Description
"Delete"	Clears the highlighted message. This button is available only if the history of the messages is displayed.
"Delete All"	Clears all messages. This button is available only if the history of the messages is displayed.
"Del. volatile"	Clears all brief messages. This button is available only if the history of the messages is displayed.
"Show History/Static"	Calls the list of all messages that have occurred since instrument switch-on. The most recent messages are displayed at the top of the list. When the button is pressed again, the list of current messages is displayed.

Refer to Chapter 6.5.5, "Managing Messages in the Info Dialog", on page 67 for information on how to manage messages.

6.2.2 Understanding the Messages in the Info Bar

Messages indicate information, warnings, and errors. They are displayed in the info line in different colors depending on their importance and display duration. The following messages are displayed:

- Error

  There are two options:

  – Critical errors are errors that prevent the instrument from working, e.g. an HW failure. Critical errors are displayed in red color.

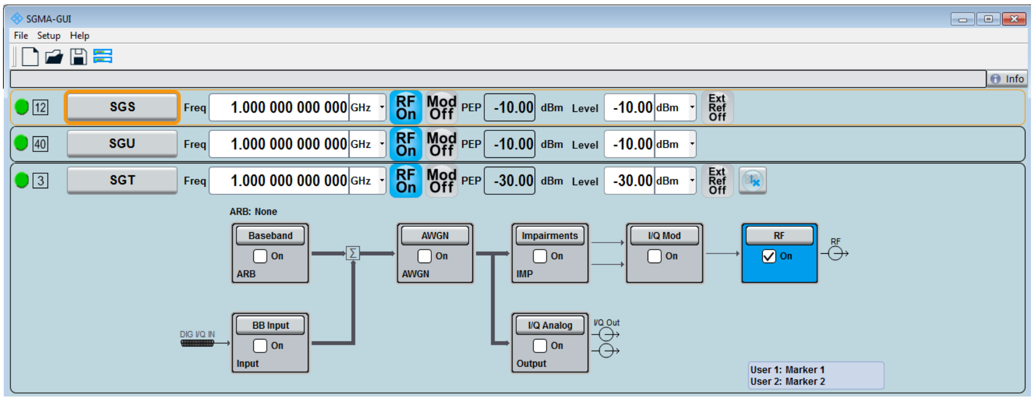
  – System errors are errors that concern the operating system, e.g., wrong file path. System errors are displayed in black color.
- Information
  The information, e.g., file not found, is displayed in black color.
- Warning
  A warning indicates a less significant error and is displayed in black color.
- Brief message
  Brief messages report automatic settings in the program, e.g. switching on illegal entries that are not accepted by the program, 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.
  Brief messages usually do not demand user actions and disappear automatically after a short period of time. They are stored in the history, however.
- Permanent messages
  Permanent messages are displayed if an error occurs that impairs further program operation. The error signaled by a permanent message must be eliminated before correct software operation can be ensured.
  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.

6.3 Main Panel

The main panel of the R&S SGMA-GUI provides quick access to the main settings of the configured instruments. The display shows one row per instrument and comprises the instrument name and state, the used frequency and power level, the states of the RF output and modulator and the used reference source.

Click one of the buttons with an instrument name on it to access the menu tree with further settings for the corresponding instrument. For a detailed description of the provided settings, see:

- Chapter 8, "General Instrument Settings and Instrument Setup", on page 243 for general settings
- Chapter 7, "Signal Generator Settings", on page 75 for R&S SGT setting.



Instrument/Connection State

The three colors of the state indicator in front of the instrument's name distinguish between the following states:

- Gray: the instrument is configured and activated in the R&S SGMA-GUI but there is no connection to the instrument.
- Green: the instrument is active, the connection is working and the instrument can be manually and remotely operated.
- Red: the instrument is in one of the following states:
  – Standby state
    To operate the instrument manually, it has to be switched to ready state (see "To return the instrument from standby to ready state" on page 271).
  – Instrument locked
    The red state indication together with the message "Instrument Locked" in the "Info" line indicates that the instrument is locked for Exclusive Access from another SGMA-GUI or controller.
  – The instrument is performing a time consuming operation, e.g. a selftest.

Maximum Frequency

The numbers in the rectangular box 6 on the left of the instrument's name indicate the maximum frequency of the instrument.

Pulse Modulation

A ⎍ sign on the left of the instrument's name indicates that the pulse modulation is switched on.

Instrument Name

Displays the alias name of the instrument, as selected by the parameter "SGMA-GUI > Setup > Instruments > Add/Edit Instruments > Symbolic Name".

Click the button to access a menu tree for configuring the available instrument's settings, e.g. "Level" settings.

Freq/Freq (Offs)

Sets the RF frequency, incl. enabled frequency offset.

The following apples:

"Freq" = Frequency + Offset

Where, the value set with the parameter "SGMA-GUI main panel > instrument name > Frequency/Phase > Frequency" is the RF frequency at the RF output, without the frequency offset.

The icon "Freq (Offs)" indicates that a frequency offset is applied.

Remote command:
`[:SOURce]:FREQuency[:CW|FIXed]` on page 340

RF On/Off

Activates and deactivates the RF output signal.

The current state of the RF output (activated and deactivated) is indicated in the main panel by the different block color (blue or grey) and the status "On/Off".

Remote command:
`:OUTPut[:STATe]` on page 328

I/Q Mod State

Switches the I/Q modulation on and off.

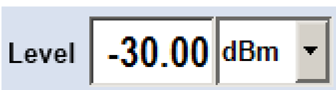
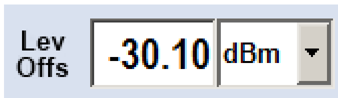
The following functions have the same effect:
- The "Mod On/Off" icon in the SGMA-GUI.
- The "I/Q Mod > On/Off" in the I/Q Mod block in the block diagram.
- The "I/Q Modulator" > State parameter.

Remote command:
`[:SOURce]:IQ:STATe` on page 424

Level/Level Offset

Sets the RF level at the RF output connector of the selected instrument.

If you set a digital attenuation, while "I/ Q Mod > Modulation Source > Internal Baseband" and "I/ Q Mod > Modulation State > ON", it will be indicated in the R&S SGMA-GUI main panel by a change in the name of this parameter from "Level" to "Level Offset".

Note: The SCPI command `[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]` sets the level of the "Level" display, that means the level containing offset while `[:SOURce]:POWer:POWer` sets the level at the RF output connector.

Remote command:
`[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]` on page 468
`[:SOURce]:POWer:POWer` on page 468

Ref. Oscillator Source/Ext Ref On/Off

Determines whether the internal built-in oscillator (TXCO or OXCO) is used as a reference source or if an external reference is used.

The internal reference oscillator OCXO requires the additional option R&S SGT-B1.

To feed in an external instrument reference, use the input connector REF/LO IN. To output the reference frequency at the output REF/LO OUT, select "SGMA-GUI > Instrument Name > RF > Ref. Oscillator > REF/LO Output > REF".

"Int"	The internal reference signal of 10 MHz is used.
"Ext"	An external reference signal is used. The frequency of the external reference signal must be selected with the parameter "SGMA-GUI > Instrument Name > RF > Ref. Oscillator > Ex. Ref. Input Frequency".

Remote command:
`[:SOURce]:ROSCillator:SOURce` on page 470

LO Scr Ext

This icon indicates that the internal local oscillator is switched off.

See "Source" on page 201.

6.4 Block Diagram

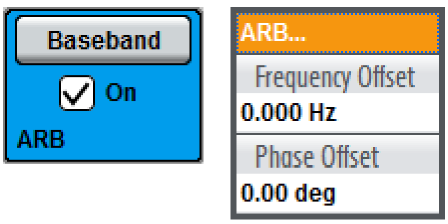
The block diagram, available for setting up the R&S SGT, shows provided options, signal configuration and the currently selected signal flow of the generator with inputs and outputs used. Signal generation can be operated from the block diagram.

To display the block diagram, click the  button next to the instrument's name.

6.4.1 Function Blocks in the Block Diagram

Each block represents a function of signal generation. The function is indicated in the headline of the block. In the checkbox, the respective function can be quickly activated/deactivated. After activation, the block is displayed in blue. Status information is displayed below the checkbox. It is different for the different blocks.

Example: Baseband block



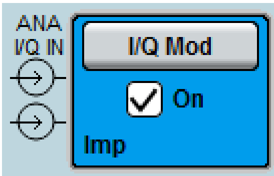
In this block, the arbitrary waveform generation and trigger, marker and clock are set.

6.4.2 Signal Flow and Input/Output Symbols in the Block Diagram

The input/output symbols in the block diagram show the currently used inputs and outputs of the signal generator. Unused inputs and outputs are not shown. The lines indicate the signal flow.

Symbols and labels refer to the corresponding inputs and outputs on the front and rear panel of the signal generator. The direction - input or output - is indicated by an arrow.

Example:



The symbols indicate the inputs for the analog I and Q signal.

Symbols and lines are displayed in different colors depending on their function.

- The baseband signal is indicated by a three line arrow, the I- and Q-components of the signal by a single-line arrow.
- Connections are indicated by a "solder point".
- Black is used for the generated signal.
- Green is used for control signals.

6.5 Working with R&S SGMA-GUI

This section explains how to work with the R&S SGMA-GUI software and perform configuration tasks for manual operation of the instruments.

6.5.1 Storing and Loading Settings

To proceed work with a particular configuration of the instruments in the R&S SGMA-GUI, it is useful to save the used settings and load them again later.

How to store and load settings

1. Select "SGMA-GUI main panel > File > Save As".
2. Navigate to the desired directory and enter the filename.
   The extension `*.savrcl` is applied automatically.

   The current settings of the software are saved to the selected file.
3. To load settings from a file, select "SGMA-GUI main panel > File > Open"
4. Navigate to the directory the file is stored in and select the setting file.

The saved settings are loaded to the R&S SGMA-GUI and the main panel of the software displays the saved instrument's configuration.

6.5.2 Handling Instruments in the R&S SGMA-GUI

This section provides information on how to configure and manage instruments in the R&S SGMA-GUI.

For reference information about all provided settings in the user interface, refer to the corresponding sections:

- Chapter 6.1.2.1, "Configure Instruments", on page 50 and Chapter 6.1.2.2, "Add/Edit Instruments", on page 52
- Chapter 6.1.2.3, "Versions/Options Dialog", on page 54
Chapter 6.1.2.5, "Reset SGMA-GUI", on page 55

6.5.2.1 How to Automatically Add New Instruments to the SGMA-GUI

1. For each new instrument perform the following steps:
   a) Connect the instrument to the network.
   b) Switch on the instrument.
   c) Press the ID key on the front panel of the instrument.
2. Start the SGMA-GUI on a computer connected to the same network.

   All instruments are added automatically to the main panel of the SGMA-GUI.

6.5.2.2 How to Manually Add New Instruments to the SGMA-GUI

1. In the R&S SGMA-GUI main panel, select "Setup > Instruments".

   The Configure Instruments dialog opens.
2. Select the "New" button.

   The Add Instrument dialog opens to register a new instrument.
3. In the "Symbolic Name" field, enter an alias name of your choice, e.g. SGT-100021.
4. In the "Instrument Type" field, select the device family to connect to.
5. Select "Remote Control > Hardware Channel" and select the hardware interface.
6. For LAN or Socket interfaces, select "Remote Control > Instrument Name / IP Address" and enter the IP Address or the hostname of the connected instrument, e.g. rssgt100a100021.

   Tip: See also Chapter 6.5.3, "Finding Out the Default Hostname of the Instrument", on page 65 .

7. For USB or PCIe interfaces, select "Remote Control > Serial Number" and enter the serial number of the connected instrument , e.g. 100021.
8. Set "Active > On" to activate the instrument. Only active instruments are displayed in the R&S SGMA-GUI main panel.
9. Click "OK" to confirm the settings and to close the dialog or press the "Apply" button to confirm the settings.
10. Click the "Cancel" button to discard settings and to close the dialog.

6.5.2.3 How to Scan for New Instruments

1. In the R&S SGMA-GUI main panel, select "Setup > Instruments".

   The Configure Instruments dialog opens.
2. Click the "Scan" button to trigger the instrument to scan all remote channel interfaces for connected instruments.

   Tip: To limit the amount of the searched instruments and to speed up the scan process, select "Configure Instruments > Scan LAN instruments with hostname prefix" and enter the prefix the searched hostnames begin with.
   The scan function searches only for instruments whose hostnames begin with the selected prefix.

   All instruments which are connected to one of the available interfaces, are switched on and are not locked are displayed in the"Available Instruments" list. The R&S SGMA-GUI obtains all information for connecting to the instrument, so further configuration is not necessary.

6.5.2.4 How to Activate Instruments for Control from the R&S SGMA-GUI

1. In the R&S SGMA-GUI main panel, select "Setup > Instruments".

   The "Available Instruments" in the Configure Instruments dialog lists all instruments configured in the software.
2. Select the newly configured/connected or deactivated instrument and set "Active > On" to activate it.

   Tip: Only active instruments are displayed in the R&S SGMA-GUI main panel!

6.5.2.5 How to Edit Instruments

1. In the R&S SGMA-GUI main panel, select "Setup > Instruments".

   The Configure Instruments dialog opens and lists the "Available Instruments".
2. Select the instrument to be edited and click the "Edit" button.

The Edit Instrument dialog opens.

3. Change the settings and confirm with OK.

   The edited settings are applied.

6.5.2.6 How to Delete an Instrument

1. In the R&S SGMA-GUI main panel, select "Setup > Instruments".
   The Configure Instruments dialog opens.
2. Select the instrument to be deleted and click the "Delete" button.

   The selected instrument is deleted from the list of "Available Instruments".

6.5.2.7 How to Delete All Instruments

1. In the R&S SGMA-GUI main panel, select "Setup > Instruments".
   The Configure Instruments dialog opens.
2. Click the "Clear" button.

   All instruments are deleted from the list of "Available Instruments".

6.5.2.8 How to Reserve the Instrument for Control

1. Open the "SGMA-GUI > Setup > Instruments > Configure Instruments" dialog, select the instrument in the list of "Available Instruments" and select "Edit".
2. In the "Edit Instrument" dialog, enable "Exclusive Access".
3. Alternatively, send the SCPI command `:INSTruments:EACCess[:STATe]` from the external PC the R&S SGMA-GUI is installed on.

   The instrument is reserved for control from this external PC and cannot be accessed from any other controller. A scan function started from another controller finds the instrument but the instrument is indicated as locked.

The two functions "Exclusive Access" and monitoring are mutually exclusive!

The "Exclusive Access" must be disabled to remote control or monitor the instrument form another external PC (see Chapter 10.6, "Using the R&S SGMA-GUI to Monitor the Remote Control Operation", on page 301).

6.5.3 Finding Out the Default Hostname of the Instrument

The default hostname of the instrument is a non-case-sensitive string built as follows:

`hostname = <instrument name><serial number>`, where

`<serial number>` is the individual serial number of the instrument

`<instrument name>` is the complete name of the instrument, written without spaces.

How to query the hostname of the instrument

1. Find the individual serial number on rear of the instrument , e.g. 100021.
2. Build the default hostname.

   For the R&S SGT with serial number 100021, the default hostname is `rssgt100a100021`.

For instructions on how to change the default hostname, refer to Chapter 9.8, "How to Use Computer Names", on page 272.

6.5.4 Bidirectional Instrument Identification

In practice, instruments are integrated into a large network or placed in racks together with several other instruments of the same kind. It might be difficult then to find out which of the instruments configured in the R&S SGMA-GUI corresponds to which physical instrument or to localize all instruments operated by the current controller.

The R&S SGMA-GUI and the instrument provide the "Device Identification" function for this purpose.

How to find an instrument in the R&S SGMA-GUI

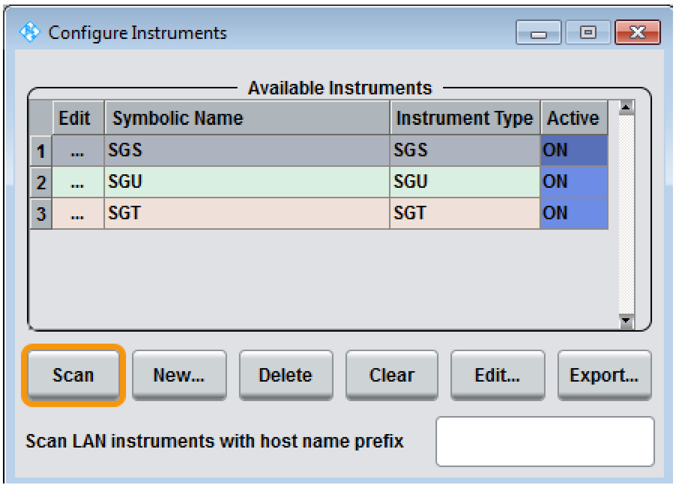
► If several instruments have been configured and activated in the R&S SGMA-GUI, press the ID button on the instrument's front panel to trigger device identification.

  The "Edit Instrument" dialog of this instrument opens.
  Field "Edit Instrument > Symbolic Name" displays the name of the instrument as shown in the R&S SGMA-GUI main panel.

Dialog "Edit Instrument" does not appear

If this dialog does not open, perform the following:

- Check whether the instrument is correctly connected to the external PC on which you work with the R&S SGMA-GUI.
- Check if the instrument is configured in the R&S SGMA-GUI and perform, if necessary, the steps described in Chapter 6.5.2, "Handling Instruments in the R&S SGMA-GUI", on page 63.
- Select "SGMA-GUI > Setup > Instruments", check the state of the instrument in the "Configure Instruments > Available Instruments" table and activate it, if disabled.



How to identify an instrument in an instrument set

► To identify the instrument in an instrument set, use one of the device identification functions:

a) Select "SGMA-GUI > Setup > Instruments > Available Instruments > Instrument > Edit > Edit Instrument" and trigger "Device Identify"

b) Select "SGMA-GUI > Instrument Name > Setup > Remote > Remote Channels" and trigger "Device Identify"

The green LAN LED on the front panel of the instrument blinks.

6.5.5 Managing Messages in the Info Dialog

How to get additional information on the message

► In the "Info" dialog, click a message to select it.

In the lower section of the dialog, additional information on the highlighted message is displayed.

How to display all messages

► In the "Info" dialog, click the "History" button.

A history of all messages that have occurred since the R&S SGMA-GUI software was started is listed in the upper dialog pane. The most recent message is displayed first.

How to delete an error message

► In the "Info" dialog, select the highlighted message and click the "Delete" button.

Tip: This button is available only when the history of the messages is displayed.

The highlighted message is cleared.

How to delete all error messages

► In the "Info" dialog, click the "Delete All" button.

Tip: This button is available only when the history of the messages is displayed.

All messages are cleared.

How to delete all brief messages

► In the "Info" dialog, click the "Del. volatile" button.

Tip: This button is available only when the history of the messages is displayed.

All brief messages are cleared.

How to call the history

1. In the "Info" dialog, click the "History" button.

   A list of all messages that have occurred since the instrument switch-on is displayed. The most recent messages are displayed at the top of the list.
2. Click the "History" button once more.
   A list of current messages is displayed.

6.6 Remote Control of the R&S SGMA-GUI

This section focuses on the remote control of the R&S SGMA-GUI software.

6.6.1 Configuring Instruments in the R&S SGMA-GUI

This section provides an example of the automation of the R&S SGMA-GUI.

In the following example we assume that a remote PC with installed R&S SGMA-GUI on it is connected to a LAN and that the remote PC and the instruments are switched on.

For more information, refer to section "Connecting an External PC and Devices" in the Getting Started manual.

For more information, refer to Chapter 2.3, "Connecting an External PC and Devices", on page 24.

```
// *******************************************************************
// Trigger the scan function to search for instruments connected
// to the remote computer via all of the available interfaces.
// *******************************************************************

:INSTruments:SCAN:HNPRefix "rssg"
// scan returns only instruments with hostname beginning with "rssg"
:INSTruments:SCAN 1
*OPC?

// *******************************************************************
// Query the number of available instruments and the settings of each
// configured instrument: instrument type, symbolic name,
// remote channel used, serial number, hostname/IP address
// Adjust settings if required
// *******************************************************************

:INSTruments:COUNt?
// Response: 3

:INSTruments:TYPE?
// Response: SGU,SGS,SGT

:INSTruments:NAME?
// Response: SGU-100002,SGS-100006, SGT-100008

:INSTruments:SERial?
// Response: 100002,100006,100008

:INSTruments:REMote:CHANnel?
// Response: LAN,USB, PCIe

:INSTruments:REMote:NAME?
// Response: rssgu100a100002, rssgs100a100006, rssgt100a100008

// *******************************************************************
// Check the instrument state and activate instruments if required
// *******************************************************************

:INSTruments:ACTive:STATe?
// Response: 0,1,1
```

```
:INSTruments:ACTive:STATe ON,OFF,OFF
// Activates the first  instruments in the list,
// i.e. the instruments with symbolic names SGS-100006

// ******************************************************************
// Export the configuration into a mapping file
// ******************************************************************

:INSTruments:MAPPing:FILE 'd:\mapping_files\mapping.map'

// ******************************************************************
// Enable exclusive access for the selected instrument
// ******************************************************************

:INSTruments:EACCess:STATe?
// Response: 0,0,0
:INSTruments:EACCess:STATe ON,0FF, 0FF
// Locks the first instrument
```

6.6.2 R&S SGMA-GUI Settings

This section comprises the SCPI commands provided to remote control the R&S SGMA-GUI.

:INSTruments:ACTive[:STATe] <State>

Enables/disables the instrument for the R&S SGMA-GUI. The main panel of this software displays only activated instruments.

Parameters:

<State> List of BOOL-values

<StateInstr#1>,<StateInstr#2>,...
0, 1, ON, OFF

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Available Instruments" on page 50

:INSTruments:COUNt?

Queries the number of the currently available instruments.

Return values:

<Count> float

Range: 0 to 12

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Usage: Query only

Manual operation: See "Available Instruments" on page 50

:INSTruments:EACCess[:STATe] <State>

"Locks" the instruments, meaning the instrument is reserved and can be operated exclusively from the remote PC that sent this SCPI command.

Tip: It is recommended to lock the instrument prior to further configuration.

Parameters:

<State> List of BOOL-values

<LockInstr#1>,<LockInstr#2>,...
0,1,OFF,ON

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Exclusive Access" on page 53

:INSTruments:MAPPing:FILE <File>

Saves the list of the available instruments in a mapping file. Mapping files are stored with the predefined file extension `.map`; the file extension may be omitted.

The file is saved in the default directory. Use the command `MMEM:CDIRectory` to change the default directory or specify the complete path.

Parameters:

<File> string

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Export" on page 51

:INSTruments:NAME <Name>

Selects the alias name of the instruments, i.e. sets the "Symbolic Name".

Parameters:
<Name> <SymbolicNameInstr#1>,<SymbolicNameInstr#2>,...

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Available Instruments" on page 50

:INSTruments:REMote:CHANnel <Channel>

Sets the hardware interface used by the remote channel.

Parameters:
<Channel> List of CHAR-Data

<ChannelInstr#1>,<ChannelInstr#2>,...
The available interfaces are: `LAN`, `USB`, `SOCKET`, `PCIe`, `GPIB`, `HiSLIP`

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Hardware Channel" on page 53

:INSTruments:REMote:NAME <Name>

Enters the IP Address or the host name of the connected instrument.

Parameters:
<Name> <Hostname/IP-AddressInsr#1>,<Hostname/IP-AddressInsr#2>,...

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Instrument Name / IP Address" on page 53

:INSTruments:GPIB:ADDRess <Serial>

Sets the GPIB Address of the connected instrument.

Parameters:
<Serial> List of Numbers

Manual operation: See "GPIB Address" on page 53

:INSTruments:GPIB:BOARd <Board>

Identifies the GPIB bus card the controller uses.

Parameters:
<Board> List of Numbers

Manual operation: See "Board Number" on page 54

:INSTruments:SCAN <State>

Triggers a scan function and searches for instruments connected to the remote computer via all of the available interfaces.

Parameters:

<State> number

1 = triggers the scan function, 0 = aborts the running scan process
The query command returns 1 as long as scan is running; 0 indicates completed scan process.

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Scan" on page 50

:INSTruments:SCAN:HNPRefix <Prefix>

Sets the prefix the searched host names begin with.

Parameters:

<Prefix> string

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Scan LAN instruments with host name prefix" on page 51

:INSTruments:SERial <Serial>

Enters the serial number as instrument's identification while using the USB interface for remote control.

Parameters:

<Serial> <SerialNumberInstr#1>, <SerialNumberInstr#2>,...

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Serial Number" on page 54

:INSTruments:TYPE <Type>

Selects the instrument's family.

Parameters:

<Type> List of CHAR-Data

<TypeInstr#1>,<TypeInstr#2>,...

Example: See Chapter 6.6.1, "Configuring Instruments in the R&S SGMA-GUI", on page 68.

Manual operation: See "Available Instruments" on page 50

6.6.3 List of R&S SGMA-GUI Commands

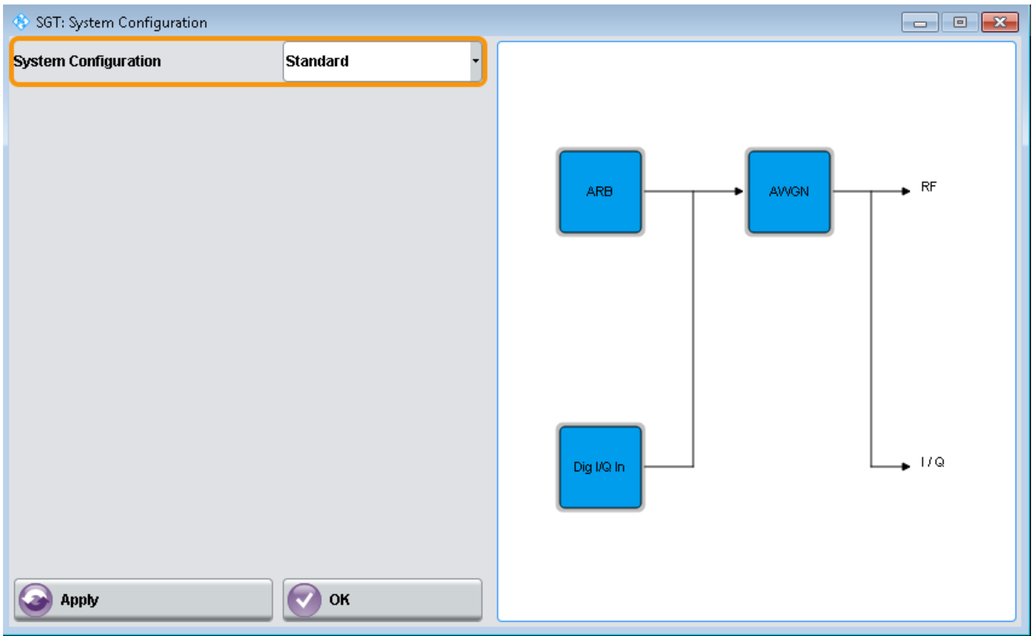
7 Signal Generator Settings

This section summarizes the settings necessary to configure the instrument for signal generation. The description in this section follows the menu tree structure of the graphical user interface.

7.1 Baseband

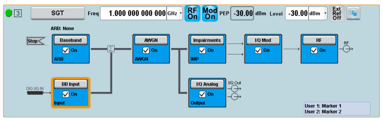
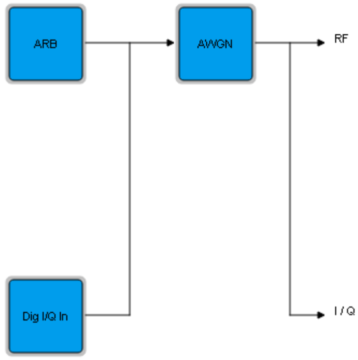
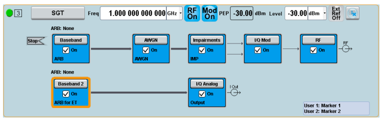
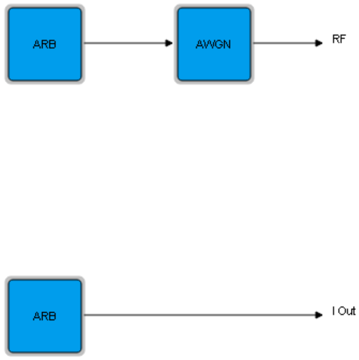
7.1.1 System Configuration

► To access the "System Configuration" dialog, select "SGMA-GUI > Instrument Name > Baseband >System Configuration".



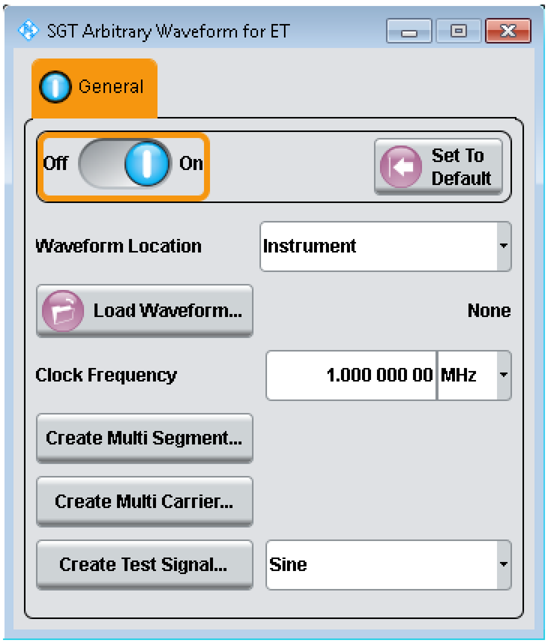
In the "System Configuration" dialog, you can select the signal settings. Depending on the selected settings the signal flow block diagram may look different, see Table 7-1.

Table 7-1: System configuration modes

<table>
<tr><td>"Standard"</td><td></td><td>
</td></tr>
<tr><td>"ARB for Envelope Tracking"</td><td></td><td>
</td></tr>
</table>

When the "ARB for Envelope Tracking" mode is selected, a second ARB for the envelope tracking is generated, which is output at the analog I/Q output. The ARB of the first "Baseband" is then output at the RF output.

You can configure the envelope tracking signal in the "Arbitrary Waveform for ET" dialog. To access this dialog, click on the "Baseband 2 " block or select "SGMA-GUI > Instrument Name > Baseband > ARB for Envelope Tracking". For a description of the settings, see Chapter 7.1.2, "ARB", on page 77.



The ARB waveform for the envelope tracking ("Baseband 2") uses the same trigger, marker and clock settings as the first ARB waveform ("Baseband").

For more information on the envelope tracking, see Chapter 7.5, "Generation of Envelope Tracking Signals", on page 146.

System Configuration
Selects the signal flow settings.

"Standard" Selects the standard mode for the signal generator.

"ARB for Envelope Tracking"
When this mode is enabled, a second ARB signal is generated, which is output at the analog output connectors. This ARB can be only used for envelope tracking.

Remote command:
`:SCONfiguration:MODE` on page 328

Apply
Triggers the instrument to adopt the selected configuration.

OK
Applies the configuration and exits the dialog.

7.1.2 ARB

The Arbitrary Waveform Generator (ARB) is an I/Q modulation source forming an integral part of the R&S SGT. The ARB allows the playback and output of any externally calculated modulation signals in the form of waveform files and the generation of multicarrier or multi-segment signals from waveform files.

The ARB generator requires option R&S SGT-K510.

7.1.2.1 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 and multi-segment wave functions, refer to:

- Chapter 7.1.2.4, "Multi-Carrier Waveforms", on page 93
- Chapter 7.1.2.3, "Multi-Segment Waveforms", on page 83

Waveform Files Sources

In ARB mode, the R&S SGT uses ARB waveform files to obtain the digital I/Q data of the baseband signal. The R&S SGT can replay any waveform file stored on its solid-state drive (SSD) 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 SGT, the instrument inserts a tagged waveform header at the beginning of each created ARB file. For more information, refer to Chapter 12, "Waveform and List Format", on page 502.

Depending on whether the R&S SGT 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.
- Externally generated waveforms
  The ARB can also process externally generated waveform files. For example: the waveform files generated on a PC by the Windows software package R&S WinIQSIM2, the software R&S ARB Toolbox, the R&S Pulse Sequencer software or signals calculated using a mathematical program such as Matlab.
  Generation of waveform files and their transfer from R&S WinIQSIM2 or R&S Pulse Sequencer to the R&S SGT is menu-guided.
  For more information, see the R&S WinIQSIM2 user manual and the R&S Pulse Sequencer user manual.
  The externally generated waveform files can be loaded into the instrument via one of the available interfaces (USB, LAN or PCIe). For a detailed description, see Chapter 9.5, "How to Load and Play Waveform Files", on page 269.

Types of required software options

Two types of software options are relevant in this context:

- **R&S SGT-K2xx/-K4xx:**
  These options are required to process a waveform file generated with R&S WinIQ-SIM2.
  Multi-segment waveform files require the options for *all* included digital standards.

For some of the R&S SGT-K2xx/-K4xx options, Rohde & Schwarz provides also a library containing some already generated waveform files.

- **R&S SGT-KVxx:**
  Additional waveform libraries are offered as R&S SGT-KVxx options. Such an option allows you to process all waveform files included in the library.

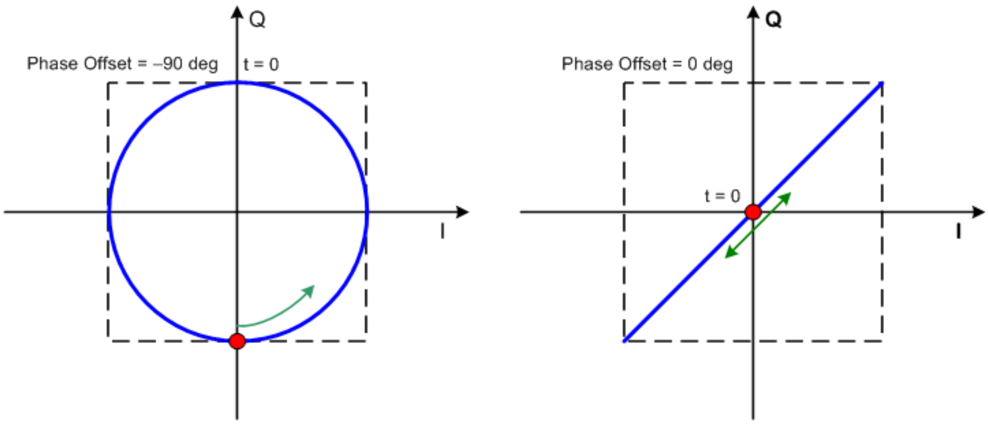
For more information also on the required options, see the product page at http://www.rohde-schwarz.com/product/SGT100A.html.

See also the Application Note 1MA28, “IQWizard - I/Q Signal Measurement and Conversion".

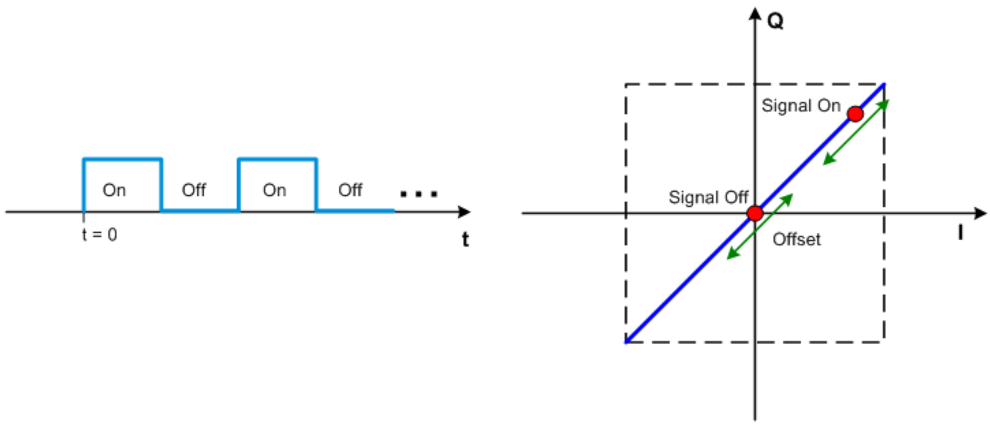
ARB Test Signals

The following test signals are available:

- **Sine test signal:** Two sine wave 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, determine 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)).

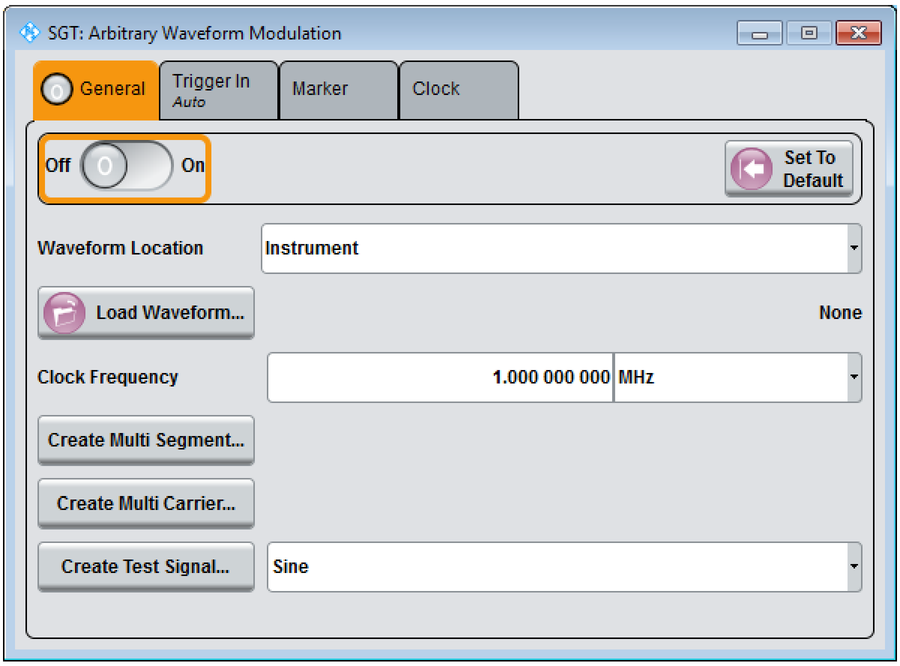
  In general, the I/Q samples are located on a deformed circle which is confined to the dashed square in the upper diagrams.
- **Rectangular test signal:** Rectangle signal with selectable but equal On and Off periods and amplitude. The period is defined by the selected frequency: <Period> = 1 / "Frequency".
  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).



- **Constant 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.

7.1.2.2 General Settings

The "Arbitraty Waveform Modulation" menu provides settings for enabling the ARB and calling further dialogs for selecting and configuring a waveform.



State
Enables/disables ARB modulation.

The output is based on the waveform file that is loaded. The name of the waveform file is displayed next to "Load Waveform".

If a multi-segment waveform is loaded, the section "Multi Segment Waveform Options" is indicated. In this section, the segment to be output is selected.

If no waveform file is loaded, ARB modulation cannot be powered up. "None" is displayed next to "Load Waveform". An error message asks the user to load a waveform file:

"No waveform file loaded. ARB MOD state remains off. Please select a waveform file to load, before switching ARB MOD state on."

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:STATe` on page 352

Set To Default
Calls default settings. The values are shown in Table 7-2.

Table 7-2: 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 352

Waveform Location
Selects the location of the waveform that you want to load.

"Instrument" The waveform file is located on the instrument's internal memory.

"Local file system"
The waveform file is located on the local computer. In this case, the waveform is first automatically copied on the instrument's internal memory and then selected.

Note: To load a waveform from a USB memory stick (or external hard disk) plug the stick into the controller PC, select "Waveform Location > Local file system" and in the "Load Waveform" >"File Select" dialog navigate to the external drive.

Load Waveform
Calls the "File Select" menu for loading the waveform file.

The files last used are listed in the "Recent Data Sets" section. The directory can be selected from the center left section. All waveform files (file extension `*.wv`) available from the selected directory are listed on the right side. The file info (tag contents and multi-segment state) for the selected file is displayed below the file section.

The "Select..." button selects the marked file. This file is loaded when the ARB modulation is enabled ("State On").

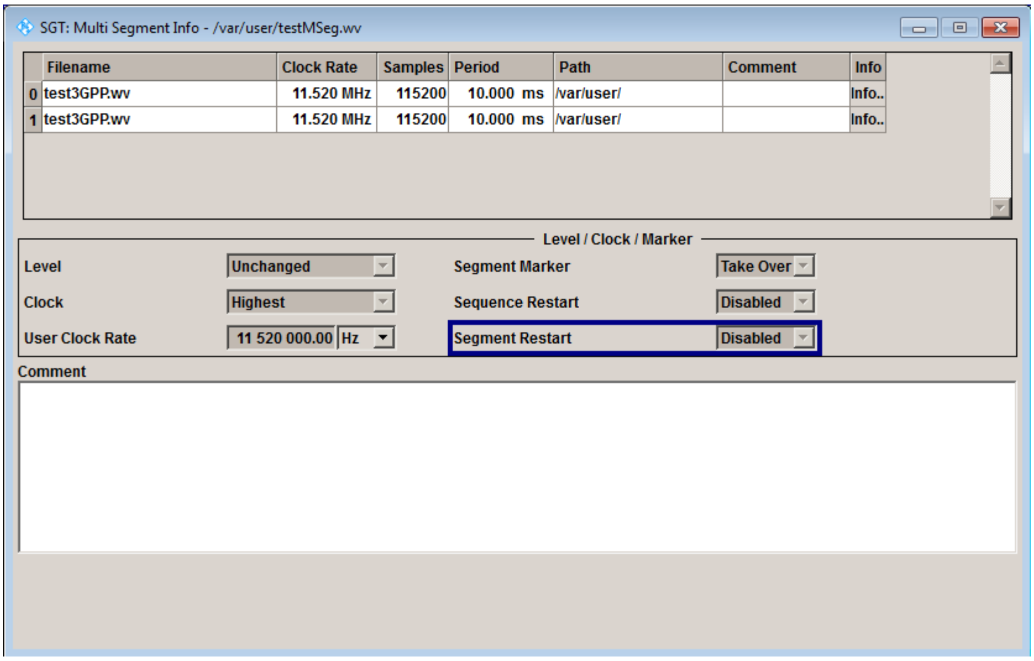
For a description on how to manage the waveform files, refer to Chapter 5.2, "Managing Files on the R&S SGT", on page 46.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect` on page 389

Waveform Info

Opens a dialog with detailed information about the currently selected waveform.

The waveform information displayed in this dialog depends on whether the selected waveform file is a multi-segment one or not. All parameters are read-only.



For non-multi segment waveform files, the values of the settings can be queried by means of the Tag commands (see Chapter 12, "Waveform and List Format", on page 502).

Remote command:
n.a.

Clock Frequency

Displays or enters the ARB output clock rate.

When the waveform file is loaded, this value is automatically set to the clock rate defined in the file (Clock tag). The user can subsequently alter the value if necessary.

When intending to work with an external clock source, the frequency to be applied must be entered here.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:CLOCk on page 353

Multi Segment
Calls the menu for calculating multi-segment waveforms (seeChapter 7.1.2.3, "Multi-Segment Waveforms", on page 83).

Remote command:
n.a.

Multi Carrier
Calls the dialog for calculating multi-carrier waveforms (see Chapter 7.1.2.4, "Multi-Carrier Waveforms", on page 93).

Remote command:
n.a.

Create Test Signal...
Selects the form of the test signal and calls the menu for generating it. A sinusoidal, rectangular or test signal with constant I/Q can be selected.

See the corresponding section for detailed description of the parameters for the selected test signal:
- Chapter 7.1.2.5, "Sine Test Signal", on page 106
- Chapter 7.1.2.6, "Rect Test Signal", on page 107
- Chapter 7.1.2.7, "Const I/Q Test Signal", on page 108

Remote command:
n.a.

7.1.2.3 Multi-Segment Waveforms

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 SGT provides the functionality to generate multi-segment wave-form files.

This section introduces the concept of the multi-segment waveform files, together with description of the provided settings and some typical configuration examples.

Introduction

A multi-segment waveform is a composed signal containing multiple independent waveforms called segments. Each segment represents a independent waveform that can be output with its own marker and clock settings.

The Figure 7-1 shows the principle of building a multi-segment waveform.

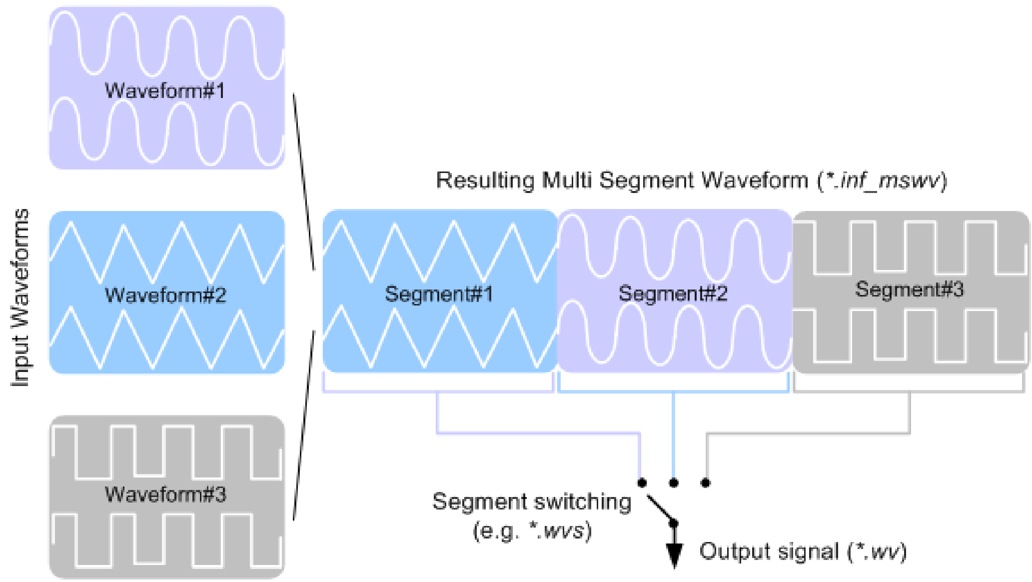


Figure 7-1: ARB multi-segment waveform concept

It is also possible to create and output a blank segment, i.e. segments containing a zero signal.

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, and the segment intended to be output at any given moment.

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 SGT 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 filename. 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 SGT 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.

Multi Segment Waveform Settings

To access the "Multi Segment" dialog, select "SGMA-GUI > Instrument Name > Baseband > ARB > Multi Segment...".

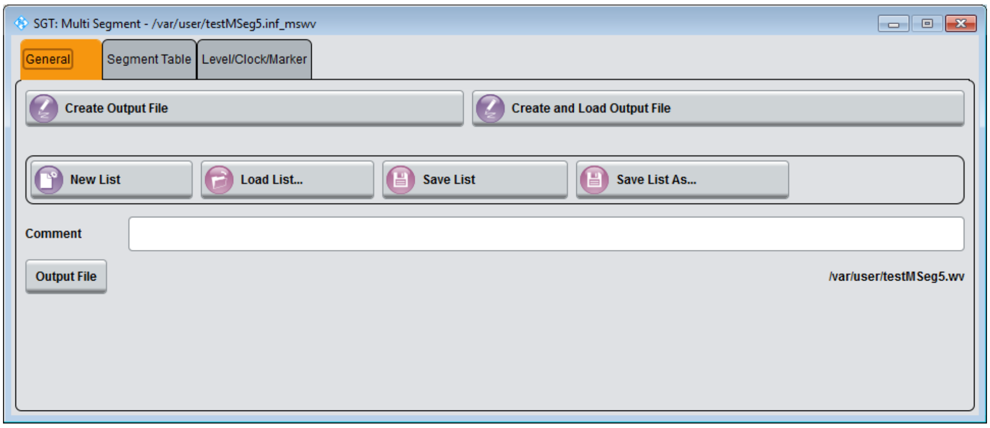
Example

How to create multi segment waveform file

1. Select "New List" to create an empty list.
2. Use the "Append" function to add two or more waveform files.
3. Adjust the "Level", "Clock" and "Segment Marker" settings.
4. Select the "Output File" and enter a filename.
5. Select "Save List" to save the configuration.
6. Select "Create" or "Create and Load" to create and save the multi segment waveform.

General Settings

► To access this dialog, select "SGMA-GUI > Instrument Name > Baseband > ARB > Multi Segment.. > General".



This dialog comprises the settings for managing files and lists as well as the possibility to add a comment.

New List
Calls the "Create Multi Segment Waveform List" dialog to enter the name of the new file.

A new configuration table is created.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect on page 396

Load List
Opens the file menu to select the configuration file to be edited.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog? on page 392
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect on page 396

Save List

Saves the current entries of the table in a configuration file, including the level mode, clock mode, segment marker mode and output filename settings.

The filename is entered in the "File" menu. Configuration files have the file extension `*.inf_mswv`. They can be used later as the basis for further multi segment waveforms.

Before a multi segment configuration file can be saved, a filename must be entered in "Output File", since this is saved with the configuration file for internal purposes.

Remote command:
The configuration file to be used for the creation of the multi segment waveform is defined with the command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate`
The filename of the waveform file is always determined with the command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe`

Create

Creates a new multi segment waveform using the current table entries.

This multi segment waveform is saved with the filename specified in "Output File". As with normal waveforms, the file extension is "*.wv".

Depending on the configuration of the multi segment waveform, calculation may take some time. A panel with a progress bar and an "Abort" button appears during creating of the multi segment waveform.

In remote control the configuration file to be used for the creation of the multi segment waveform is defined with the command: `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate` or `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad`.

The filename of the waveform file is always determined with the command `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe`

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate` on page 397

Create and Load

Creates a new multi segment waveform using the current table entries.

This multi segment waveform is saved with the filename specified in "Output File". As with normal waveforms, the file extension is `*.wv`.

Depending on the configuration of the multi segment waveform, calculation may take some time.

Following this the "Create Multi Segment Waveform File" submenu is closed and the new multi segment waveform is loaded.

In remote control the configuration file to be used for the creation of the multi segment waveform is defined with the command: `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate` or `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad`.

The filename of the waveform file is always determined with the command `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe`

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad` on page 390

Comment

Adds a comment to the multi segment file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent on page 393

Output file

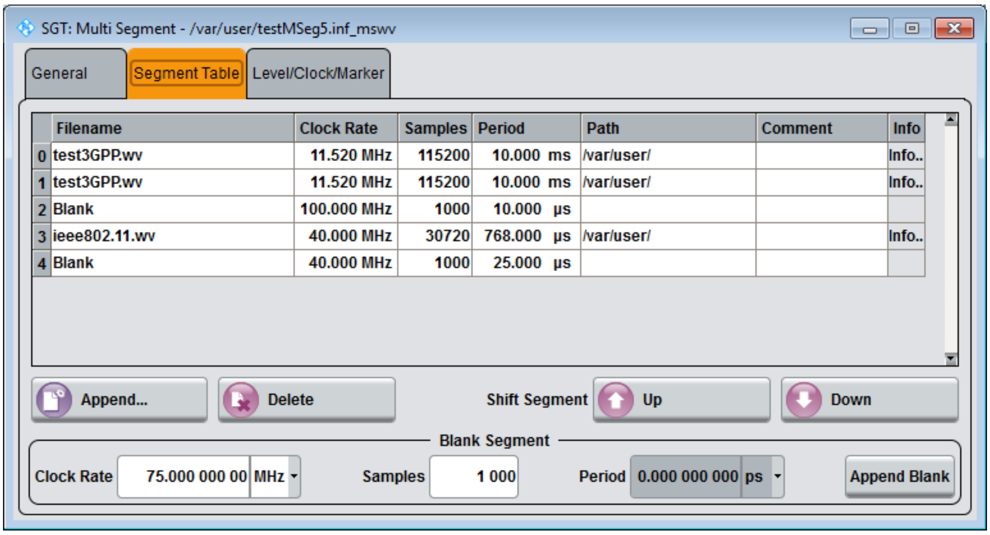
Opens the File menu, where the filename of the multi segment waveform which has to be calculated can be entered. The multi segment waveform is saved under this name by clicking the "Create" or "Create and Load" button.

A name must also be entered here before the list can be saved as a configuration file ("Save List"). In this case, the name is needed for internal storage procedures. It is entered as the default name for the multi segment waveform file when loading the list.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe on page 395

Segment Table

► To access this dialog, select "SGMA-GUI > Instrument Name > Baseband > ARB > Multi Segment.. > Segment Table".



This dialog comprises the settings for creating and adjusting the contents of the multi segment file.

Multi Segment Table

The table lists the individual waveforms (segments) of the selected multi segment waveform. The information about the segments is taken from the tags of the corresponding waveform files.

"Segment#"	Indication of segment index. The segment index is used to select the segment to be output. The segment index also defines the sequence of the output during triggering in the "Next Segment" or "Next Segment Seamless".
"Filename"	Indication of the waveform filename of the segment.

"Clock Rate"	Indication of the clock rate of the segment.
"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 comment on the segment.
"Info"	Opens a dialog with detailed information about the currently selected waveform.

Remote command:
n.a.

Append
Opens the file menu to enter the filename of the waveform file to be appended.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?`
on page 396
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend`
on page 396

Delete
Deletes the selected segment.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete` on page 393

Shift Seg.# Up/Down
Shifts the selected segment up and down.

Clock Rate
Selects the clock rate of the blank segment.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend`
on page 391

Samples
Selects the number of samples for the blank segment.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend`
on page 391

Period
Displays the resulting period for the blank segment.

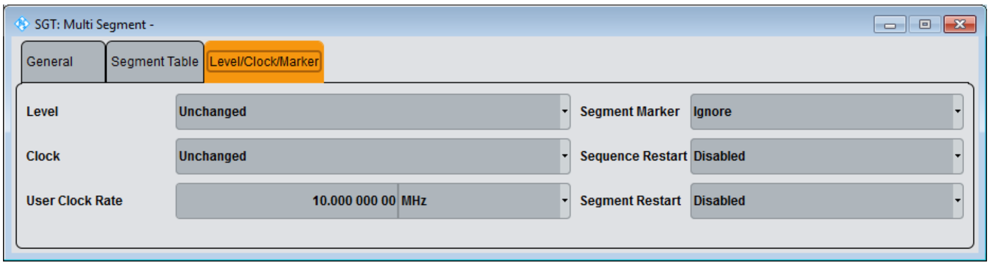
Remote command:
n.a.

Append Blank
Adds the blank segment to the multi segment file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:BLANk:APPend
on page 391

Level / Clock /Marker

► To access this dialog, select "SGMA-GUI > Instrument Name > Baseband > ARB > Multi Segment.. > Segment Table".



The Level/Marker/Clock section provides the parameters necessary to adjust the level, marker and clock settings for the selected multi segment waveform file.

Level
Defines the level mode for the multi segment waveform.

"Unchanged" Concerning the level settings, the segments are output exactly as defined in the files. The "Level" display applies only to the segment with the highest rms value. In some circumstances, the remaining segments are output at a lower level than that displayed.

"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 393

Clock
Selects the clock rate mode for the multi segment waveform.

"Unchanged" A segment is output with the clock rate defined in the file.
If segments have different clock rates, extended trigger mode "Next Segment" allows internal segment switchovers only ("Internal" trigger source).
Extended trigger mode "Next Segment Seamless" can only be selected if all segments have the same clock rate.

"Highest" All segments are output at the highest available clock rate.
This mode provides very short switchover times between segments.
The time for calculating the multi segment waveform is increased since the individual segments have to be resampled.

"User" All segments are output at the clock rate defined in "User Clock". This mode provides very short switchover times between segments. The time for calculating the multi segment waveform is increased since the individual segments have to be resampled.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE`
on page 392

User Clock Rate

Defines the sample rate used for multi segment waveform output in case of Clock Mode "User".

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk` on page 392

Segment Marker

Defines the way the marker information within the separate segments is processed.

"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 395

Sequence Restart

Enables/disables the generation of an additional marker restart signal in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered.

"Disable" No additional marker is generated.

"Marker 1/2/3/4" Generates a restart marker signal at the beginning of the first segment for the corresponding marker.
Use this setting to generate a restart marker for the complete sequence.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment`
on page 394

Segment Restart

Enables/disables the generation of an additional marker restart signal in the output waveform file.

If additional marker generation is enabled, the existing marker signals in the individual segment waveform files are not considered.

"Disable" No additional marker is generated.

"Marker 1/2/3/4" Generates a restart marker signal at the beginning of each segment for the corresponding marker.
The segment begin is defined by the low-high slope of the marker.
This applies for switching between two segments as well as in case of segment replay.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment
on page 394

Multi Segment Waveform Sequencing

The settings provided in the "Multi Segment Waveform Sequencing" dialog can be adjusted to crate a “play list”, i.e. to define the sequence in which the waveform file segments are processed and how many times each of them is repeated. The configured play list is displayed in form of a "Sequencing Graphic".

All segments in a “play list” must have the same clock rate.

In the "ARB" main dialog or in the "ARB Trigger/Marker/Clock" dialog, set the "Next Segment Mode" to "Sequencer" to activate the configured “play list”.

Sequencing List

Displays the name of the selected sequencing list file, i.e. the file with the “play list” settings.

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. More than one sequencing list files can be created per multi segment waveform file.

The sequencing list file carries information only about the segment number, the corresponding wavefile names are retrieved form the assigned multi segment waveform file, i.e. the same sequencing list file can be reused for different multi segment waveform files with the same number of segments.

Changes and re-calculations of a multi segment waveform file cause a re-check whether the assigned sequencing list files are still valid. A message is displayed to inform about necessary corrections in the “play list”.

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

The "Sequencing Play List" table is used to define the sequence in which the waveform file segments are processed and how many times each of them is repeated.

Id# ← Sequencing Play List
Indication of the row number.

n.a.

State ← Sequencing Play List
Enables/disables the selected row. Only active segments are processed.

n.a.

Segment# ← Sequencing Play List
Indication of segment index.

The sequencing list file carries information only about the segment index, the corresponding wavefile names are retrieved form the assigned multi segment waveform file.

n.a.

Waveform ← Sequencing Play List
Indication of the waveform filename of the segment. The filename is retrieved form the assigned multi segment waveform file.

Available for selection are only waveform files from the pool of segments of the selected multi segment waveform file.

n.a.

Repetition Cycles ← Sequencing Play List
Sets the number of times the selected segment is cyclically repeated before the next segment in the sequence is processed.

n.a.

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 re-played 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.

Remote command:
n.a.

Info ← Sequencing Play List
Opens a dialog with detailed information about the currently selected waveform.

Remote command:
n.a.

Append
Inserts a new row at the end of the sequencing play list table.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect on page 400
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:APPend on page 399

Delete
Deletes the selected row.

Remote command:
n.a.

Shift Id# Up/Down
Shifts the selected row up and down.

Remote command:
n.a.

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.

Remote command:
n.a.

New Sequencing List
Opens the "Select Sequencing List" dialog to enter the name of the new file.

Remote command:
n.a.

Load Sequencing List
Opens the "Select Sequencing List" dialog to select an existing play list file.

Remote command:
n.a.

Save Sequencing List
Saves the current entries of the table in a play list file.

The default filename of the play list file is the same as the multi segment waveform filename, but it can be changed.

Play list files have the file extension `*.wvs`.

Remote command:
n.a.

7.1.2.4 Multi-Carrier Waveforms

Multi-carrier waveforms consisting of up to 512 carriers modulated by user-selectable baseband signals can be created to simulate complex multi-carrier scenarios with different baseband signals (e.g. CDMA2000 or 3GPP FDD).

The carriers are centered toward the RF frequency or baseband DC line, respectively. The carrier spacing is adjustable within the total available baseband bandwidth. Each carrier can be separately defined in terms of power, phase and modulated input signal. Optionally, crest factor optimization can be applied.

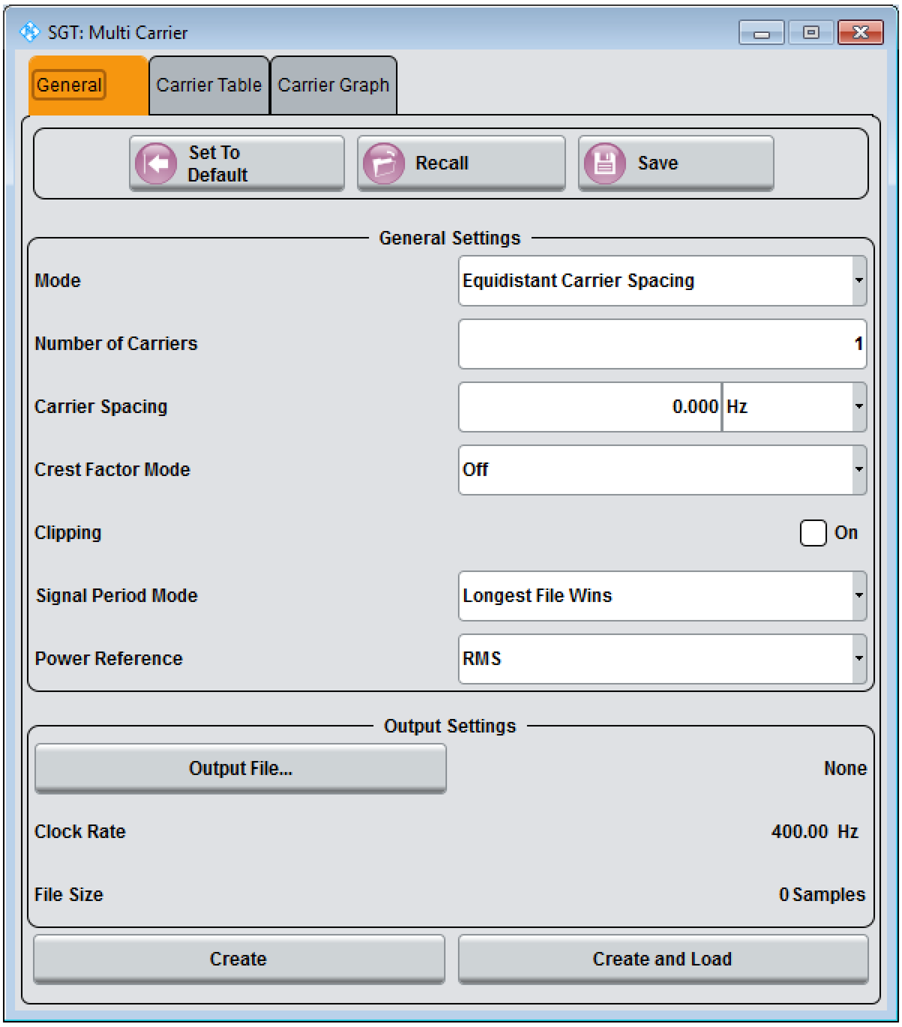
Thus, multi-carrier waveforms can be easily configured as broadband test signals and used for such purposes as transmitter or receiver tests. Even complex multi-carrier scenarios composed of signals from different digital standards can be created and used for these tests.

Example for the creation of a multi-carrier waveform file

1. Configure general settings.
2. Configure carrier table.
3. Enter filename of the multi-carrier waveform ("Output File").
4. Save and load the multi-carrier waveform ("Create" or "Create and Load").

User interface

To access the "Multi Carrier" dialog, select "Baseband > ARB > Multi Carrier...".



The menu can be used to create a multi-carrier waveform and save it under its own name. As with normal waveforms, the file extension is `*.wv`. Information on clock rate, number of samples and creation day is displayed in the File menu when a waveform is loaded.

Default Settings and State

The upper part of the "General"dialog is used for calling the default settings and saving and recalling existing ARB multi carrier submenu settings.

Set to Default

Calls default settings. The values are shown in the following table.

Parameter	Value
Number of Carriers	1
Carrier Spacing	0 MHz
Crest Factor Mode	Off
Signal Period Mode	Longest file wins

[:SOURce<hw>]

"Arbitrary Carrier Frequency"
Enables you to specify the carrier frequency in the carrier table. Carrier spacing is not relevant.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE on page 370

Number of Carriers
Sets the number of carriers for the multi carrier waveform.

By default the multi carrier table lists 1 carrier. 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 carrier already have been defined before, the settings are preset according to the former settings. Otherwise the parameters are preset with the default values.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt on page 370

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).

The total baseband bandwidth is 160 MHz.

Note: In order to avoid wrap-around problems, the effective "Carrier Spacing" might be slightly modified.
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:
  RoundedCarrierSpacing=1/OutputSignalDuration* round(CarrierSpacing * OutputSignalDuration)
- For even number of carriers:
  RoundedCarrierSpacing=2/OutputSignalDuration*round(0.5 *CarrierSpacing * OutputSignalDuration)

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing on page 370

Crest Factor Mode
Selects the mode for optimizing the crest factor by calculating the carrier phases.

The crest factor represents the ratio of the peak voltage value to the rms voltage value. The higher the crest factor and resulting dynamics of a signal, the greater the requirement for a power amplifier fed by the signal to be linear.

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 373

Clipping
Switches baseband clipping on and off.

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 the sum of the RMS level of the unclipped multi carrier signal and the input parameter "Target Crest Factor". Note that clipping reduces also the RMS level. Hence the resulting crest factor of the clipped signal is slightly above the "Target Crest Factor". In order to get the unclipped parts of the clipped multicarrier signal matched with the unclipped multicarrier signal, the RF output power should be reduced by the difference between resulting crest factor and "Target Crest Factor".

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] on page 375

Target Crest Factor
Available only for "Clipping > On".

Sets the value of the desired crest factor.

A "Target Crest Factor" above the crest factor of the unclipped multicarrier signal has no effect.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor on page 374

Filter Cut Off Frequency
Available only for "Clipping > On"

Sets the cut off frequency 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 multicarrier signal, but may also increase the resulting crest factor.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff on page 374

Signal Period Mode
Selects the mode for calculating the resulting signal period of the multi carrier waveform. The carrier table provides an information button to obtain sample rate and file length data of each carrier.

The resulting period is always calculated for all carriers in the carrier table irrespective of their state (On/Off).

Note: Wrap-around and timing problems may occur when I/Q signals of different length are used. Thus, demodulation of a carrier may be difficult or even impossible. It is therefore recommended to consider the timing already when creating the input I/Q files or to adjust the signal duration to the carrier which is subsequently 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 can be set by the user in the "Signal Period" field. 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 383

Signal Period

Available only for "Signal Period Mode > User"

Sets the signal period. 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 383

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.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:POWer:REFerence on page 373

Carrier Table

Calls the table for configuring individual carriers. A selectable carrier range can be set with the aid of the optional "Carrier Table Assistant" (see "Carrier Table Assistant" on page 102).

The multi carrier configuration can be checked with the aid of the "Carrier Graph".

Output Settings

The "Output Settings" section in the multi carrier dialog indicates the name, the size and the clock rate of the currently calculated multi carrier output file.

Output File

Opens the "File" dialog, where the output filename of the multi carrier waveform which has to be calculated can be entered.

The multi carrier waveform is calculated and saved under this name by clicking the "Create" or "Create and Load" button.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe on page 380

Clock Rate

Displays 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.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk? on page 376

File Size

Displays the resulting number of samples of the multi carrier waveform.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles? on page 381

Create

Creates a new multi carrier waveform defined by the multi carrier table and general setting entries.

This multi carrier waveform is saved with the filename specified in "Output File". If no filename is specified, the "File Manager" opens so that the filename can be entered. As with normal waveforms, the file extension is `*.wv`.

Depending on the configuration of the multi carrier waveform, calculation may take some time. A panel with a progress bar and an "Abort" button appears during the calculation process.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate` on page 376

Create and Load
Creates a new multi carrier waveform defined by the multi carrier table and general setting entries and loads it subsequently in the "ARB" main menu.

This multi carrier waveform is saved with the filename specified in "Output File". If no filename is specified, the "File Manager" opens so that the filename can be entered. As with normal waveforms, the file extension is `*.wv`.

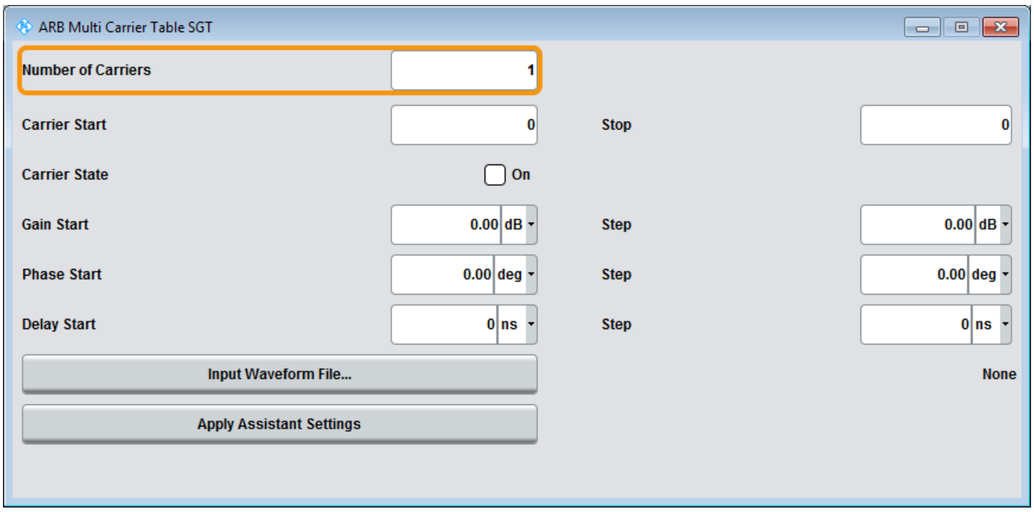
Depending on the configuration of the multi carrier waveform, calculation may take some time. A panel with a progress bar and an "Abort" button appears during the calculation process.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad` on page 375

Multi Carrier Table

The "Multi Carrier Table" dialog is opened by means of the "Carrier Table" button in the middle part of the Multi Carrier Waveforms menu. The carrier settings can be checked in the graphical "Carrier Graph" subdialog.

The "Carrier Table Assistant" section can be used to set a selectable carrier range. This section serves as a optional mean to quickly set up a multi carrier scenario within a specified carrier range.



Carrier Table Assistant

Number of Carriers
Sets the number of carriers for the multi carrier waveform.

By default the multi carrier table lists 1 carrier. 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 carrier already have been defined before, the settings are preset according to the former settings. Otherwise the parameters are preset with the default values.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:COUNt` on page 370

Carrier Start
Defines the start 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 380

Carrier Stop
Defines the stop index of the carrier range to which the assistant settings are intended to apply.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP` on page 380

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 380

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 379

Gain Step
Sets the step width that is used to increment the gain

The resulting carrier gain in the carrier table equals:

GainStart + n* 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 379

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 379

Phase Step
Sets the step width that is used to increment the phase.

The resulting phase in the carrier table equals:

PhaseStart + n* PhaseStep

where n ranges from 0 to (Carrier Stop – Carrier Start)

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP
on page 379

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 377

Delay Step
Sets the step width that is used to increment the delay.

The resulting delay in the carrier table equals:

DelayStart + n* DelayStep

where n ranges from 0 to (Carrier Stop – Carrier Start).

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP
on page 377

Input Waveform File
Calls the "File" dialog for selecting the inputfile 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 378

Apply Assistant Settings
Transfer the assistant settings to the carrier table.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute
on page 377

Carrier Table
The table displays the settings of all available carriers. Previously applied assistant settings can be further refined. The number of lines corresponds to the number of carriers.

Note: The phase/deg settings are only valid if optimization of the crest factor is disabled ("Crest Factor Mode" = Off).

No ← Carrier Table
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 ← Carrier Table
Switches On/Off a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe` on page 373

Carrier Freq Offs. ← Carrier Table
Sets the carrier frequency offset.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency`
on page 372

Gain ← Carrier Table
Sets the gain of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer` on page 373

Phase ← Carrier Table
Sets the starting phase of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe` on page 372

Delay ← Carrier Table
Sets the starting delay of a carrier.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:DELay` on page 371

File ← Carrier Table
Calls the "File" menu 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 372

Info ← Carrier Table
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.

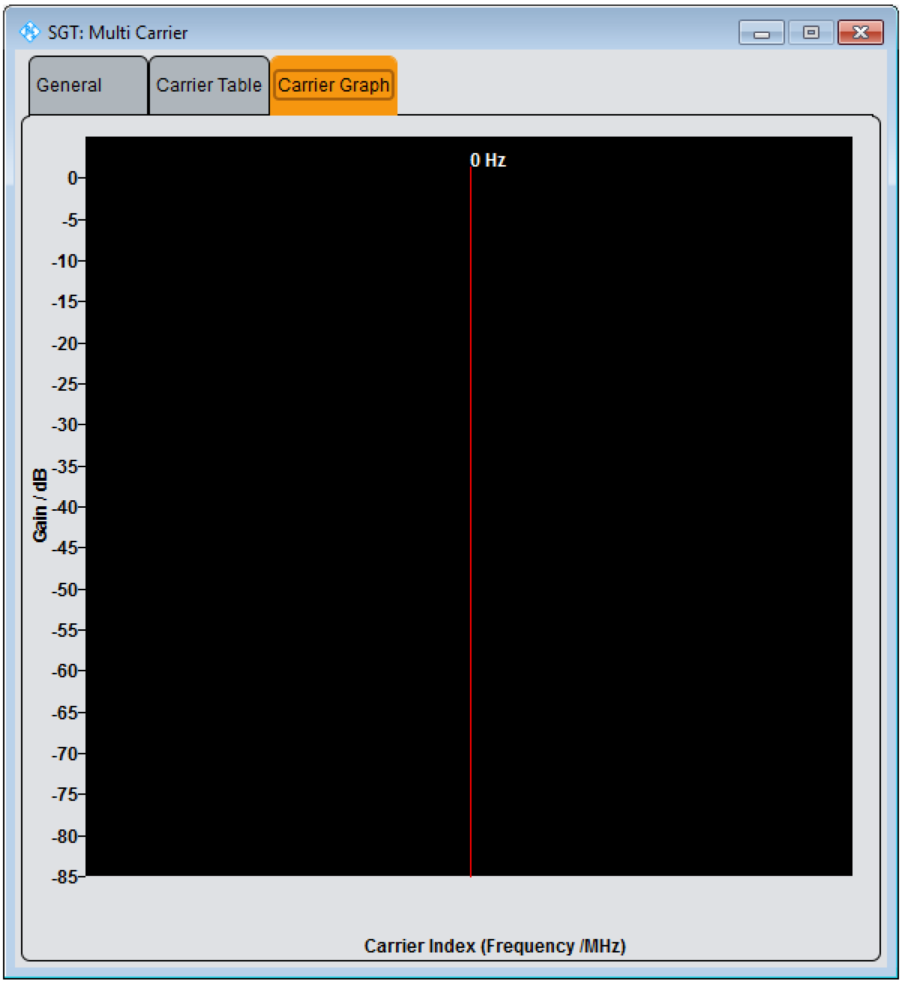
Remote command:
n.a.

!!! ← Carrier Table
Indicates an occurred conflict by means of a red LED. A conflict arises when the carriers overlap.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:CONFlict?
on page 371

Carrier Graph Table

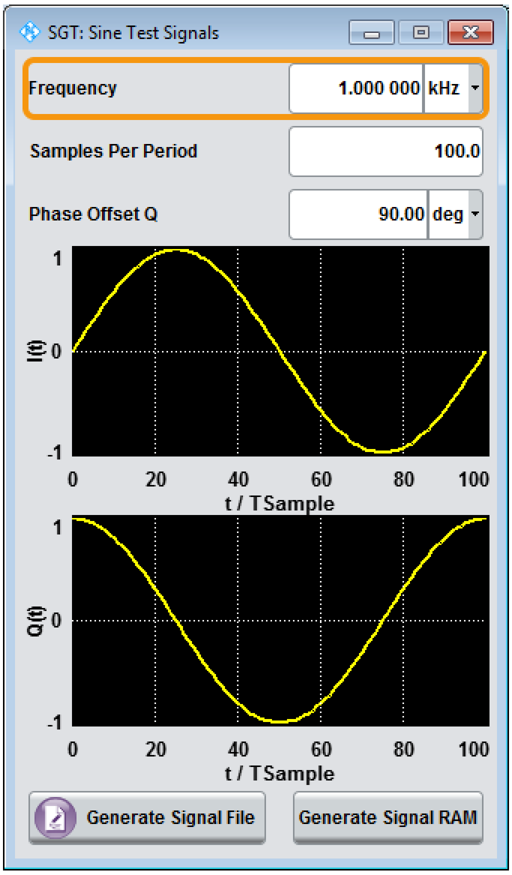
► To access this dialog select "Baseband > ARB > Multi Carrier... > Carrier Graph"



Carrier Graph
Calls a graphical representation of the current multi carrier configuration in the frequency domain.

The height of the bars corresponds to the chosen gain of each individual carrier. The bandwidth of the carriers signals is indicated by the width of the bars.

7.1.2.5 Sine 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.

The dialog displays the characteristic of the currently selected signal.

Frequency

Enters the frequency of the test signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency` on page 368

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 368

Phase Offset Q

Enters the phase offset of the sinewave signal on the Q channel relative to the sinewave signal on the I channel.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:PHASe on page 368

Generate Signal File
Generates a signal and saves it to a file.

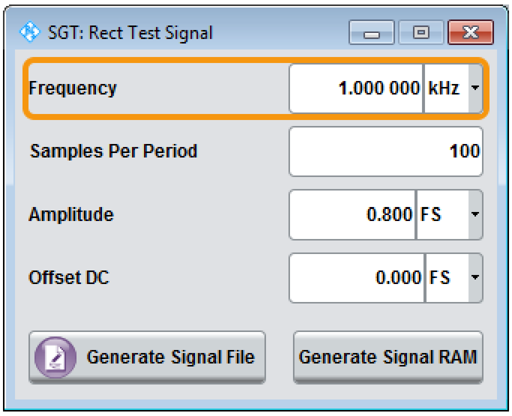
The "File Select" window opens automatically and the signal can be stored as a waveform file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed on page 366

Generate Signal RAM
Generates a signal and uses it as output straight away.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate on page 366

7.1.2.6 Rect 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.

Frequency
Enters the frequency of the test signal.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:FREQuency on page 367

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 367

Amplitude
Enters the digital amplitude of the rectangular wave. The abbreviation FS stands for full scale.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:AMPLitude on page 366

Offset DC
Enters a DC component.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:OFFSet on page 367

Generate Signal File
Generates a signal and saves it to a file.

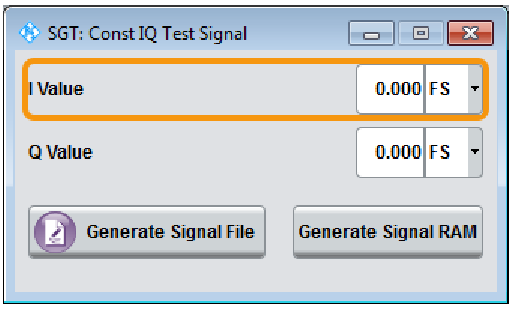
The "File Select" window opens automatically and the signal can be stored as a waveform file.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed on page 366

Generate Signal RAM
Generates a signal and uses it as output straight away.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate on page 366

7.1.2.7 Const I/Q 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.

Converted to analog, the signal is output directly at the I and Q connectors of the instrument.

I Value

Enters the value for the I component of the test signal.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I on page 366

Q Value

Enters the value for the Q component of the test signal.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q on page 366

Generate Signal File

Generates a signal and saves it to a file.

The "File Select" window opens automatically and the signal can be stored as a waveform file.

Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate:NAMed on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate:NAMed on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate:NAMed on page 366

Generate Signal RAM

Generates a signal and uses it as output straight away.

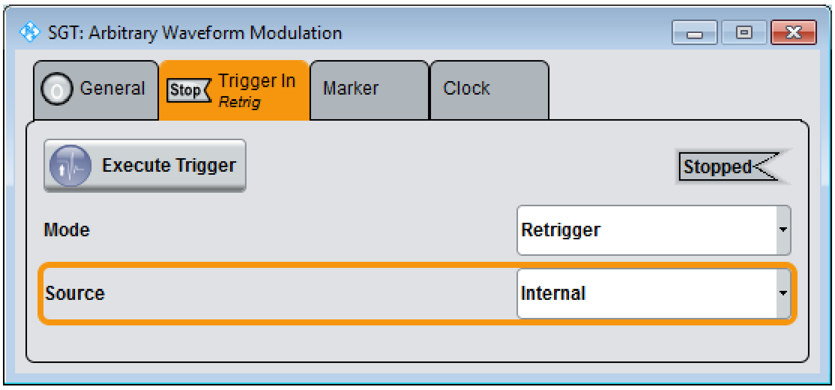
Remote command:

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:CREate on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:RECTangle:CREate on page 366
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:CREate on page 366

7.1.3 Trigger Marker Clock

7.1.3.1 Trigger In

► To access this dialog, select "SGMA-GUI > Instrument Name > Baseband > ARB > Trigger In".



The "Trigger In" section is where the trigger for the signal is set. Various parameters will be provided for the settings, depending on which trigger source - internal or external - is selected. The current status of signal generation ("Running" or "Stopped") is indicated for all trigger modes.

Trigger Mode

Selects trigger mode.

The trigger mode determines the effect of a trigger on the signal generation.

"Auto" The signal is generated continuously.

"Retrigger" The signal is generated continuously. A trigger event (internal or external) causes a restart.

"Armed_Auto" The signal is generated only when a trigger event occurs. Then the signal is generated continuously.

"Armed_Retrigger"
The signal is generated only when a trigger event occurs. Then the signal is generated continuously. Every subsequent trigger event causes a restart.
Button "Arm" stops the signal generation. A subsequent trigger event (internal with "Execute Trigger" or external) causes a restart.

"Single" The signal is generated only when a trigger event occurs. Then the signal is generated once to the length specified at "Signal Duration". Every subsequent trigger event (internal with "Execute Trigger" or external) causes a restart.

Remote command:
[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence on page 361

Signal Duration Unit
Available only for "Trigger Mode > Single".

Defines the unit for the entry of the length of the signal sequence to be output.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit on page 359

Signal Duration
Available only for "Trigger Mode > Single".

Defines the length of the signal sequence to be output. The unit of the entry is defined under "Signal Duration Unit". It is then possible to deliberately output just part of the signal, an exact sequence of the signal, or a defined number of repetitions of the signal.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth on page 358

Running/Stopped
Displays the status of signal generation.

"Running" The waveform is output; a trigger was (internally or externally) initiated in triggered mode.
If "Armed_Auto" or "Armed_Retrigger" have been selected, the generation of signals can be stopped with the "Arm" button. A new trigger (internally with "Execute Trigger" or externally) causes a restart.

"Stopped" The waveform output is stopped. The instrument waits for an internal or external trigger event to restart. ARB modulation is disabled.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe? on page 357

Arm
Available only in the "Running mode" and for "Trigger Mode > Armed_Auto" or "Trigger Mode > Armed_Retrigger".

Stops the waveform output.

Signal output can be restarted by a new trigger (internally with "Execute Trigger" or externally).

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute on page 356

Execute Trigger
Executes the trigger manually. A manual trigger can be executed only when an internal trigger source and a trigger mode other than "Auto" have been selected.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute on page 356

Trigger Source
Selects trigger source.

"Internal" The trigger event is executed by "Execute Trigger".

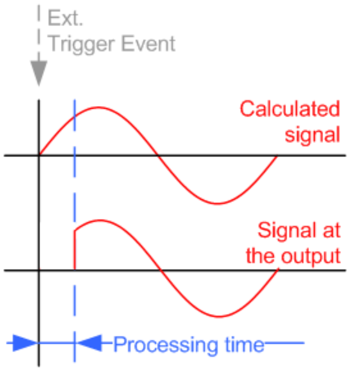
"External" The trigger event is executed with the aid of the active edge of an external trigger signal.
The trigger signal is supplied via the USER 1/2 connector.
The polarity, the trigger threshold and the input impedance of the trigger input can be set in the "Connector" dialog.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce` on page 359

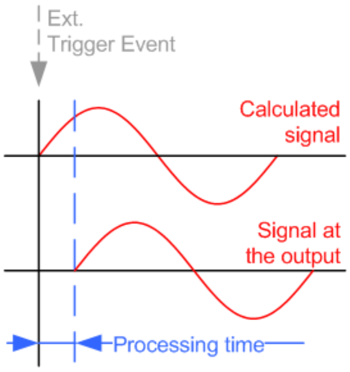
Sync. Output to External Trigger
Available only for "Trigger Source > External".

Enables/disables output of the signal synchronous to the external trigger event.

"On" Corresponds to the default state of this parameter.
The signal calculation starts simultaneously with the external trigger event but because of the instrument's processing time the first samples are cut off and no signal is outputted. After the internal processing time elapses, the output signal is synchronous to the trigger event.



"Off" The signal output begins after the elapsing of the processing time and starts with sample 0, i.e. the complete signal is outputted.
This mode is recommended for triggering of short signal sequences with signal duration comparable to the processing time of the instrument.



Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut`
on page 356

External Delay Unit
Determines whatever the trigger delay is expressed in samples or directly defined as a time period (seconds).

The parameter displays the delay converted in time.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT on page 360

Trigger Delay
Sets the trigger signal delay in samples on external triggering. his enables the R&S SGT to be synchronized with the device under test or other external devices.

The parameter displays the delay converted in time.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:DELay on page 360
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:TDELay on page 360

Actual Trigger Delay
Displays the time (in seconds) an external trigger event is delayed by.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:RDELay? on page 360

Trigger Inhibit
Sets the duration for inhibiting a new trigger event subsequent to triggering. The input is to be expressed in samples.

In the "Retrigger" mode, every trigger signal causes signal generation to restart. This restart is inhibited for the specified number of samples.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:INHibit on page 361

7.1.3.2 Multi Segment Waveform Options

The section "Multi Segment Waveform Options" of the menu is only displayed if a multi segment waveform is loaded.

The section comprises the settings necessary to adjust the trigger for the switch between the segments of a multi segment waveform. The parameters displayed depend on the selected trigger source.

Current Segment
Indication of the waveform segment (segment filename and index) that is currently output.

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment? on page 390
[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME? on page 397

Next Segment
Selects the waveform segment to be output next. It determines the start segment when switching on the ARB and enables switchover to any other segment.

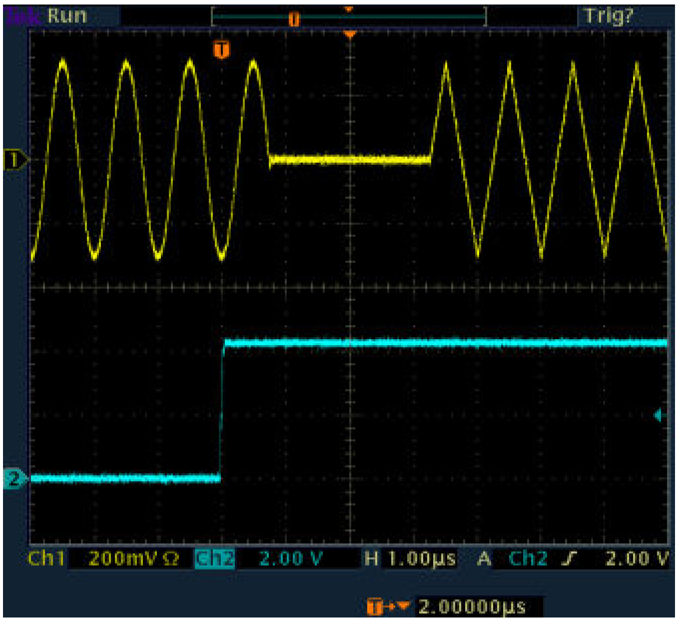
The switchover is performed either after receiving an external next segment trigger event or, for the internal trigger case, by changing the segment index in the "Next Segment" field. The definition whether the new segment is generated immediately or only after the previous segment has been fully generated (wrap around) is determined by the parameter Next Segment Mode.

The segment currently being output (segment index and filename) is displayed at "Current Segment". The subsequent trigger event after the last segment causes the first segment to be output again.

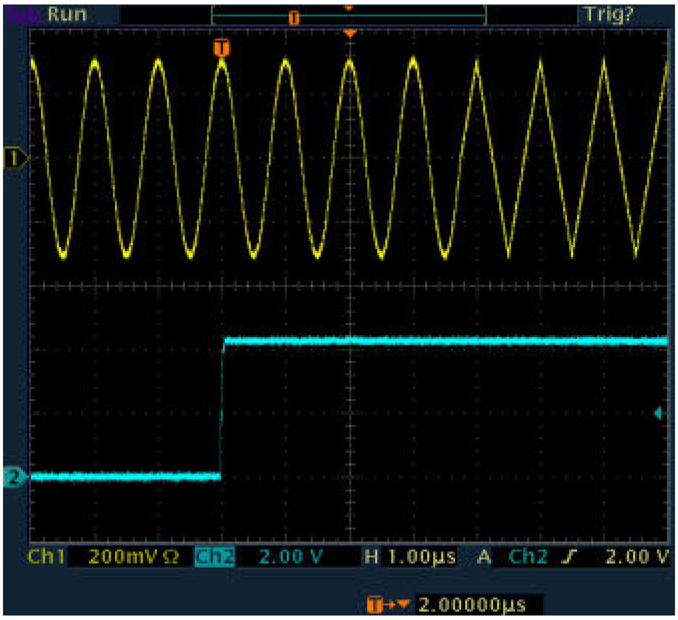
Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT` on page 398

Next Segment Mode
Sets the segmented trigger mode of a multi segment waveform, i.e. defines the way the **switch over between the segments** in a multi segment waveform will be executed:

- In "Same Segment" mode, 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 the upon receiving of a trigger event.
  Switching between the segments is triggered by changing the segment index in the "Next Segment" field.
- When "Next Segment" is selected, the current segment ceases to be output as soon as a trigger event for a new segment occurs, and the new segment starts to be output after a system-imposed signal gap.
  The following figure shows an example of the transition from a sinewave signal segment to a sawtooth segment (I channel, above) in the case of next segment external triggering (below).



- When "Next Segment" Seamless is selected and a new segment trigger event occurs, the new segment is not output until the whole of the current segment has been output (wrap around). In this case the signal transition is seamless. As a prerequisite for a seamless switchover, all segments must have the same sample rate. The following figure shows an example of the seamless transition from a sinewave signal segment to a sawtooth segment (I channel, above) in the case of next segment external triggering (below).



The regular trigger mode for starting the waveform generation and **triggering the whole multi segment sequence** is set with the parameters in the "Trigger In" section of the "Trigger/Marker/Clock" dialog.

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.

"Same Segment"

Depending on the trigger setting, the currently selected segment is continuously output either immediately or after a trigger event.

Signal generation takes place differently according to the trigger selected in the "Trigger In" section:

- In the case of "Trigger = Auto", output starts at once and the segment is generated continuously. Trigger events are ignored.
  If the segment is changed in "Next Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap (see above).
- In the case of "Trigger = 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 "Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.
- In the case of "Trigger = Retrigger", output starts at once and the segment is generated continuously, a trigger event causes a restart.
  If the segment is changed in "Next Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap (see above).
- In the case of "Trigger = 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 "Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.
- In the case of "Trigger = 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 "Next Segment", signal output is not stopped. The new segment is not output until a trigger occurs.

"Next Segment"

Depending on the trigger setting, the segment selected under "Next Segment" is output either immediately or after a trigger event.

- In the case of "internal Trigger = Auto", output starts at once and the segment is generated continuously.
  If the segment index is changed in "Next Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
- In the case of "internal Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment index is changed in "Next Segment", output of the current segment is stopped and the new segment is output immediately, following a system-imposed signal gap.
- In the case of "internal Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment index is changed in "Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.
- In the case of "internal Trigger = 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 "Next Segment", the new segment is not output until a trigger occurs.
- In the case of "External Trigger = Auto", output starts at once and the segment is generated continuously.
  If the segment index is changed in "Next 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.
- In the case of "External Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment is changed in Next 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.
- In the case of "External Trigger = Single", output starts after the first trigger event. The segment is then generated once.
  If the segment is changed in "Next 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.

"Next Segment Seamless"

The segment selected under "Next Segment" is output.
This mode is only available if all segments have the same sample rate.

- In the case of "Internal Trigger = Auto", output starts at once and the segment is generated continuously.
  If the segment is changed in "Next Segment", the new segment is output seamlessly after the output of the current segment is complete.
- In the case of "internal Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment is changed in"Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.
- In the case of "External Trigger = Auto", output starts at once and the segment is generated continuously.
  If the segment is changed in "Next Segment", the new segment is output seamlessly after the output of the current segment is complete.
- In the case of "External Trigger = Armed_Auto", output starts after the first trigger event. The segment is then generated continuously.
  If the segment is changed in "Next Segment", signal output is stopped and the new segment is not output until a trigger occurs.

The remaining trigger modes ("Retrigger" and "Armed_Retrigger") are not available.

"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.

Note: This feature is disabled in case the segments in the multi segment waveform file have different clock rates.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe` on page 359

Execute Next Segment

Triggers manually switchover to the subsequent segment in the multi segment file. A manual trigger can be executed only when an internal "Next Segment Source" has been selected.

To perform a switchover to any segment within the multi segment file, adjust the parameter "Next Segment".

This parameter is disabled, if a sequencing play list is enabled.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute` on page 398

Sequencing List
Open a dialog box for defining the “play lists” (see "Multi Segment Waveform Sequencing" on page 91).

Remote command:
[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect on page 400

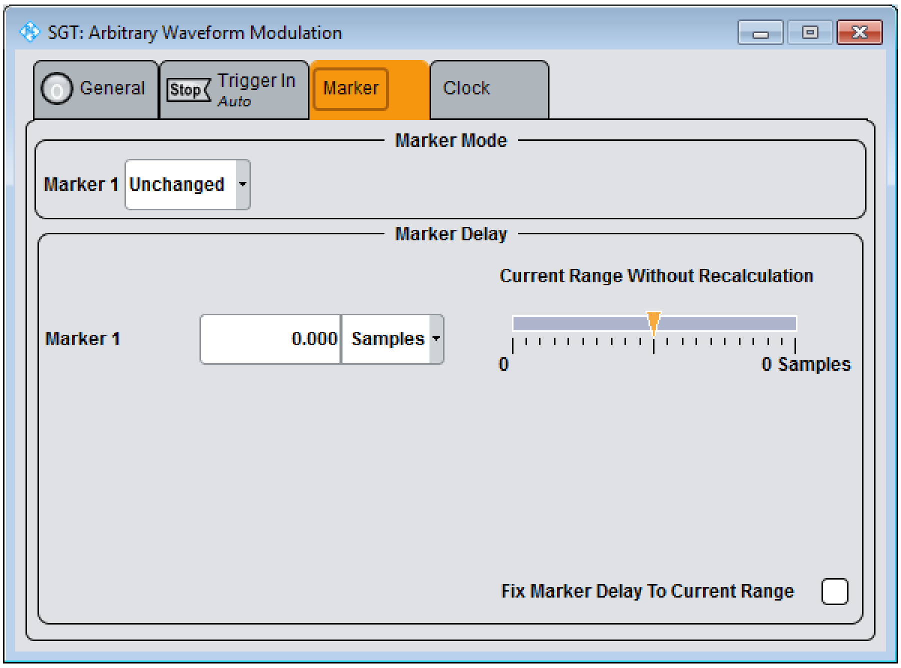
Trigger Example
Displays an example of a multi segment waveform. The currently enabled trigger and next segment mode are considered. After the instrument switch on, the graph of the last loaded waveform is displayed.

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.

7.1.3.3 Marker Settings

► To access this dialog, select "SGMA-GUI > Instrument Name > Baseband > ARB > Marker".



Provides the settings necessary to define the marker output signal for synchronizing external instruments and the delay of the marker signals on the USER 1/2 connector.

Marker Mode

Marker configuration for up to 2 marker channels. The settings are used to select the marker mode defining the shape and periodicity of the markers. The contents of the dialog change with the selected marker mode; the settings are self-explanatory.

Note: The marker trace in the waveform file remains unchanged. It is not overwritten, even if something else than "Unchanged" has been selected.

"Unchanged" The marker signal remains unchanged as defined in the waveform file.

"Restart" A marker signal is generated at the start of each ARB sequence.
This marker mode is not enabled for multi segment waveforms.

"Pulse" A regular marker signal is generated. The pulse frequency is defined by entering a divider. The frequency is derived by dividing the sample rate by the divider. The input box for the divider opens when "Pulse" is selected, and the resulting pulse frequency is displayed below it.
The precision of the frequency setting depends on the sampling rate.
The maximum pulse frequency is equal to half of the sampling rate.

"Pattern " A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 64 bits and is defined in an input field which opens when "Pattern" is selected.
The pattern bits switch the marker signal to high and low state.

"ON/OFF Period" A regular marker signal that is defined by an ON/OFF ratio is generated. A period lasts one ON and OFF cycle.

The "ON Time" and "OFF Time" are each expressed as a number of samples and are set in an input field which opens when ON/OFF ratio is selected.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE` on page 363
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider` on page 364
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?` on page 364
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern` on page 364
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime` on page 363
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime` on page 363

Marker x Delay

Enters the delay between the marker signal at the marker output and the start of the frame or slot.

If the setting "Fix marker delay to dynamic range" is enabled, the setting range is restricted to the dynamic range. In this range the delay of the marker signals can be set without restarting the marker and signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay` on page 365

Current Range without Recalculation
Displays the dynamic range within which the delay of the marker signals can be set without restarting the marker and signal.

The delay can be defined by moving the setting mark.

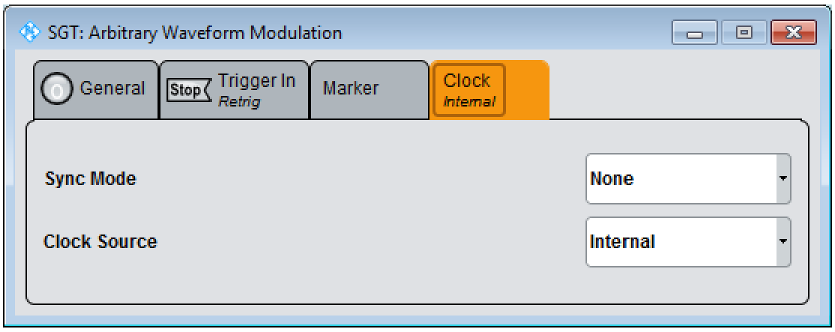
Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MINimum?` on page 357
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MAXimum?` on page 357

Fix marker delay to current range
Restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut:DELay:FIXed` on page 365

7.1.3.4 Clock Settings

► To access this dialog, select "SGMA-GUI > Instrument Name > Baseband > ARB > Marker".



In the "Clock Settings" section you can set the clock source and a delay if required.

Sync Mode
Selects the synchronization mode.

"None"	The instrument is working in stand-alone mode.
"Sync Master"	The instrument provides all connected instrument with its synchronization (including the trigger signal) and reference clock signal.
"Sync Slave"	The instrument receives the synchronization and reference clock signal from another instrument working in a master mode.
"Sync Dig I/Q In"	The instrument receives the synchronization and reference clock signal from the DIGITAL I/Q connector.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:CLOCk:SYNChronization:MODE` on page 354

Clock Source

Selects the clock source.

"Internal" The internal clock reference is used to generate the symbol clock.

"External" The external clock reference is fed in as the symbol clock or multiple thereof via the USER 1/2 connector.
The symbol rate must be correctly set to an accuracy of +/-2 % (see data sheet).
The polarity of the clock input can be changed in the "Connector" dialog.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce` on page 354

Clock Mode

Available only for "Clock Source > External"

Enters the type of externally supplied clock.

"Sample" A sample clock is supplied via the USER 1/2 connector.

"Multiple Sample" A multiple of the sample clock is supplied via the USER 1/2 connector; the sample clock is derived internally from it.
The "Multiplier" window provided allows the multiplication factor to be entered.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:CLOCk:MODE` on page 353

Sample Clock Multiplier

Available only for "Clock Mode > Multiplier".

Enters the multiplication factor.

Remote command:
`[:SOURce<hw>]:BB:ARBitrary:CLOCk:MULTiplier` on page 353

Measured External Clock

Provided for permanent monitoring of the enabled and externally supplied clock signal.

Remote command:
`:CLOCk:INPut:FREQuency?` on page 313

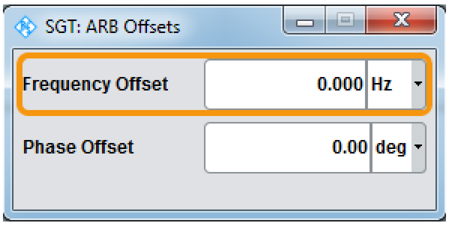
Synchronisation State

For instruments working in slave synchronization mode, this parameter displays the status of the external clock source, i.e. whether the external clock source of the slave instrument is synchronized or not synchronized yet.

Remote command:
n.a.

7.1.4 ARB Offsets

► To access this dialog, select "SGMA-GUI > Instrument Name >Baseband > Frequency/Phase Offsets".



Frequency Offset

Sets the frequency offset for the and shifts the ARB signal in the center frequency.

Remote command:

`[:SOURce]:BB:FOFFset` on page 350

Phase Offset

Sets the phase offset of the ARB signal.

Remote command:

`[:SOURce]:BB:POFFset` on page 350

7.2 Additive White Gaussian Noise (AWGN) - Noise Generator

This section introduces the concept of the AWGN generator and describes the settings for generation of noise, sine wave interferer and adding noise to the generated signal.

The AWGN requires option R&S SGT-K62.

7.2.1 About the AWGN Generator

The R&S SGT 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.

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.

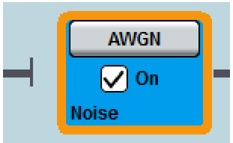


Figure 7-2: Representation of an "AWGN > Mode > Noise Only" in the block diagram

- **"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 7-3 illustrates the relation between the signal and noise parameters.

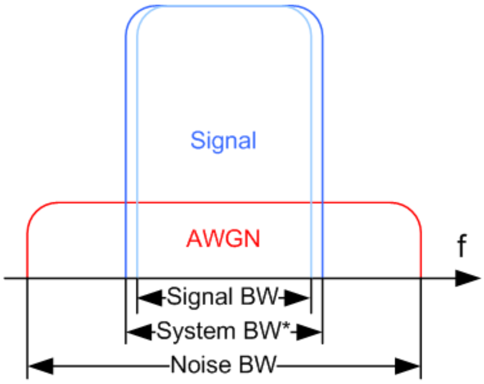


Figure 7-3: Graphical representation of the relation between system bandwidth and noise bandwidth (Minimum Noise/System BW = 2)

System BW* = Occupied BW

The **system bandwidth** is a measure for the transmitted RF bandwidth. The selected value is usually the occupied bandwidth and may therefore be a value greater than the pure signal bandwidth.

In the most test cases, the signal and the noise power are not defined directly but by the target's signal-to-noise ratio (SNR) or **carrier/noise ratio**.

The **carrier power** is a measure for the *signal without the noise distribution*.

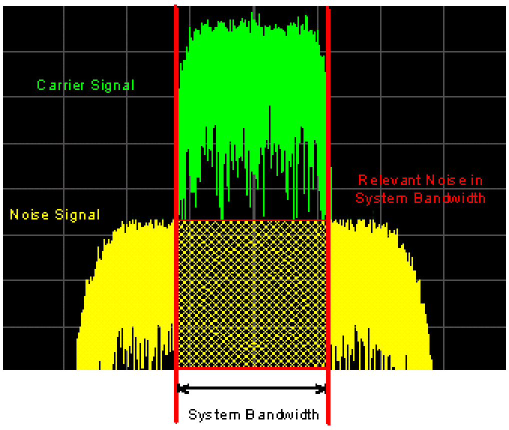
To ensure flat noise within the selected system bandwidth, the **noise bandwidth** should be larger than the system bandwidth. The minimum noise bandwidth is sometimes part of the specifications and is calculated as follows:

"Noise Bandwidth" = "System Bandwidth" x "Minimum Noise/System Bandwidth Ratio"

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**.

The noise power of digitally modulated signal is characterized by the parameter $\mathbf{E_b/N_0}$ indicating the ratio of bit energy to noise power density. The correlation to the SNR is as follows:

$C/N \text{ or } S/N = (E_b/N_0)*(f_{bit}/B_{sys})$,

where B_{sys} is the system bandwidth and

Bit Rate f_{bit} = *"Symbol Rate" * Modulation Value*

Application fields

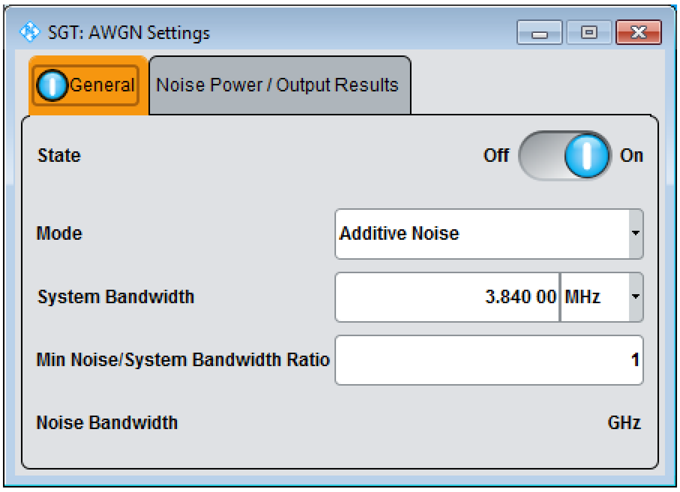
Typically, the noise generator is required for the following tests:

- In receiver sensitivity tests with predefined SNR of the receiver
- In bit-error or block-error measurements, depending on the set signal-to-noise ratio (SNR)
- Whenever a pure noise signal is required

7.2.2 AWGN Settings

7.2.2.1 General Settings

► To access the dialog box, select "SGMA-GUI > Instrument Name > AWGN > General"



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 350

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.

Remote command:
`[:SOURce<hw>]:AWGN:MODE` on page 346

System Bandwidth

Available only for "Mode > Additive Noise" or "Mode > Noise Only".

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.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth` on page 343

Minimum Noise/System Bandwidth Ratio

Available only for "Mode > Additive Noise" or "Mode > Noise Only".

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 344

Target CW Frequency Offset
Available only for "Mode > CW Interferer".

Sets the desired frequency of the sine wave.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:TARGet` on page 346

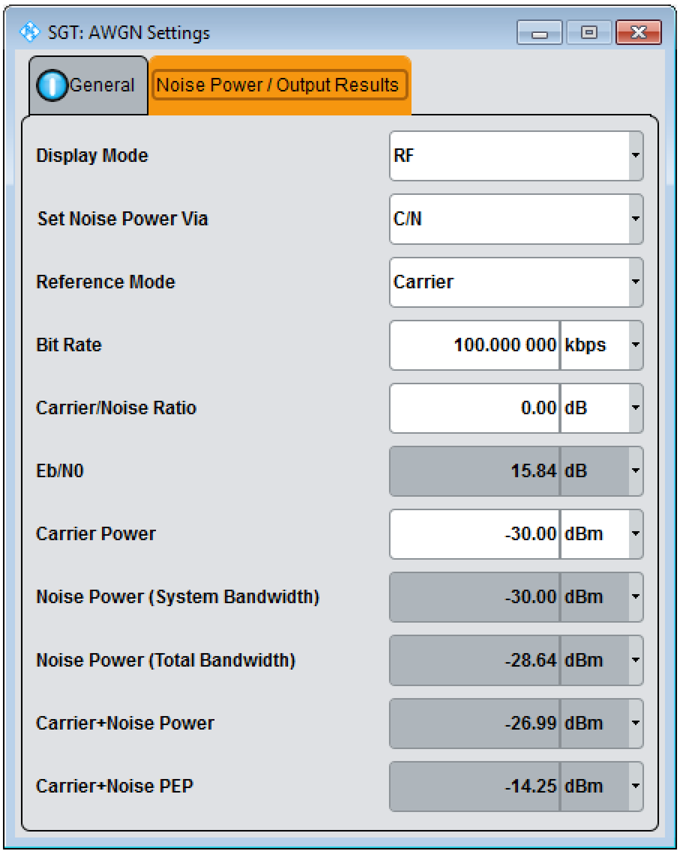
Resulting CW Frequency Offset
Available only for "Mode > CW Interferer".

Indicates the resulting frequency offset of the sine wave.

Remote command:
`[:SOURce<hw>]:AWGN:FREQuency:RESult?` on page 345

7.2.2.2 Noise Power/ Output Results Settings

► To access the dialog box, select "SGMA-GUI > Instrument Name > AWGN > Noise Power/ Output Results"



Noise Bandwidth
Available only for "Mode > Additive Noise" and "Mode >Noise Only" and when the AWGN generator is activated.

Indicates the real noise bandwidth.

Remote command:
`[:SOURce<hw>]:AWGN:BWIDth:NOISe?` on page 343

Display Mode
Sets the output to which the displayed settings are related to.

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

Remote command:
`[:SOURce<hw>]:AWGN:DISP:MODE` on page 344

Set Noise Power Via
Available only for "Mode > Additive Noise".

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.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:MODE` on page 347

Reference Mode
Selects whether the carrier or the noise power is kept constant if the C/N or Eb/N0 ratio is changed.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:RMODe` on page 348

Bit Rate
Available only for "Mode > Additive Noise".

Indicates the bit rate used for converting C/N or S/N to E_b/N_0.

Remote command:
`[:SOURce<hw>]:AWGN:BRATe` on page 342

Carrier/Noise Ratio / Signal/Noise Ratio
Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

Sets the carrier/noise, signal/noise or respectively signal/interferer ratio.

Whether a configuration of C/N or S/N is enabled, depends on the selected output Display Mode.

- For "Reference Mode > Carrier ", this entry determines 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.
- For "Reference Mode > Noise ", this entry determines 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 / Signal 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 under Carrier + Noise Power / Signal + Noise Power (System Bandwidth) / Carrier + Interferer Power / Signal + Interferer Power .

Remote command:
`[:SOURce<hw>]:AWGN:CNRatio` on page 344

E_b/N_0
Available only for "Mode > Additive Noise".

Sets the ratio of bit energy to noise power density.

- For "Reference Mode > Carrier ", this entry determines 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.
- For "Reference Mode > Noise ", this entry determines 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 / Signal Power. This indication corresponds to the "Level" value in the "Status bar".
- The power of the output signal is displayed under Carrier + Noise Power / Signal + Noise Power (System Bandwidth) / Carrier + Interferer Power / Signal + Interferer Power .

Remote command:
`[:SOURce<hw>]:AWGN:ENRatio` on page 345

Carrier Power / Signal Power
Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

The name of this parameter depends on the selected output Display Mode.

- For "Reference Mode > Carrier ", this parameter 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.
- For "Reference Mode > Noise ", this parameter 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 under "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.

Remote command:
`[:SOURce<hw>]:AWGN:POWer:CARRier` on page 346

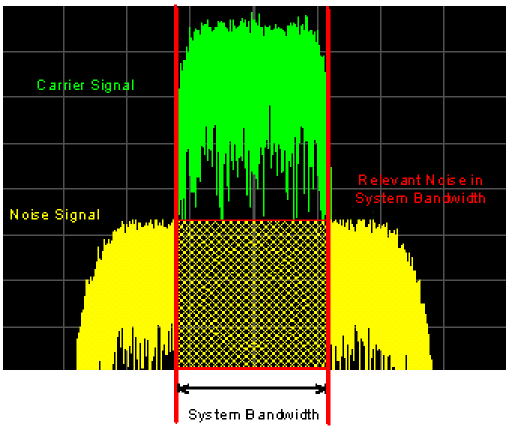
Noise Power (System Bandwidth) / Interferer Power
Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

Displays the power of the noise signal in the system respectively to the total bandwidth.

- "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 Eb/N0 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 Eb/N0 value. The carrier power is selected with "Carrier Power"; respectively the signal power is displayed by "Signal Power".

- "CW Interferer" mode
  – "Noise Reference Mode"
    Sets the power of the interfering signal. The power of the carrier is derived from the entered C/N or S/N value.
  – "Carrier Reference Mode"
    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 (see below) usually exceeds the value displayed here. For correct measurement of the noise power within the system bandwidth, it is advisable to perform channel power measurement with a signal analyzer.



Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe on page 347

Noise Power (Total Bandwidth)
Displays the power of the noise signal in the total bandwidth in "Noise Only" and "Additive Noise" mode.

Remote command:
[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal? on page 348

Carrier + Noise Power / Signal + Noise Power (System Bandwidth) / Carrier + Interferer Power / Signal + Interferer Power
Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

Displays the overall power of the noise/interferer signal plus useful signal.

The output selected with the parameter Display Mode determines:
- The name of this parameter
- The units the overall power is measured in, dBm or dB (full scale)

Remote command:
[:SOURce<hw>]:AWGN:POWer:SUM? on page 349

Carrier + Noise PEP / Signal + Noise PEP (Total Bandwidth) / Carrier + Interferer PEP / Signal + Interferer PEP
Available only for "Mode > Additive Noise" and "Mode > CW Interferer".

Displays the peak envelope power (PEP) of the overall signal comprised of noise signal plus useful signal.

The output selected with the parameter Display Mode 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 349

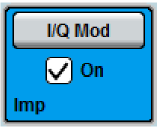
7.3 I/Q Modulation and Impairment Settings

7.3.1 I/Q Modulation

The R&S SGT offers I/Q modulation with:

- External analog I/Q signals,
- External digital signals,
- Iternal digital signals.

Either the external digital signal or the externally or internally generated baseband signal is fed into the I/Q modulator ("I/Q Mod" function block).



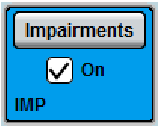
The external signal is input via the I and Q connector and transferred directly to the I/Q modulator ("I/Q Mod" function block). The external digital signal is configured in the "BB In" function block (see Chapter 7.9, "External Baseband Signal - Baseband Input", on page 235).

The internally generated baseband signal is configured in the Baseband function block (see Chapter 7.1, "Baseband", on page 75). Before the signal is fed into the I/Q modulator, noise can be added and/or the signal can be impaired.

Impairments can also be set in the I/Q Mod menu to allow an externally applied analog I/Q signal to be impaired. An internal baseband signal can thus be impaired both digital (in the Impairment block in the Impairment menu) and analog in the I/Q modulator. If impairments are set in both menus, they superimpose each other in the signal.

7.3.2 Impairments

The R&S SGT allows the digital I/Q signal to be impaired before it is passed on to the I/Q modulator. These settings are available in the block diagram in the "Impairements" functional block.



7.3.2.1 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 usually 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 below.

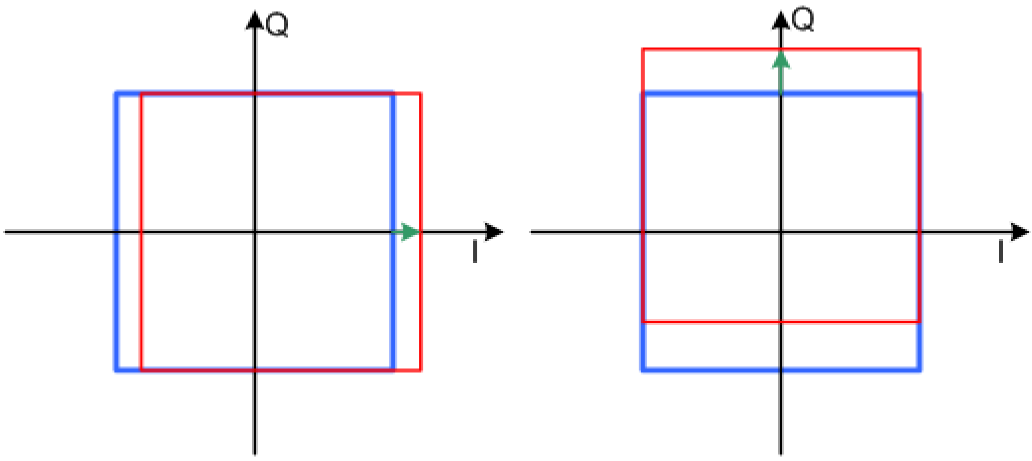


Figure 7-4: I offset (left) and Q offset (right) in the I/Q constellation diagram

7.3.2.2 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 below.

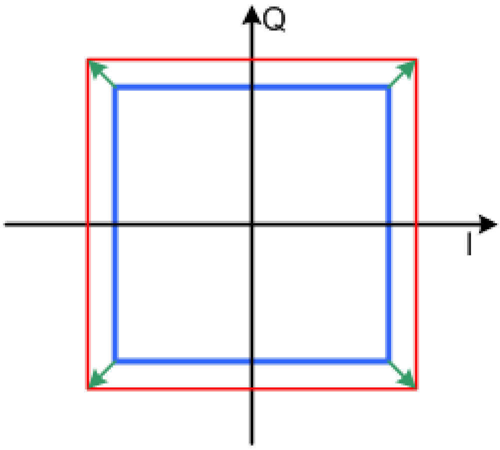


Figure 7-5: Effect of an increased amplitude in the I/Q constellation diagram

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 usually 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 below.

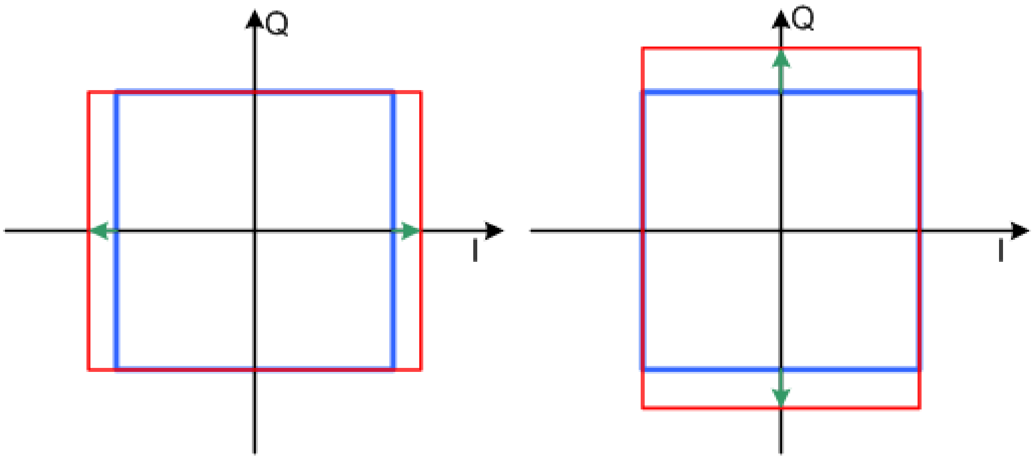


Figure 7-6: Negative gain imbalance (left) and positive (right) gain imbalance in the I/Q constellation diagram

7.3.2.3 Quadrature Offset

Changes the phase angle between the I and 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 below.

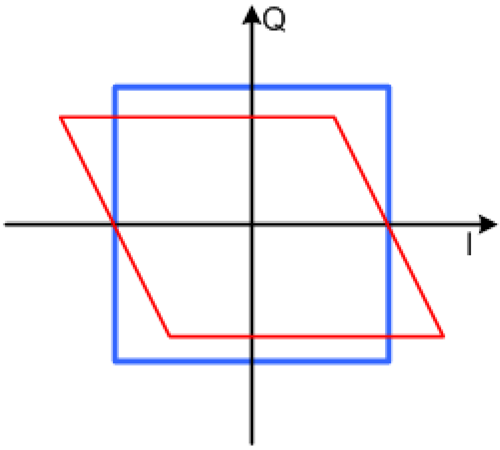


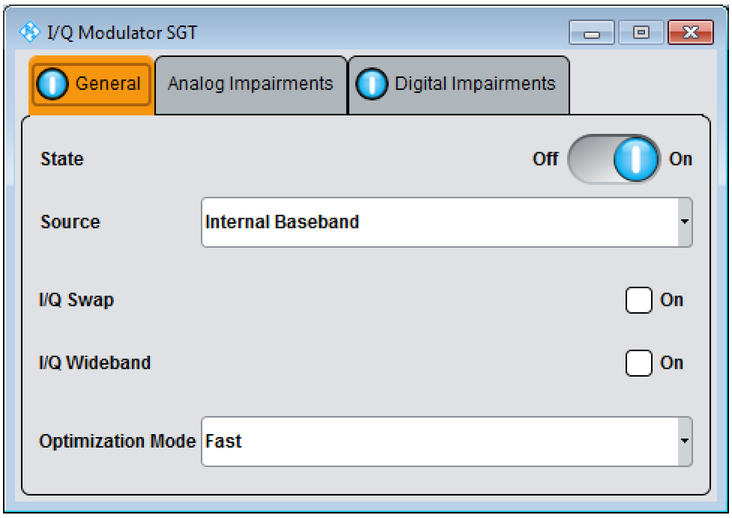
Figure 7-7: Positive quadrature offset in the I/Q constellation diagram

7.3.3 I/Q Modulator Settings

7.3.3.1 General

► To access this dialog, select:

a) "SGMA-GUI > Instrument Name > IQ Mod > General"
b) "SGMA-GUI > Instrument Name > Impairments > General"



State
Activates/deactivates I/Q modulation.

If "Analog Wideband I/Q In" is selected, the I/Q modulator is also deactivated and acti-vated.

If "Internal Baseband I/Q In" is selected, the I/Q modulator is always activated automatically as soon as signal generation is activated in the "Baseband" block. It can, however, be deactivated later.

The following functions have the same effect:
- The Mod On/Off icon in the SGMA-GUI.
- The "I/Q Mod > On/Off" in the I/Q Mod block in the block diagram.
- The "I/Q Modulator" > "State" on page 135 parameter.

Remote command:
`[:SOURce]:IQ:STATe` on page 424

IQ Source

Selects the input signal for the I/Q modulator.

"Analog Wideband I/Q In"	Selects an external analog signal as the input signal. The signal must be applied at the inputs I and Q.
"Internal Baseband I/Q In"	Selects the internal baseband signal as the input signal. This setting requires the additional equipment options for generating the various baseband signals.

Remote command:
`[:SOURce]:IQ:SOURce` on page 425

I/Q Swap

Available only for "Source > Internal Baseband".

Selects normal or swapped I/Q control. The modulation sidebands are inverted by swapping the I and Q signals.

This parameter enables I/Q modulation to be performed on signals according to IS2000 (cdma2000 standard) and the majority of all other standards. As a result, an I/Q demodulator defined according to IS2000 can also be used for demodulating the generated signals.

The I/Q modulator defined in the IS2000 standard differs from the definition in the R&S SGT. The definition on which the R&S SGT is based is used by virtually all digital communication standards (except IS95 and IS2000).

In the final step, the filtered I/Q signal is modulated to the desired RF in a different way in the I/Q modulator:

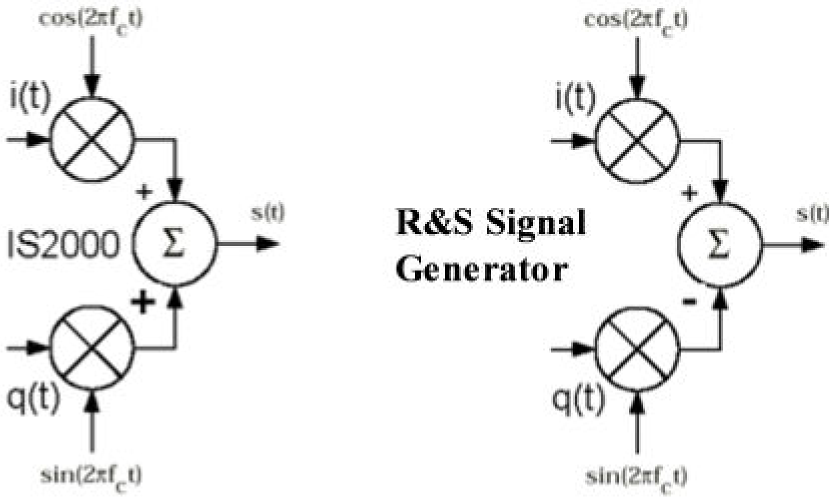


Figure 7-8: Definition of I/Q modulator in IS2000 and R&S SGT

According to IS2000, the RF signal s(t) is derived from the baseband I/Q signal as follows:

$s(t)=i(t)\cos(2pif_ct)\mathbf{+}q(t)\sin(2pif_ct)$

The instrument family is based on the following definition:

$s(t)=i(t)\cos(2pif_ct)\mathbf{-}q(t)\sin(2pif_ct)$

"I/Q Swap" must now be set to "On" so that an I/Q modulator defined according to IS2000 can cope with the RF signal generated by the R&S SGT.

"Off"	I/Q control is normal.
"On"	The I and Q signals are swapped.

Remote command:
`[:SOURce<hw>]:IQ:SWAP[:STATe]` on page 425
`[:SOURce]:IQ:IMPairment:SWAP[:STATe]` on page 424

I/Q Wideband
Optimized setting for wideband modulation signals (>5 MHz).

The modulation frequency response is decreased 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]:IQ:WBSTate` on page 425

Optimization Mode
Available only for "Source > Internal Baseband".

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 an extremely flat signal. For information on the I/Q modulation performance, see the data sheet.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE` on page 410

Crest Factor
Available only for "Source > Analog Wideband I/Q Input"

Sets the crest factor of the external analog signal.

The crest factor gives the difference in level between the peak envelope power (PEP) and average power value (RMS) in dB.

This value is necessary to allow the correct output power to be generated at the RF output. When the set output power is generated, the R&S SGT uses this value to compensate the average power which is lower compared to the peak power.

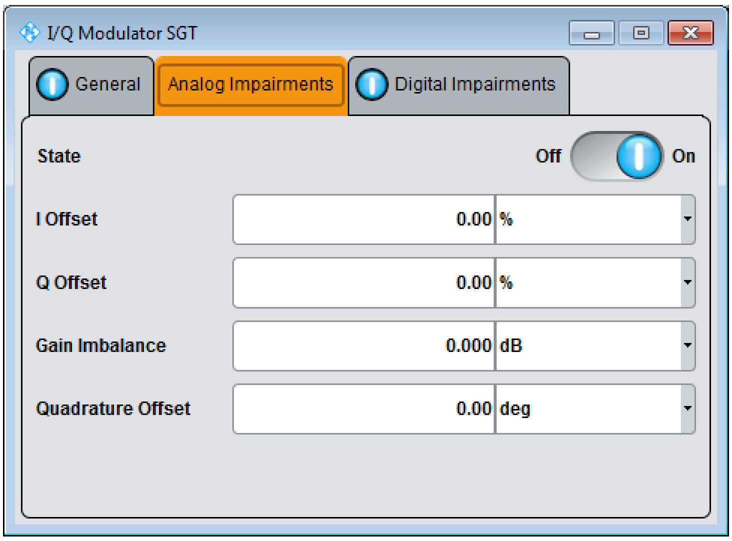
The maximum input voltage at the I/Q input is equated to the peak power and is used as the "reference" for setting the level of the output signal. Since the signal does not usually supply the peak power at a constant level and instead supplies a lower average power, the crest factor specifies how many dB have to be added internally so that the correct output power is achieved.

Remote command:
`[:SOURce]:IQ:CREStfactor` on page 423

7.3.3.2 Analog Impairments

► To access this dialog, select:

a) "SGMA-GUI > Instrument Name > IQ Mod > Analog Impairments"
b) "SGMA-GUI > Instrument Name > Impairments >Analog Impairments"



I/Q impairment for specific impairment of the I/Q modulation is set in the "Analog Impairments" dialog.

State
Activates/deactivates I/Q impairment.

If activated, the settings for leakage, I/Q imbalance and quadrature offset become effective.

Whether or not I/Q impairment is activated is indicated in the function block.

Remote command:
`[:SOURce<hw>]:BB:IMPairment:STATe` on page 410

I/Q Offset
Sets the 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 7.3.2.1, "I and Q Offset", on page 133.

Remote command:
`[:SOURce]:IQ:IMPairment:LEAKage:I` on page 423
`[:SOURce]:IQ:IMPairment:LEAKage:Q` on page 423

Gain Imbalance
Sets the imbalance of the I and Q vector, see Chapter 7.3.2.2, "Gain and Gain Imbalance", on page 133.

The entry is made in dB (default) or %, where 1 dB offset is roughly 12 % according to the following:

Imbalance [dB] = 20log (| GainQ | / | 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.

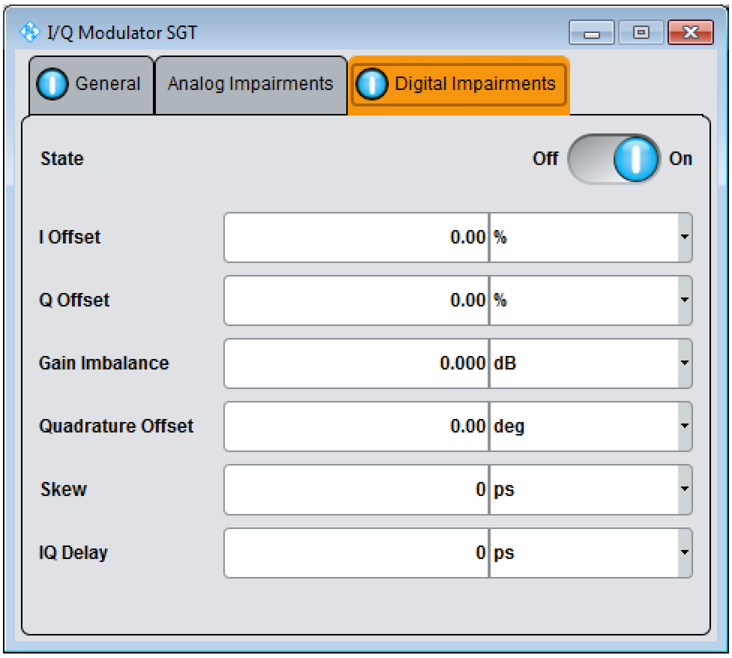
Remote command:
`[:SOURce]:IQ:IMPairment:IQRatio[:MAGNitude]` on page 423

Quadrature Offset
Sets the quadrature offset, see Chapter 7.3.2.3, "Quadrature Offset", on page 134.

Remote command:
`[:SOURce]:IQ:IMPairment:QUADrature[:ANGLe]` on page 424

7.3.3.3 Digital Impairments

► To access this dialog, select:
 a) "SGMA-GUI > Instrument Name > IQ Mod > Digital Impairments"
 b) "SGMA-GUI > Instrument Name > Impairments > Digital Impairments"



State

Activates/deactivates digital I/Q impairment.

When activated, the settings for carrier leakage, I/Q imbalance and quadrature offset become effective.

Internal predistortion for compensating the I/Q modulator is not influenced by this setting.

Remote command:

`[:SOURce<hw>]:BB:IMPairment:STATe` on page 410

`[:SOURce]:BB:IMPairment:IQOutput<ch>:STATe` on page 411

I/Q Offset

Sets the carrier leakage (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 leakage completely (offset = 0 percent).

For more information, see Chapter 7.3.2.1, "I and Q Offset", on page 133.

Remote command:

`[:SOURce<hw>]:BB:IMPairment:LEAKage:I` on page 408

`[:SOURce<hw>]:BB:IMPairment:LEAKage:Q` on page 409

`[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:I` on page 412

`[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:Q` on page 412

Gain Imbalance

Sets the imbalance of the I and Q vector (see Chapter 7.3.2.2, "Gain and Gain Imbalance", on page 133).

The entry is made in dB (default) or %, where 1 dB offset is roughly 12 % according to the following:

Imbalance [dB] = 20log (| GainQ | / | 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.

Remote command:
[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude] on page 408
[:SOURce]:BB:IMPairment:IQOutput<ch>:IQRatio[:MAGNitude]
on page 412

Quadrature Offset
Sets the quadrature offset (see Chapter 7.3.2.3, "Quadrature Offset", on page 134).

Remote command:
[:SOURce<hw>]:BB:IMPairment:QUADrature[:ANGLe] on page 409
[:SOURce]:BB:IMPairment:IQOutput<ch>:QUADrature[:ANGLe]
on page 411

Skew
Sets the time offset between the I and Q vectors.

In an I/Q modulator without I/Q skew, the I and Q vectors are aligned to the marker. With an I/Q skew, both vectors are shifted relative to the marker so that the offset of each of the vectors to the marker will be the half of the I/Q skew value.

A positive I/Q skew means that the Q vector delays relative to the I vector and vice versa.

Remote command:
[:SOURce<hw>]:BB:IMPairment:SKEW on page 409
[:SOURce]:BB:IMPairment:IQOutput<ch>:SKEW on page 412

IQ Delay
Sets the time delay of both I and Q vectors relative to the selected trigger and marker or relative to the other instrument(s) working in the master-slave synchronous mode.

A positive value means that the I and Q vectors delay relative to the marker/trigger or to the other instrument and vice versa.

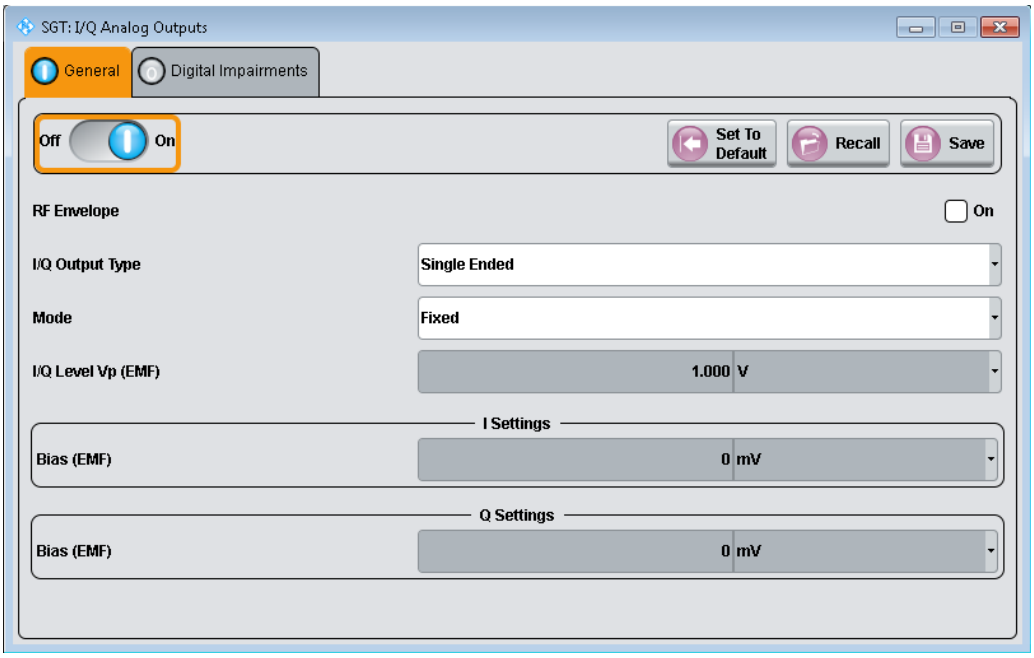
Remote command:
[:SOURce<hw>]:BB:IMPairment:DELay on page 408
[:SOURce]:BB:IMPairment:IQOutput<ch>:DELay on page 411

Optimize internal IQ-Impairments for RF Output
Activates/ deactivates internal compensation of signal distortions of the RF output. Signal distortions can be optimized for the RF output (active).

Remote command:
[:SOURce<hw>]:BB:IMPairment:OPTimization:STATe on page 410

7.4 I/Q Analog Output Settings

The I/Q Analog Output requires option Differential Analog I/Q Outputs R&S SGT-K16.



7.4.1 General Analog I/Q Output Settings

Access:

► Select "I/Q Analog > I/Q Analog Settings > General".

Settings:

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 426

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 Vp (EMF)"	1 V
"Bias (EMF)"	0 V

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet` on page 426

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 filename and the directory, in which the settings are stored, are user-definable; the file extension is however predefined.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog?` on page 426
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:STORe` on page 426
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:LOAD` on page 427
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:DELete` on page 427

RF Envelope
In instruments equipped with option R&S SGT-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/I BAR 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.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:STATe`

I/Q Output Type
Selects the type of output signal.

The provided parameters in the "I/Q Analog Outputs" dialog depend on the selected output mode.

"Differential"
- If "RF Envelope > On"
  The inverted envelope signal $\bar{E}$ is output at the I BAR connectors.
- If "RF Envelope > Off"
  The analog I/Q signal components are output at the I/Q BAR connectors.

"Single-Ended"
- If "RF Envelope > On"
  The envelope signal E is output at the I connectors.
- If "RF Envelope > Off"
  Single-ended output at the I/Q connectors.

You can define a bias between the output signal and ground.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE` on page 427

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 7-3.

Table 7-3: 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 SGT-K16)
Enables modification of the I/Q signal components settings.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:MODE` on page 428

I/Q Level Vp EMF

Sets the output voltage for both signal components.

See Chapter 7.3.2, "Impairments", on page 133.

Table 7-4: Maximum I/Q level and overall output voltage

"I/Q Output Type"	Value range "I/Q Level Vp (EMF)"	Maximum overall output voltage V_{EMF}max
"Single ended"	20 mV to 2 V	"I/Q Level Vp (EMF)" + "Bias (EMF)" ≤ 4 V
"Differential"	40 mV to 4 V	0.5*"I/Q Level Vp (EMF)" + |"Bias (EMF)"| + 0.5*"Offset (EMF)" ≤ 4 V

Remote command:
`[:SOURce<hw>]:IQ:OUTPut:LEVel` on page 428

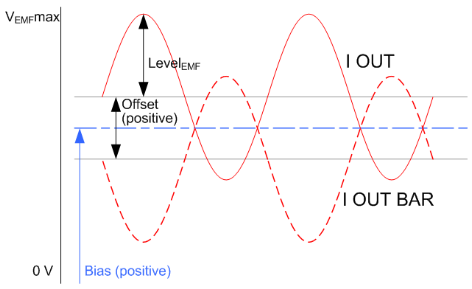
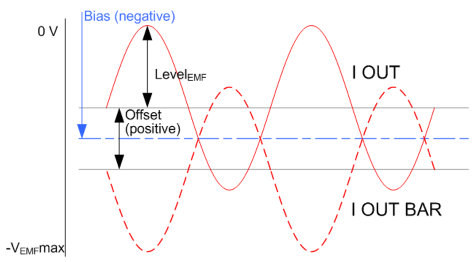
Couple I/Q Bias

In "Variable Mode", activates/deactivates coupling of bias setting of the I signal and the Q signal component. With activated coupling, the settings of the I signal component automatically apply to the Q signal component.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:COUPling[:STATe]` on page 427

Bias (EMF)

If a bias is enabled, a DC voltage is superimposed upon the I or Q signal.

Effect of a positive bias	Effect of a negative bias
	

In "Single Ended" mode, this parameter defines the bias between the output signal and ground.

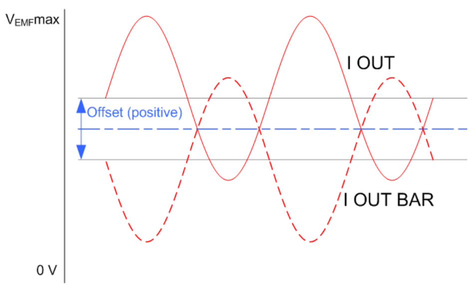
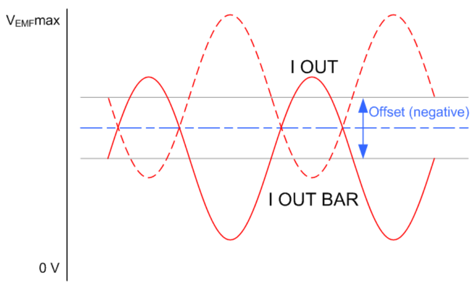
Use this parameter to define the operating point of a DUT.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:I` on page 428
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:BIAS:Q` on page 428

Offset (EMF)

Sets an offset between the inverting and the non-inverting output.

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
	
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.	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.

Example: Effect of a positive offset on the I signal component

"I Offset" = 100.0 mV

The offsets applied on the two output connectors as follows:
- +50.0 mV at the positive signal output
- -50.0 mV at the inverted signal output

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:I` on page 429
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:OFFSet:Q` on page 429

7.5 Generation of Envelope Tracking Signals

The envelope tracking (ET) is a method used by modern power amplifiers (PA) to improve their efficiency, especially when they amplify RF signals with a high peak to average power (PAPR). An envelope tracking detector "tracks" the power variations in the input signal of the PA; the PA then varies synchronously to this variation the supply voltage v_{cc} at its end amplifying stage.

This section introduces the concept of the envelope tracking functionality and the way it is implemented in the R&S SGT.

7.5.1 Required Options

The equipment layout for generation and output of envelope tracking signal includes:

- Option Differential Analog I/Q Outputs (R&S SGT-K16)
- Option Envelope Tracking (R&S SGT-K540)
- Optional option AM/AM AM/PM Predistortion (R&S SGT-K541)

7.5.2 About the Envelope Tracking

Provided the required options are installed, the R&S SGT allows you to generate an envelope tracking signal, that follows the envelope variation of the RF signal.

Principle of the envelope tracking

The Figure 7-9 shows a simplified test setup for testing of a PA with an envelope tracking. This illustration is intended to explain the principle in general, not all connections and required equipment are considered.

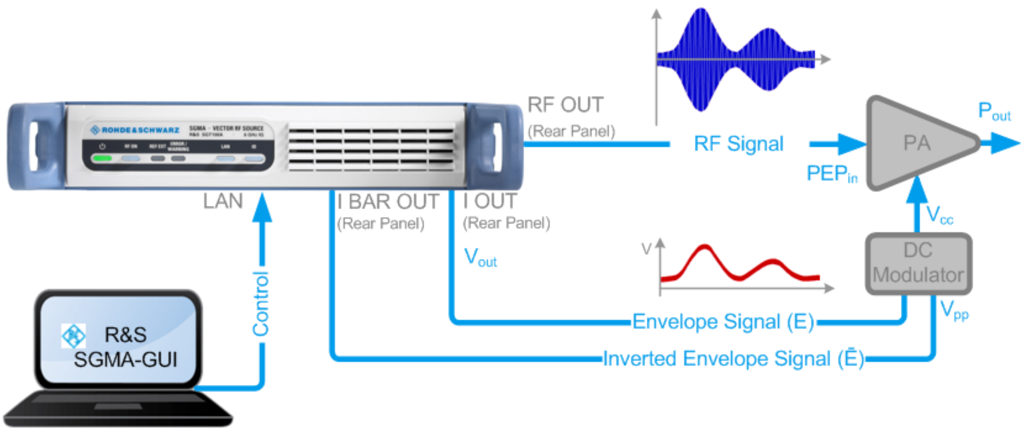


Figure 7-9: Simplified test setup for power amplifier envelope tracking tests

The R&S SGT in this setup is configured to generate both, an RF signal with complex modulation scheme and an envelope signal, that follows the envelope variation of this RF signal. A suitable test signal is for example an EUTRA/LTE DL signal.

The R&S SGT generates the envelope signal directly from the baseband signal. The envelope signal is a voltage signal, with voltage level V_{out} proportional to the power of the RF signal ($\sqrt{[I(t)^2+Q(t)^2]}$) of the corresponding path. If you do not apply a shaping function, the envelope signal follows the variation of the envelope of the RF signal linearly dependent.

The envelope signal is output at the I OUT and I BAR OUT rear panel connectors. This envelope signal is then further fed to an external DC modulator.

The PA receives the RF input signal and the dynamically adapted supply voltage v_{cc}. Ideally, the PA gain should stay constant.

Suitable baseband signal to observe the effect of the envelope tracking settings

To simplify the explanation in the following sections, we use a simple ramp function as a baseband signal modulated on the RF carrier.

Other suitable baseband signals are signals with relative constant envelope. You find a choice of predefined signals in the "Baseband > Custom Dig Mod" dialog. For instance, with the default settings in this dialog ("Custom Dig Mod > Set acc. to the standard > GSM"), you can observe the generated envelope signal and the effects of enabled shaping.

7.5.2.1 Envelope Voltage Adaptation Modes

In the R&S SGT, you define the voltage of the generated envelope signal using one of the following modes:

- **Auto Power/Normilized Envelope Voltage Adaptation:**
  In this mode, you define the desired input characteristics of the power amplifier.

  Based on these values and depending on the crest factor of the currently generated signal, the R&S SGT calculates:
  - The voltage on the I OUT/I BAR OUT connectors (V_{out}Min/Max) and a bias (Bias),
  - The RMS level of the RF signal

  The auto voltage adaptation mode is a suitable choice, if you have knowledge on the power amplifier components and characteristics, like for example the supply voltage V_{cc}, the input power PEP_{in} required for working in the linear range, as well as the gain characteristics of the external DC modulator.
  You find the required values in the documentation of your power amplifier, for example in its data sheet.
- **Manual Envelope Voltage Adaptation:**
  In this mode, you can additionally define the operating range of the power amplifier based on a pre-gain and a post-gain range. Based on these values, the instrument calculates the supply voltage V_{cc}.

All modes support envelope shaping.

7.5.2.2 Signal Parameters for Testing According to the eTrak® Specification

In the R&S SGT, you can select one of the predefined eTrak® interface types so that the generated signal is conform with the MIPI®Alliance specification "Analog Reference Interface for Envelope Tracking Specification".

Table 7-5: Default parameters per eTrak® Interface Type

Parameter	1.2 Vpp	1.5 Vpp	2 Vpp
I/Q output Type	Differential	Differential	Differential
Bias	500 mV	600 mV	900 mV
Vpp Max	1.2 V	1.5 V	2 V
Vcc Max	1.2 V	1.5 V	2 V
Bipolar Input	On	On	On

7.5.2.3 Envelope Shaping and Shaping Methods

Envelope shaping is a method that uses functions to describe the relationship between supply voltage and RF input power. An envelope shaping function is a trade-off between effectivity and improved linearity of the PA.

In the R&S SGT, you can select the way you define the shaping function. You can choose between:

- 2 predefined simple linear functions
  (see "About the Linear Functions" on page 149)
- 3 detroughing functions with a configurable factor
  (see "About the Detroughing Function" on page 149)
- A polynomial function with up to 10 polynomial coefficients
  (see "About the Polynomial Function" on page 150)
- A shaping function defined as a shaping table
  (see "About the Shaping Table" on page 151)
- To set the correction values in raw format with a single remote control command
  (see "Shaping Function in Raw Data Format" on page 152)

The linear, the detroughing and the polynomial shaping functions are mathematical expressions that are described as function of the variable x, see Table 7-6.

Table 7-6: Definition of the variable x depending on the envelope voltage adaptation mode

"Envelope Voltage Adaptation"	x
Auto Power	$x = V_{in} - V_{in,\ min}$ $x \geq 0$
Auto Normalized	$x = V_{in}/V_{in,max}$
Manual	$x = V_{Env}/V_{Env,max}$

The mathematical expressions and further information on the shaping functions are provided in the corresponding sections.

See also "Converting Shaping Functions and Understanding the Displayed Values" on page 152.

About the Linear Functions

The linear shaping can be used for less demanding applications, simple analysis, and the first interactions by designing the optimum envelope shape. Because the shaping gain of the linear function is 0 dB, in "Envelope Voltage Adaptation > Manual" mode this function is suitable for determining the "Pre-/Post-Gain" values (see Example "Calculating the current V_{CC} in "Manual" mode" on page 156).

Provided are two linear functions, where each of them depends on the "Envelope Voltage Adaptation" mode:

- Linear (Voltage)
  – f(x) = x in "Auto Normalized/Manual"
  – f(x) = b*x + $V_{cc,min}$ in "Auto Power"
- Linear (Power)
  – f(x) = x^2 in "Auto Normalized/Manual"
  – f(x) = b*x^2 + $V_{cc,min}$ in "Auto Power"

Where:

- the variable *x* depends on the "Envelope Voltage Adaptation" mode, see Table 7-6.
- The constant *b* is calculated as:
  b = ($V_{cc,max}$ - $V_{cc,min}$)/($V_{in,max}$ - $V_{in,min}$)

See also "Converting Shaping Functions and Understanding the Displayed Values" on page 152.

About the Detroughing Function

Detroughing functions are well-defined mathematical functions that prevent that the supply voltage V_{cc} drops down to zero or falls under specified limits. That is, they prevent that the signal is clipped.

Provided are the following functions:

- f(x) = x + d*$e^{-x/d}$
- f(x) = 1 - (1 - d)*cos(x*pi/2)
- f(x) = d + (1 - d)*x^a

Where:

- x is a variable, that depends on the "Envelope Voltage Adaptation" mode, see Table 7-6
- a is the Exponent (a)

- d is the Detroughing Factor (d), that limit the supply voltage V_{cc} in the low-power region and controls the shaping.
  The detroughing factor (d) can be set manually or derived from the selected V_{cc} value. In the latter case, it is calculated as follows:
  $d = V_{cc,min}/V_{cc,max}$
  See Couple Detroughing Factor with Vcc.
  A "Detroughing Factor = 0" defines a linear function.

See also "Converting Shaping Functions and Understanding the Displayed Values" on page 152.

About the Polynomial Function

The polynomial function is an analytical method to describe a shaping function. The polynomial function is defined as follows:

$f(x) = a_0 + \sum(a_n * x^n)$, where $n \leq 10$ and:

- Depending on the "Envelope Voltage Adaptation" mode, *f(x)* is:
  - $f(x) = V_{cc}(x)$ in "Auto Power"
  - $f(x) = V_{cc}/V_{cc,max}(x)$ in "Auto Normalized/Manual"
- The polynomial order *n*, the polynomial constant a_0, and polynomial coefficients a_0 to a_n are user-definable, see Chapter 7.5.7, "Polynomial Coefficients Setting", on page 176
- *x* depends on the "Envelope Voltage Adaptation" mode, see Table 7-6

The default polynomial function with n = 1, a_0 = 0 and a_0 = 1 describes a linear function.

See also

- Figure 7-20
- "Converting Shaping Functions and Understanding the Displayed Values" on page 152.

File format of the polynomial function file

You can store a polynomial function in a file or even define the polynomial coefficients, store them as a file and load this file into the instrument. The polynomial files are files with extension `*.iq_poly`.

The file contains an optional header `# Rohde & Schwarz - IQ Output Envelope Polynomial Coefficients # a0,a1,a2,...` and a list of comma-separated coefficient values.

Example: Polynomial function file content

```
# Rohde & Schwarz - IQ Output Envelope Shaping Table
# a0,a1,a2,...
0.135,0.91,0.34,-0.59,-0.11
```

About the Shaping Table

The envelope shaping table is a widely used method to define the shaping function. This kind of definition is suitable if you have knowledge on or aim to achieve an exact relation between supply voltage and RF input power. For example, with suitable settings, the shaping table can precisely describe the transition region of the PA.

You can receive information on suitable envelope shaping values form the power amplifier manufacturer.

In the R&S SGT, there are two ways to define a shaping table function:

- **Externally**
  Create a shaping table file as a CSV file with Microsoft Excel, with a Notepad or a similar tool, save it with the predefined extension, transfer it to and load it into the instrument.
  See also "File format of the shaping table file" on page 151.
- **Internally**
  Use the built-in editor table editor, see Chapter 7.5.6, "Edit I/Q Envelope Shape Settings", on page 175.

File format of the shaping table file

The shaping table files are files with predefined extension and simple file format, see Table 7-7.

Table 7-7: Shaping table files: format and extensions

"Envelope Voltage Adaptation"	File extension	Header (optional)
Auto Power	`*.iq_lutpv`	`# Rohde & Schwarz - IQ Output Envelope Shaping Table` `# Power[dBm],Vcc[V]`
Auto Normalized/Manual	`*.iq_lut`	`# Rohde & Schwarz - IQ Output Envelope Shaping Table` `# Vin/Vmax,Vcc/Vmax`

The header is optional. The file content is list of up to 4000 comma-separated value pairs; a new line indicator separates the pairs.

Example: Shaping table file content (*.iq_lut file)

```
# Rohde & Schwarz - IQ Output Envelope Shaping Table
# Vin/Vmax,Vcc/Vmax
0.3,0.4
0.35,0.45
0.56,0.55
0.4,0.5
0.6,0.65
0,0.135
```

Shaping Function in Raw Data Format

The shaping values are defined directly, with a single remote control command. You define the up to 4000 comma-separated value pairs, describing the `Vin/Vmax,Vcc/Vmax` or `Power[dBm],Vcc[V]`.

Example:

```
SOURce1:OUTPut:ANALog:ENVelope:SHAPing:PV:FILE:DATA 0,0, 0.1,0.2, 1,1
```

See:

- [:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:DATA on page 443
- [:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:DATA on page 443
- [:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:NEW on page 444
- [:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:NEW on page 444

Converting Shaping Functions and Understanding the Displayed Values

If an envelope function is defined, the "Shaping" dialog displays the diagram of the resulting envelope shape (see for example Figure 7-15).

Several parameters influence the displayed information:

- The selected "Envelope Voltage Adaptation" determines whether the x-axis uses normalized or linear values
- The selected "Graphic Configuration > Scale" sets the x-axis units
- The selected V_{cc}Min/Max and PEP_{in}Min/Max values set the borders of the clipping areas
- The selected "Shaping" function and the parameters influence the envelope shape.

The illustration on Figure 7-10 shows how these parameters influence a linear shaping function.

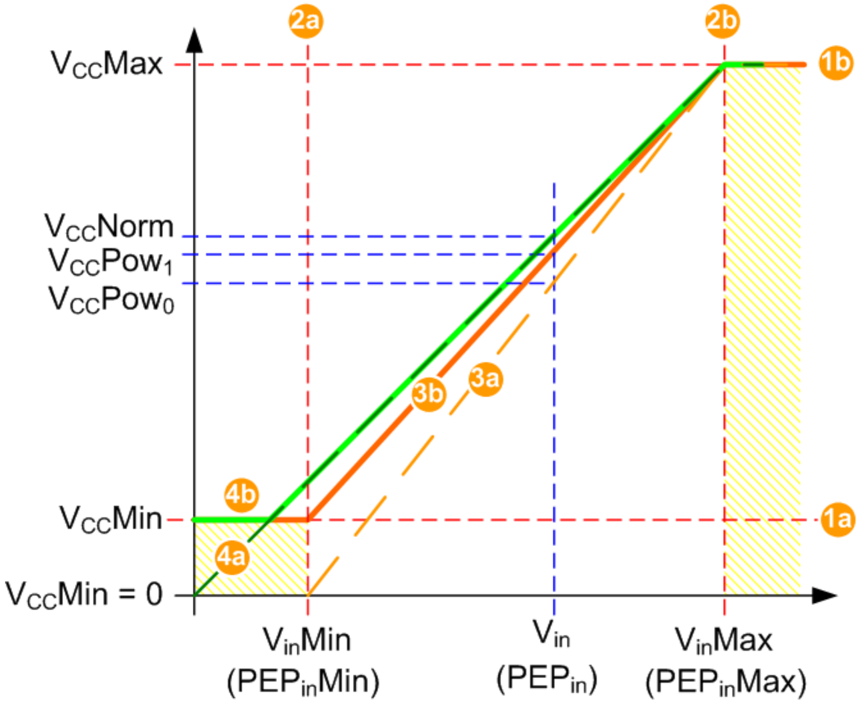


Figure 7-10: Understanding the displayed values ("Shaping > Linear (Voltage)"

Shaded area	= Area where the signal is clipped and the envelope signal is held constant
1a, 1b, 2a, 2b	= $V_{cc,min}$/$V_{cc,max}$ and PEP_{in}Min/Max values that set the borders of the clipping areas
Shaping	= Linear (Voltage)
3a	= Linear function (dashed line) in "Auto Power" mode, if $V_{cc,min}$ = 0 V
3b	= Linear function in "Auto Power" mode, if $V_{cc,min}$ > 0 V
4a	= Linear function (dashed line) in "Auto Normalized" mode, if $V_{cc,min}$ = 0 V
4b	= Linear function in "Auto Normalized" mode, if $V_{cc,min}$ > 0 V
V_{in}	= Operating point
V_{cc}Norm	= V_{cc} in "Auto Normalized" mode
$V_{cc}Pow_0$	= V_{cc} in "Auto Power" mode and $V_{cc,min}$ = 0 V
$V_{cc}Pow_1$	= V_{cc} in "Auto Power" mode and $V_{cc,min}$ > 0 V

For information on the provided shaping functions and their formulas, see:

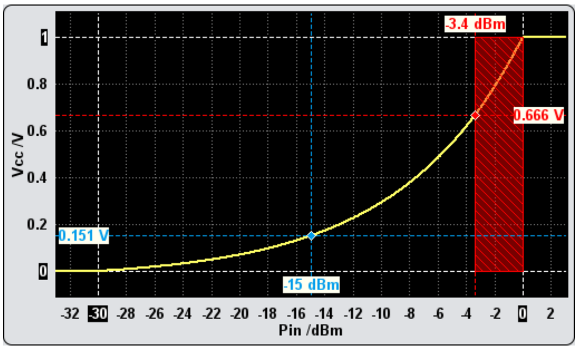
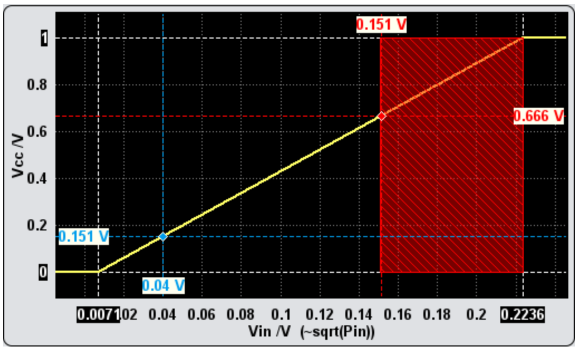
- "About the Linear Functions" on page 149
- "About the Detroughing Function" on page 149
- "About the Polynomial Function" on page 150

The group of examples in this section uses the same linear shaping function to explain the representation in the different voltage adaptation modes. The example explains the displayed values and how they are calculated and converted. The same principle applies for the other shaping methods.

Common settings

- "Envelope Voltage Adaptation > Auto Power"
- $V_{cc,max}$ = 1 V
- PEP_{in}Min = -30 dBm corresponds to $V_{in,min}$ = 0.0071 V
- PEP_{in}Max = 0 dBm corresponds to $V_{in,max}$ = 0.2236 V

- P_{in} = -15 dBm corresponds V_{in} = 0.04 V
- PEP = -3.4 dB
- "Shaping > Linear (Voltage)"

"Graphic Scale > Power"	"Graphic Scale > Voltage"
	

Example: Calculating the current $V_{cc}Pow_0$ ("Auto Power" mode, $V_{cc,min}$ = 0 V)

Configuration as described in Common settings and:

- **$V_{cc,min}$ = 0 V**
- f (x) = b*x + $V_{cc,min}$
  (see "About the Linear Functions" on page 149)

$V_{cc}Pow_0 = [(V_{cc,max} - V_{cc,min})/(V_{in,max} - V_{in,min})] * (V_{in} - V_{in,min}) + V_{cc,min}$

$V_{cc}Pow_0 = [(1 - 0)/(0.2236 - 0.0071)]*(0.04 - 0.0071) + 0$

$V_{cc}Pow_0$ = 0.151 V

Example: Calculating the current $V_{cc}Pow_1$ ("Auto Power" mode, $V_{cc,min}$ > 0 V)

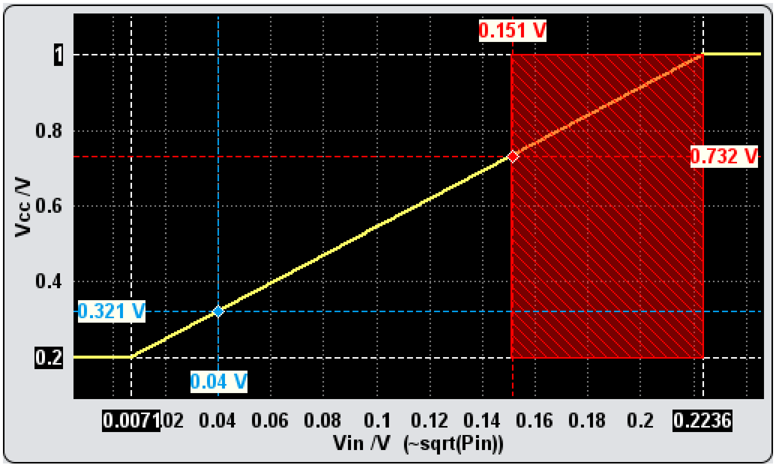
Configuration as described in Common settings and:

- **$V_{cc,min}$ = 200 mV**

$V_{cc}Pow_1 = [(V_{cc,max} - V_{cc,min})/(V_{in,max} - V_{in,min})] * (V_{in} - V_{in,min}) + V_{cc,min}$

$V_{cc}Pow_1 = [(1 - 0.2)/(0.2236 - 0.0071)]*(0.04 - 0.0071) + 0.2$

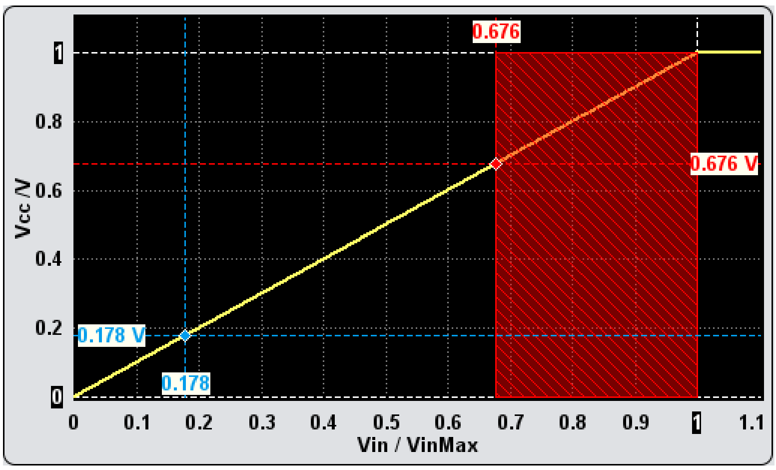
$V_{cc}Pow_1$ = 0.321 V



Example: Calculating the current $V_{cc}Norm$ ("Auto Normalized" mode)

Configuration as described in Common settings and:

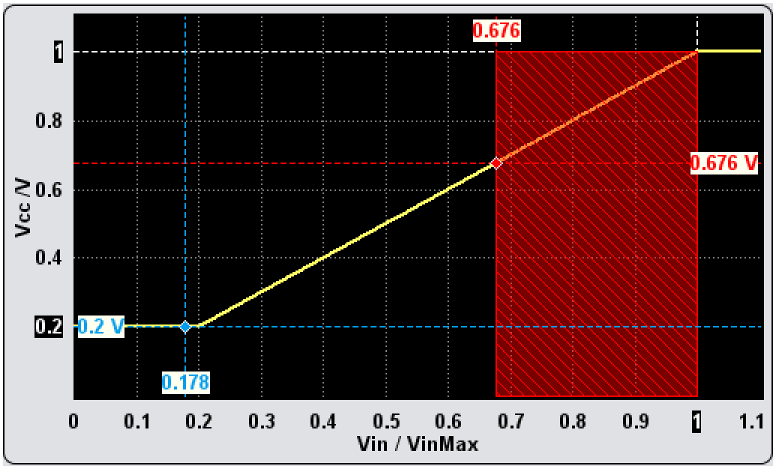
- "Envelope Voltage Adaptation > Auto Normalized"
- The x-axis shows the normalized values $V_{in}/V_{in,max}$;
  The operating point with V_{in} = 0.04 V corresponds to
  $V_{in}/V_{in.max}$ = 0.04 / 0.2236 = 0.178
- f (x) = x, i.e.
  $V_{cc}Norm = V_{in}/V_{in,max}$
  $V_{cc}Norm$ = 0.178 V



If the $V_{cc,min}$ value is changed ($V_{cc,min}$ > 0 V), then the following applies:

- If 0 < $V_{in}/V_{in,max} \leq V_{cc,min}$, the signal is clipped and V_{cc}Norm = $V_{cc,min}$
- If $V_{in}/V_{in,max} > V_{cc,min}$, then V_{cc}Norm = $V_{in}/V_{in,max}$

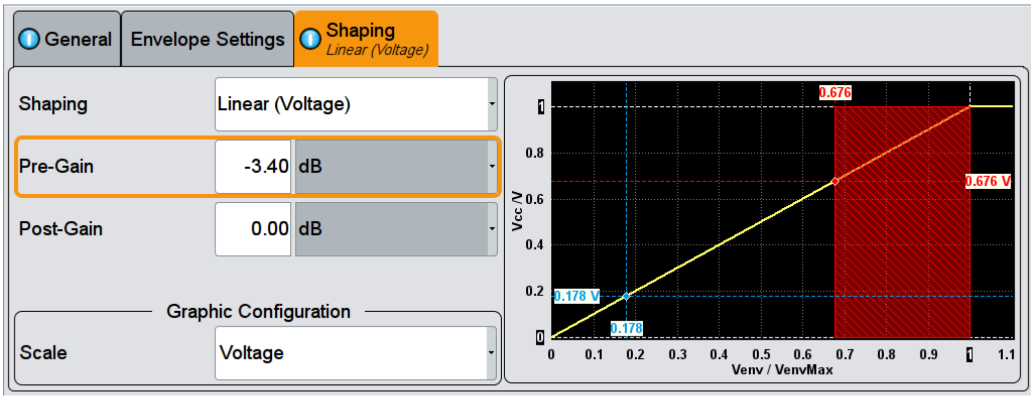
For the previous example, if $V_{cc,min}$ = 200 mV, that V_{cc}Norm = $V_{cc,min}$ = 0.2 V.



Example: Calculating the current V_{CC} in "Manual" mode

In "Envelope Voltage Adaptation > Manual" mode, set the parameter "Pre-Gain = PEP = - 3.4 dB".

The displayed shaping function resembles the shaping function in "Auto Normalized" mode; the same formulas apply, too.



You can also query the V_{CC} values for any specified x in the supported voltage adaptation mode and units.

See `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue?` on page 440.

Additional information

The described principle applies for any shaping function.

Only if linear shaping is used, the V_{CC}Norm can also be directly converted to V_{CC}Pow according to the following formula:

$f_{Pow}(x) = [f_{Norm}(x) - V_{in,min}/V_{in,max}]*[(V_{cc,max} - V_{cc,min})/(1 - V_{in,min}/V_{in,max})]$

For example, if $f_{Norm}(x) = V_{CC}Norm = 0.178$ V, $f_{Pow}(x) = V_{cc}Pow_0$ is:

$V_{cc}Pow_0 = [0.178 - 0.0071/0.2236]*[(1 - 0)/(1 - 0.0071/0.2236)]$

$V_{cc}Pow_0 = 0.151$ V

7.5.3 General RF Envelope Settings

To access the related settings and enable the generation of the envelope signal

1. Select the I/Q OUT connector to unfold the "I/Q Analog" block.
2. Select "I/Q Analog > I/Q Analog Settings > General".
3. Select "RF Envelope > On".
4. Select "I/Q Output Type > Differential".
5. Select "Envelope Voltage Adaptation > Auto Power".

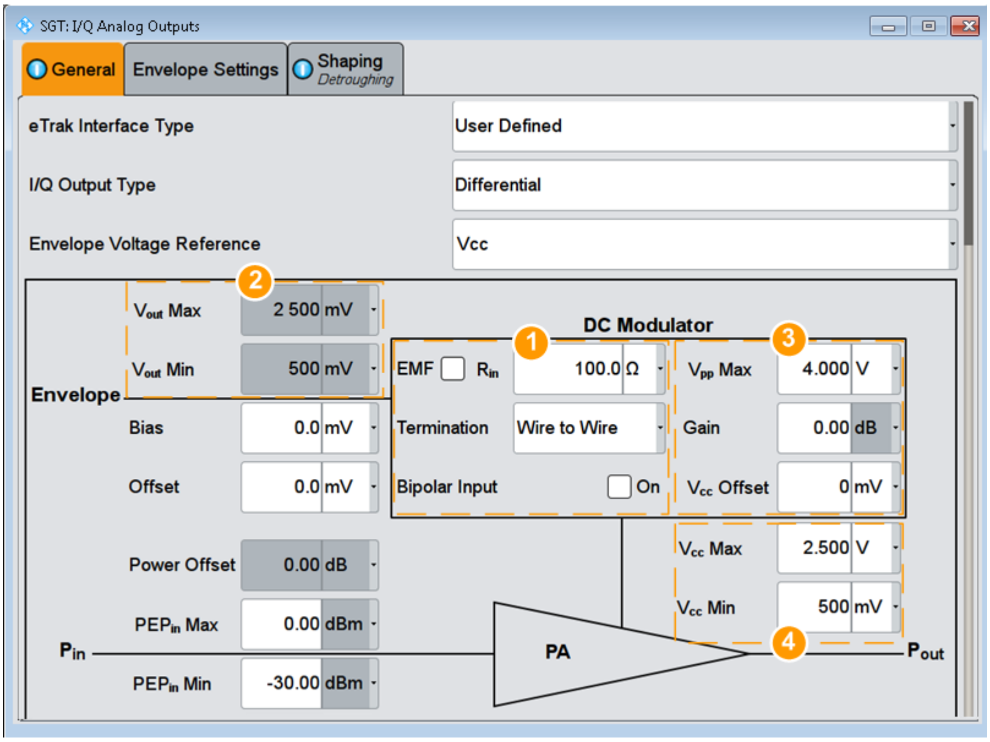


Figure 7-11: RF Envelope Settings (Example)

1 = Termination and input impedance of the circuit board
2 = Voltage level measured at the circuit board
3 = Signal characteristics of the DC Modulator
4 = Signal characteristics at the inputs of the PA (see the documentation of the PA, for example its data sheet)

The dialog displays a block diagram with parameters, necessary to configure the envelope signal.

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 426

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

Parameter	Value
"I/Q Level Vp (EMF)"	1 V
"Bias (EMF)"	0 V

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet on page 426

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 filename and the directory, in which the settings are stored, are user-definable; the file extension is however predefined.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:CATalog? on page 426
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:STORe on page 426
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:LOAD on page 427
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:SETTing:DELete on page 427

RF Envelope
In instruments equipped with option R&S SGT-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.

See:
- Chapter 7.5, "Generation of Envelope Tracking Signals", on page 146

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:STATe on page 435

Envelope Voltage Adaptation
In instruments equipped with option R&S SGT-K540, defines the way you configure the voltage of the envelope tracking generator (see Chapter 7.5.2.1, "Envelope Voltage Adaptation Modes", on page 147).

"Auto Normalized"
Generation based on the physical characteristics of the power amplifier; the power values are normalized based on the selected PEPin Max value.
This mode enables you to use the complete range of a selected detroughing function.
See also Shaping Settings and compare the values on the X axis on the graphical display.

"Auto Power"
Generation based on the physical characteristics of the power amplifier, where the input power of the PA "PEP_{in}" is defined with its min and max values.

"Manual"
Generation, in that the operating range of the amplifier is defined based on a pre-gain and a post-gain range.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:ADAPtion on page 435

eTrak® Interface Type
Selects one of the predefined interface types or allows user-defined settings.

See Chapter 7.5.2.2, "Signal Parameters for Testing According to the eTrak® Specification", on page 148.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:ETRak on page 435

Envelope Voltage Reference
Defines whether the envelope voltage V_{out} is set directly or it is estimated from the selected supply voltage V_{cc}.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VREF on page 436

I/Q Output Type
Selects the type of output signal.

The provided parameters in the "I/Q Analog Outputs" dialog depend on the selected output mode.

"Differential"
- If "RF Envelope > On"
  The inverted envelope signal Ē is output at the I BAR connectors.
- If "RF Envelope > Off"
  The analog I/Q signal components are output at the I/Q BAR connectors.

"Single-Ended"
- If "RF Envelope > On"
  The envelope signal E is output at the I connectors.
- If "RF Envelope > Off"
  Single-ended output at the I/Q connectors.

You can define a bias between the output signal and ground.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE on page 427

V_{out}Min/Max
Sets or displays the minimum and maximum values of the peak-to-peak voltage V_{out} voltage on the interface between the circuit board and the DC modulator.

To measure the V_{out} voltage:
- Use a suitable probe, i.e. use a differential probe if a "Wire to Wire" termination is used and a single ended probe otherwise
- Measure at the circuit board after the termination impedance R_{in}.

If estimated, the "V_{out}Min/Max" values are calculated based on the selected supply voltage V_{cc}Min/Max and enabled Gain and V_{cc}Offset in the DC modulator.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VOUT:MIN on page 437
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VOUT:MAX on page 437

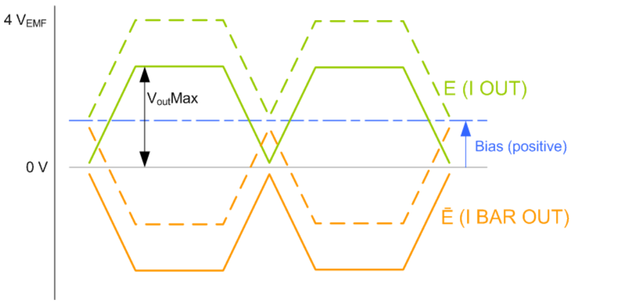
Bias

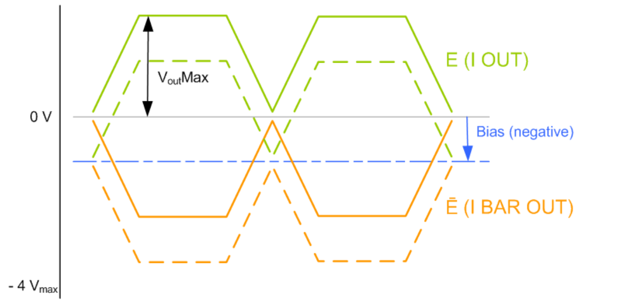
If a bias is enabled, a DC voltage is superimposed upon the envelope signal E and the inverted envelope signal E BAR.

"I/Q Output Type"	Termination	"Bias" defines
Single Ended	-	The bias between the envelope signal E and ground
Differential	"To Ground"	Superimposed DC voltage = "Bias", where "Bias" is related to the selected R_{in}. See also Table 7-8
	"Wire To Wire"	Superimposed DC voltage = "Bias", where "Bias" is related to high impedance (1 MΩ).

Table 7-8: Effect of enabled bias

Effect of a positive bias	Effect of a negative bias





Use this parameter to define the operating point of a DUT.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:BIAS` on page 437

Offset

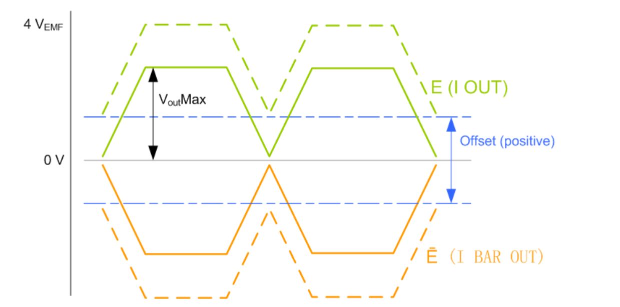
Sets an offset between the envelope and the inverted envelope signal.

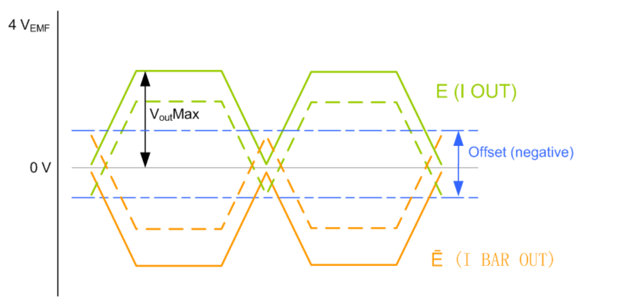
The value range is dynamically adjusted.

The selected offset is set half in the positive and half in the negative direction.

Table 7-9: Effect of an enabled envelope offset

Effect of a positive envelope offset	Effect of a negative envelope offset





See also "V_{cc}Offset" on page 164.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:OFFSet` on page 437

DC Modulator characteristics
Refer to the product documentation of the external DC modulator for information on its characteristics.

The following settings are required:

EMF ← DC Modulator characteristics
Defines whether the EMF or the voltage value is displayed.

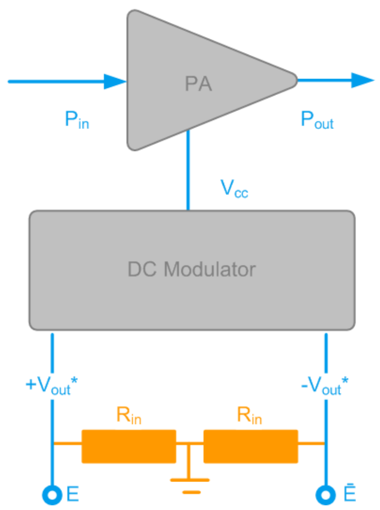
An EMF-based calculation assumes an open-end circuit. Disable this parameter for testing in more realistic conditions, where you define the input impedance of the used external DC modulator R_{in} and the instrument calculates the envelope output voltage V_{out}Min/Max based on it.

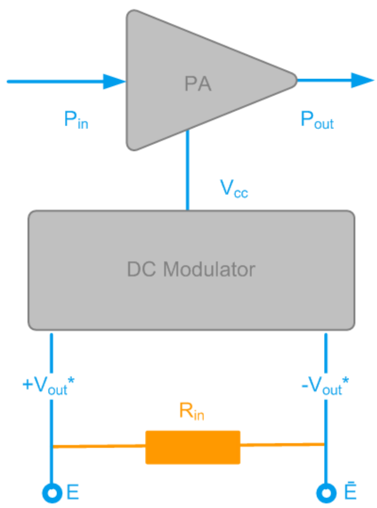
Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:EMF[:STATe]` on page 438

R_{in} ← DC Modulator characteristics
With disabled parameter EMF, sets the input impedance R_{in} of the used external DC modulator.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:RIN` on page 438

Termination ← DC Modulator characteristics
If the "I/Q Output Type > Differential", defines the way the inputs of the DC modulator are terminated.

<table>
<tr><th>"To Ground"</th><th>"Wire to Wire"</th></tr>
<tr><td>

*) Bias = 0 and Offset = 0</td><td>

*) Bias = 0 and Offset = 0</td></tr>
<tr><td>Both inputs of the DC modulator are terminated to ground.</td><td>This termination is also referred as a common mode voltage.</td></tr>
</table>

The termination influences the way an enabled Bias is applied.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:TERMination on page 438

Bipolar Input ← DC Modulator characteristics

If the "I/Q Output Type > Differential", enables the instrument to generate a bipolar signal.

The envelope signal E swings above and below the inverted envelope signal E BAR; the R&S SGT calculates and applies a suitable envelope Offset automatically, see Figure 7-12.

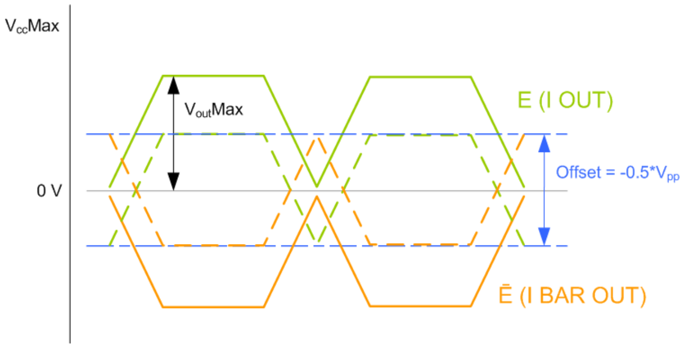


Figure 7-12: Effect of a "Bipolar Input > On"

This parameter influences the lower limit of the supply voltage V_{cc}.

The generated signal is conform with the MIPI®Alliance specification "Specification for Analog Reference Interface for Envelope Tracking".

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:BINPut on page 439

V_{pp}Max ← DC Modulator characteristics

Sets the maximum value of the peak-to-peak driving voltage V_{pp} of the used external DC modulator.

The V_{pp} limits:

- The value range of the supply voltage V_{cc}Min/Max
  $V_{pp} \geq V_{CC}$Max
- In I/Q Output Type > Differential, the voltage of the generated envelope signal V_{out}Min/Max as follows:
  $V_{pp} \geq V_{out}$Max[E] - V_{out}Max[E BAR], where [E] and [E BAR] refer to the envelope signal and the inverted envelope signal.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VPP[:MAX] on page 437

Gain ← DC Modulator characteristics

Sets the gain of the used external DC modulator.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:GAIN on page 439

V_{cc}Offset ← DC Modulator characteristics

Applies a voltage offset on the supply voltage V_{cc}Min/Max, i.e. compensates a possible offset from the external DC modulator. The envelope output voltage V_{out}Min/Max is reduced by this value to maintain the supply voltage V_{cc} in the defined value range.

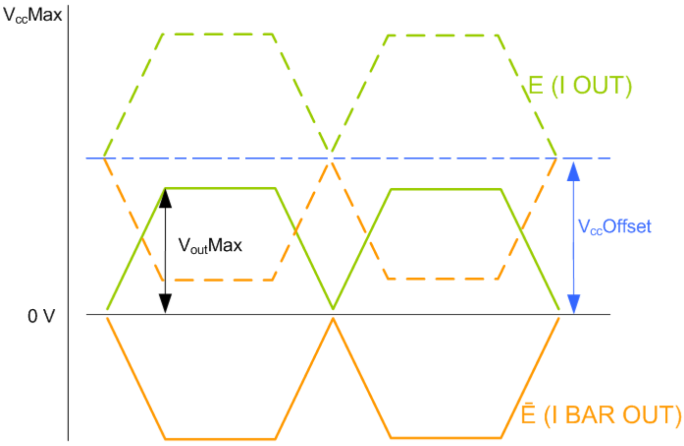


Figure 7-13: Effect of a Vcc offset

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:OFFSet` on page 439

PA characteristics

Refer to the product documentation of the PA for information on its characteristics.

The following settings are required:

V_{cc}Min/Max ← PA characteristics

Sets or displays the minimum and maximum values of the supply voltage V_{cc}, as required by the used power amplifier (PA).

The value range of the supply voltage V_{cc} is determined by the allowed peak-to-peak driving voltage V_{pp} of the used external DC modulator and the enabled V_{cc}Offset.

$V_{cc}Max \le V_{pp}Max$

The V_{cc} is calculated as follows:

V_{cc} = Vout*Gain + V_{cc}Offset

Example:

Envelope Voltage Reference = V_{cc}

V_{cc}Offset = 0 mV

V_{cc}Max = 1 V = 0 dBV

Gain = 3 dB

V_{cc}Max [dBV] - Gain [dB] = V_{out}Max or

V_{out}Max = 0 dBV - 3 dB = -3 dBV = 0.708 V

"Bipolar Input"	Value range "V_{cc}Min"
"State > On"	V_{cc}Min = - 0.5*V_{pp}Max **Note:** Implemented as a V_{cc}Offset, see Figure 7-12.
"State > Off"	V_{cc}Min = 0 to V_{cc}Max

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:MIN on page 439
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:MAX on page 439

Power Offset ← PA characteristics
Indicates an enabled power offset, for example to compensate power attenuation because of cable lengths.

The displayed value is applied as level offset to the generated RF signal and considers the following settings:
- "RF > RF Level > Level > Offset"
- "RF > RF Level > UCOR"

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:POWer:OFFSet?
on page 442

PEP_{in}Min/Max ← PA characteristics
Sets the minimum and maximum values of the input power PEP_{in}, as required by the used power amplifier (PA).

The "PEP_{in}Min/Max" parameters define the linear range of the PA. Refer to the product documentation of the PA for information on the characteristics of the required input signal.

The value range corresponds to the value range of output level.

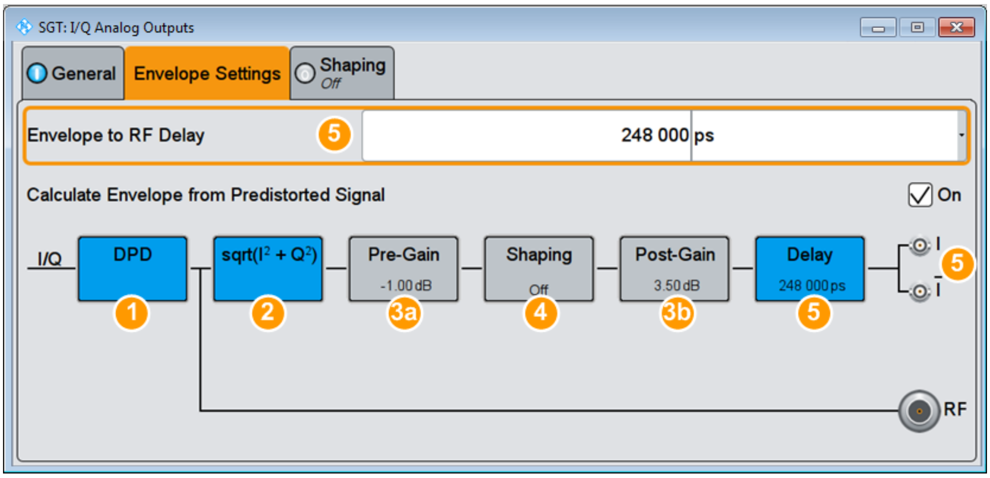
Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:PIN:MIN on page 441
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:PIN:MAX on page 441

7.5.4 Envelope Settings

The envelope tracking is a feature that requires the additional option R&S SGT-K540.

To access the envelope settings

1. Enable the generation of envelope tracking signal, see "To access the related settings and enable the generation of the envelope signal" on page 157.
2. Select "I/Q Analog Settings > Envelope Settings".



1 = Enabled Digital Predistortion
2 = Envelope detector, √[I(t)²+Q(t)²]; indication changes, depending on the Envelope Voltage Adaptation
3a, 3b = Pre-Gain/Post-Gain (available in "Envelope Voltage Adaptation > Manual" mode
4 = Shaping state and shaping function; grey background color = deactivated shaping
5 = Enabled Envelope to RF Delay
6 = Indicates the output connectors, depending on the I/Q Output Type

The dialog displays an *interactive* overview diagram of the ET processing chain. The diagram displays information on shaping state, incl. current shaping method and setting, like gains or delay.

Tip: Hotspots for quick access. The displayed blocks are hotspots. Select one of them to access the related function.

3. To shape the envelope signal, perform one of the following:
   a) on the overview diagram, select the "Shaping" block
   b) select "I/Q Analog Settings > Shaping"

   See Chapter 7.5.5, "Shaping Settings", on page 167.

Envelope to RF Delay

Sets the time delay of the generated envelope signal relative to the corresponding RF signal. A positive value means that the envelope signal delays relative to the RF signal and vice versa.

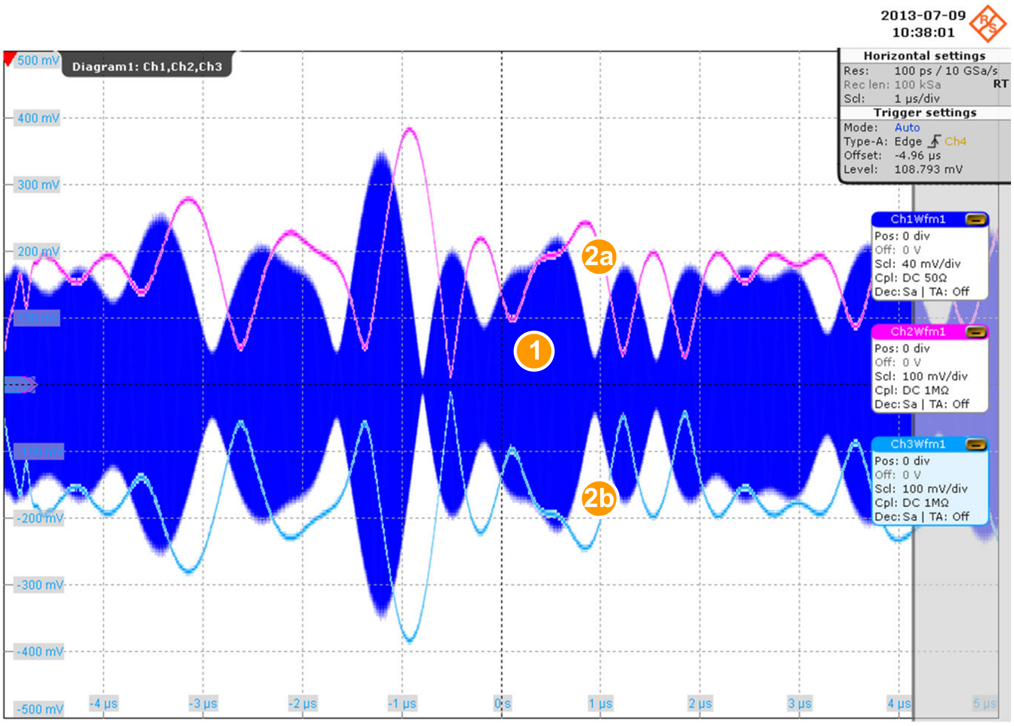


Figure 7-14: Effect of enabled positive RF delay

1 = RF signal
2a, 2b = Envelope signal E and inverted envelope signal E BAR

Use this parameter to compensate possible timing delays caused by connected cables and align the input signals at the PA to prevent unwanted effects, like memory effects or decreased linearity.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:DELay` on page 436

Calculate Envelope form Predistorted Signal

In instruments equipped with option R&S SGT-K541, enables the calculation of the envelope signal from the original baseband signal or from the AM/AM and/or AM/FM predistorted signal.

See also Chapter 7.6, "Applying Digital Predistortion", on page 178.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:FDPD` on page 436

7.5.5 Shaping Settings

The envelope tracking is a feature that requires the additional option R&S SGT-K540.

To access the shaping settings in "Envelope Voltage Adaptation > Auto Power/ Normilization" mode

1. Select "I/Q Analog > I/Q Analog Settings > General".

2. Enable "RF Envelope > On".
3. Enable "Envelope Voltage Adaptation > Auto Power/Normalization".
4. Select "I/Q Analog Settings > Shaping".

   With the provided settings, you can configure the shape of the RF envelope signal. The instrument applies the settings and calculates the shaping function. A diagram visualizes the resulting envelope shape, as function of the selected supply voltage V_{cc} and PEP_{in} value limits, the calculated pre-gain and the estimated operating point of the PA.

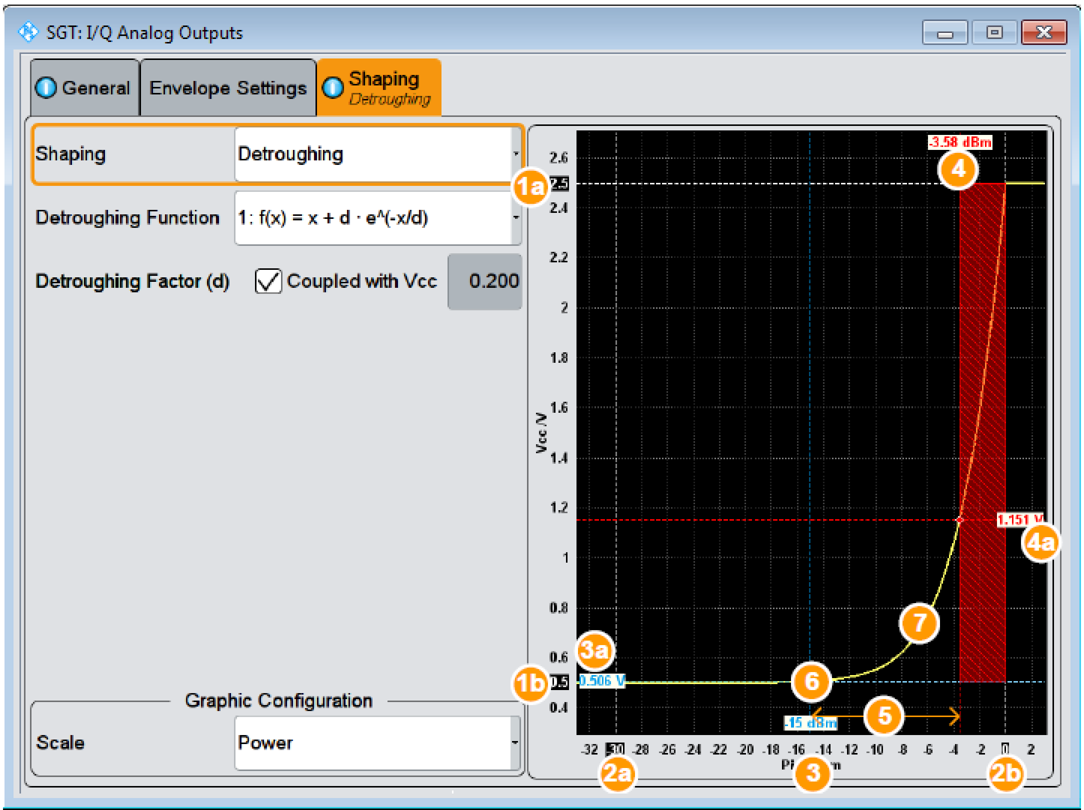


Figure 7-15: Understanding the displayed information ("Envelope Voltage Adaptation > Auto Power", "Shaping > Detroughing")

1a, 1b = Indicates the values of V_{cc}Min/Max
2a = Values smaller than PEP_{in}Min are clipped
2b = Values greater than PEP_{in}Max are clipped
3 = Operating point; corresponds to the RF RMS power level
3a = Current RF RMS power level; an enabled "RF Level > Level Offset" is considered
3b = Current V_{CC}
4 = Crest factor of the generated signal
5a, 5b = The values correspond to the PEP of the generated RF signal and the V_{CC}; shaded area indicates the calculated Pre-Gain
6 = Current envelope shape, defined by the detroughing function and detroughing factor

See also:

- "Converting Shaping Functions and Understanding the Displayed Values" on page 152.

Provided are the following settings:

Shaping

Enables envelope shaping and selects the method to define the shaping function.

For detailed information on the shaping functions, see:

- Chapter 7.5.2.3, "Envelope Shaping and Shaping Methods", on page 148
- "Converting Shaping Functions and Understanding the Displayed Values" on page 152.

"Off" Envelope shaping is not adopted.
Previously configured values of the parameters Pre-Gain and Post-Gain are ignored.

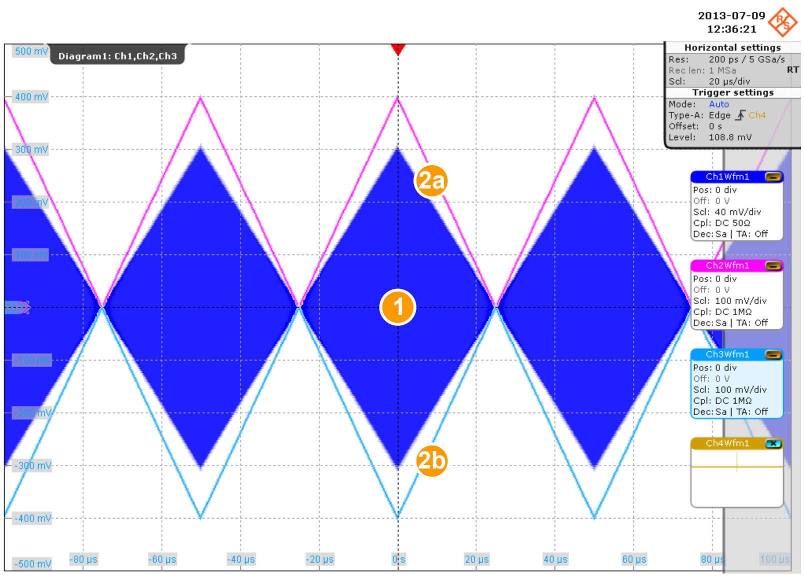


Figure 7-16: Generated RF, envelope and inverted envelope signal

1 = RF signal (simple ramp function)
2a, 2b = Envelope signal E and inverted envelope signal E BAR

"Linear (Voltage)/Linear (Power)"
The shaping function is simple linear function.
The linear shaping is not used in practice but can be used for less demanding applications, simple analysis, and the first interactions by designing the optimum envelope shape. Because the shaping gain of the linear function is 0 dB, in "Envelope Voltage Adaptation > Manual" mode this function is suitable for determining the "Pre-/Post-Gain" values.

"Detroughing"
The shaping function applies a detroughing to prevent that the supply voltage V_{cc} drops down to zero.
Use the Detroughing Factor (d) to limit the supply voltage V_{cc} in the low-power region.

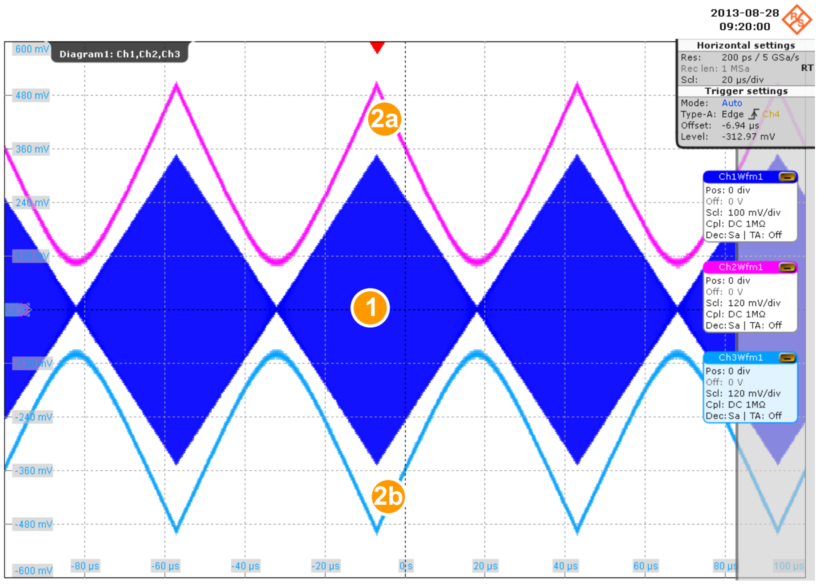


Figure 7-17: Effect of a detroughing function on the envelope and inverted envelope signal

1 = RF signal (simple ramp function)
2a, 2b = Envelope signal E and inverted envelope signal E BAR

"From Table" The shaping function is defined by user defined value pairs in form of a shaping table.
This shaping function is suitable if you have knowledge on or aim to achieve an exact relation between the supply voltage and RF output power, for example by the describing the transition region of a PA.
Select Shaping Table to access the settings.

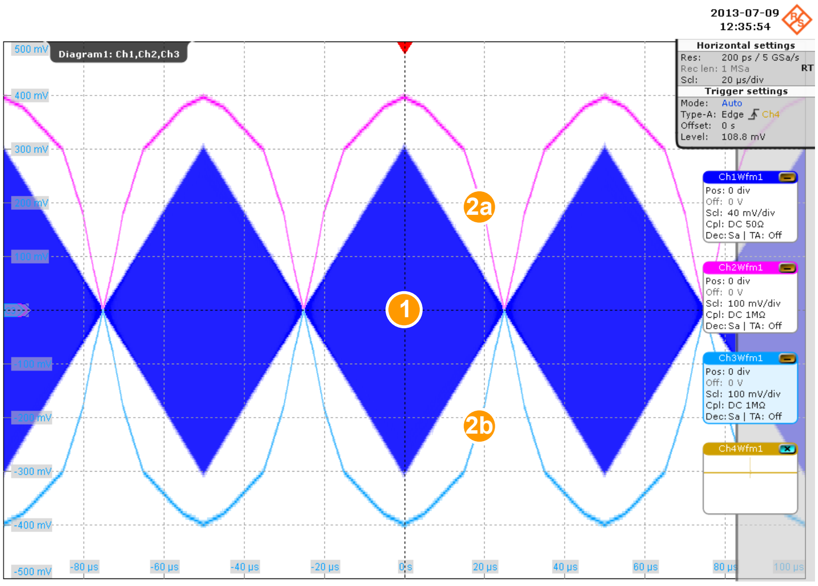


Figure 7-18: Effect of a table shaping on the envelope and inverted envelope signal

1 = RF signal (simple ramp function)
2a, 2b = Envelope signal E and inverted envelope signal E BAR

"Polynomial" The shaping function is defined by a polynomial with configurable order and coefficients.
Select Polynomial Coefficients Setting to access the settings.

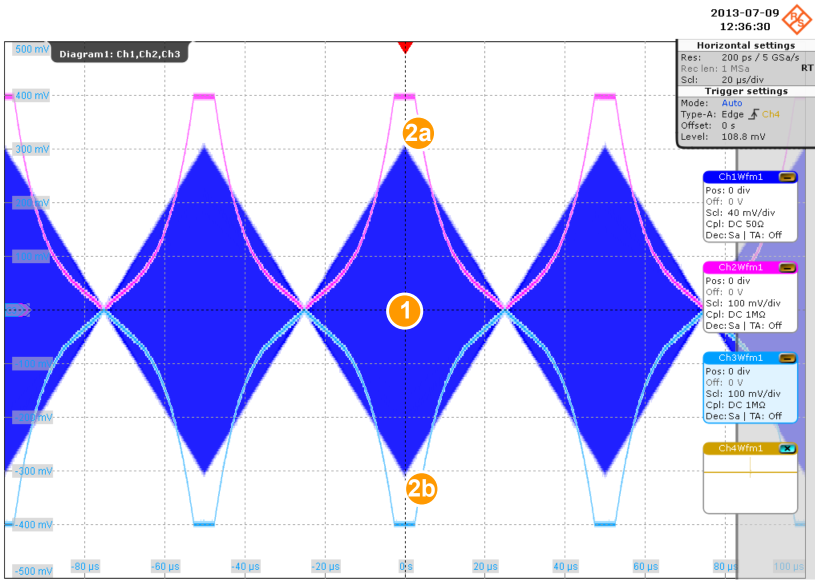


Figure 7-19: Effect of a polynomial shaping on the envelope and inverted envelope signal

1 = RF signal (simple ramp function)
2a, 2b = Envelope signal E and inverted envelope signal E BAR

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:MODE on page 442

Detroughing Function

Selects the mathematical function describing the detroughing.

The following functions are available:

- $f(x) = x + d*e^{-x/d}$
- $f(x) = 1 - (1 - d)*cos(x*pi/2)$
- $f(x) = d + (1 - d)*x^a$

where:

- x depends on the "Envelope Voltage Adaptation" mode, see Table 7-6
- d = Detroughing Factor (d)
- a = Exponent (a)

For more information, see "Converting Shaping Functions and Understanding the Displayed Values" on page 152.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:FUNCtion on page 446

Couple Detroughing Factor with Vcc

Enable this parameter to derive the detroughing factor (d) from the selected V_{cc} value.

This ensures that the minimum supply voltage V_{cc} does not drop under the specified limits and the signal is not clipped.

The detroughing factor is calculated as follows:

d = V_{cc}Min/V_{cc}Max

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:COUPling` on page 446

Detroughing Factor (d)
Sets a start offset to limit the supply voltage V_{cc} in the low-power region.

The detroughing factor also controls the shaping. A "Detroughing Factor = 0" defines a linear function.

See also "Couple Detroughing Factor with Vcc" on page 172.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:FACTor` on page 446

Exponent (a)
Sets the exponent (a) for the third detroughing function, see Detroughing Function.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:PEXPonent` on page 447

Pre-Gain
In "Envelope Voltage Adaptation > Manual" mode, sets a pre-gain (i.e. an attenuation) applied to define the operating range of the power amplifier. The pre-gain can be used to define and test only a specific (required) part of the operating range.

In "Envelope Voltage Adaptation > Auto" mode, the value is calculated automatically as following:

"Pre-Gain" = "Pin max" - "RF Level" + Crest Factor

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:GAIN:PRE` on page 443

Post-Gain
In "Envelope Voltage Adaptation > Manual" mode, sets a post-gain to compensate the attenuation introduced by the pre-gain and the gain of the shaping function.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:GAIN:POST` on page 443

Polynomial Coefficients
Accesses a dialog to describe the envelope shape as a polynomials function, see Chapter 7.5.7, "Polynomial Coefficients Setting", on page 176.

Shaping Table
Accesses the standard "Envelope Select" dialog with functions to define a new shaping table file, select or edit an existing one.

The shaping table files are files with predefined extension and file format, see "File format of the shaping table file" on page 151.

You can create a shaping table externally or internally.

"Select" Selects and loads an existing file

"New" Creates a file

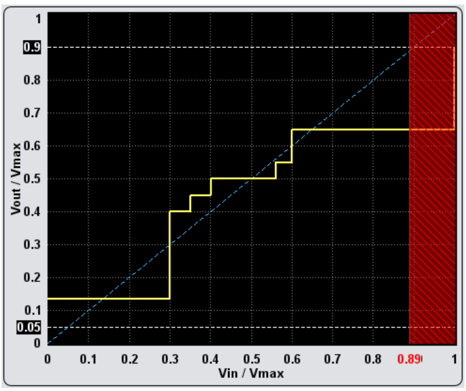
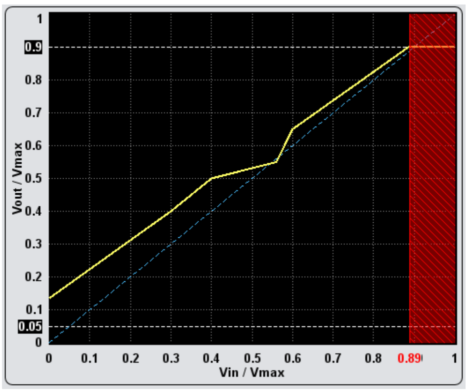
"Edit" Access a standard built-in table editor, see Chapter 7.5.6, "Edit I/Q Envelope Shape Settings", on page 175.

Remote command:
In "Envelope Voltage Adaptation > Manual" mode:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:CATalog?`
on page 443
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE[:SELect]`
on page 443
In "Envelope Voltage Adaptation > Auto" mode:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:CATalog?` on page 443
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE[:SELect]` on page 443

Interpolation
Enabled in "Shaping > From Table".

An envelope shaping function defined in a table contains a limited number of value pairs. This parameter enables a linear interpolation between the defined values to prevent abrupt changes.

Table 7-10: Effect of parameter "Interpolation"

"Interpolation > Off"	"Interpolation > Linear Voltage"
	

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:INTerp`
on page 444

Graphic Configuration
Comprises setting to configure the graphical display.

Scale ← Graphic Configuration

Determines the units, "Voltage" or "Power", used on the x and y axis.

Table 7-11: Units on the x axis

	"Scale > Power"	**"Scale > Voltage"**
Envelope Voltage Adaptation > Auto Power	P_{in} [dBm]	V_{in} [V] = $\sqrt{P_{in}}$
Envelope Voltage Adaptation > Auto Normalized	P_{in}/P_{max}	V_{in}/V_{max}

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:SCALe
on page 442

Diagram ← Graphic Configuration

Visualizes the resulting envelope shape, as function of the selected supply voltage V_{cc} and PEP_{in} value limits, the calculated pre-gain and the estimated operating point of the PA.

See Figure 7-15.

Remote command:
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue:LEVel?
on page 440
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue:PEP?
on page 440
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue? on page 440

7.5.6 Edit I/Q Envelope Shape Settings

The envelope shaping table is a method to define the shaping function.

To access the internal table editor

1. Select "I/Q Analog > I/Q Analog Settings > General".
2. Enable "RF Envelope > On".
3. Select "Envelope Voltage Adaptation > Manual".
4. Select "Shaping Settings > Shaping > From Table".
5. Select "Shaping Table > Envelope Shaping File > New"
6. Enter the "File Name", e.g. *MyLUT*

   The "Envelope Shaping File" dialog closes.
   The "Shaping > Shaping Table" confirms that the newly created file is assigned.
7. Select "Shaping Table > Envelope Shaping File > Edit"
8. Define the value pairs "Vin/Vmax" and "Vcc/Vmax". The order is uncritical.
9. Select "Save".

The instrument loads the configured values automatically and displays the shaping function.

10. Select "Shaping Settings > Interpolation > Linear (Voltage)".

    The display confirms the used interpolation.

Vin/Vmax, Vcc/Vmax/Power (dBm), Vcc (V)

Sets the normalized values of the value pairs.

"Vin/Vmax, Vcc/Vmax"
: Value pairs in "Envelope Voltage Adaptation > Manual/Auto Normalized" mode.

"Power(dBm), Vcc(V)"
: Value pairs in "Envelope Voltage Adaptation > Auto Power" mode.

Remote command:
n.a.

Goto, Edit, Save As, Save

Standard functions for editing of data lists.

Changed and unsaved values are displayed on a yellow background.

Remote command:
n.a.

Fill Table Automatically

Standard function for filling a table automatically with user-defined values.

"From / Range"
: Defines the start line and number of the rows to be filled.

"Select Column to Fill"
: Selects the respective value, including the unit.

"Start / End Value"
: Default values corresponding to the selected column.

"Increment"
: Determines the step size.

"Fill"
: Fills the table.
Fill both columns and then save the list. Otherwise the entries are lost.

7.5.7 Polynomial Coefficients Setting

The polynomial function is an analytical method to describe a shaping function.

To access the polynomial coefficients setting and define a higher-order polynomial

1. Select "I/Q Analog > I/Q Analog Settings > General".
2. Enable "RF Envelope > On".
3. Select "Shaping Settings > Shaping > Polynomial".
4. Select "Envelope Voltage Adaptation > Auto Normalized".
5. Select "Polynomial Coefficients"

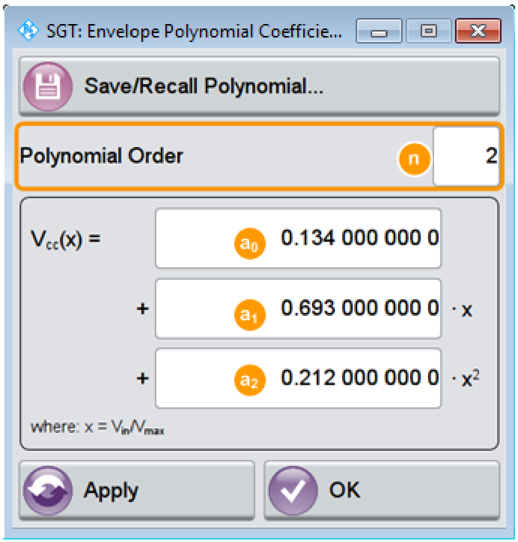


Figure 7-20: Polynomial Coefficients: Understanding the displayed information

With the provided settings, you can define a polynomial function with up to 10^{th} order to describe the envelope shape.

6. Select "Polynomial Order = 2" (n = 2).
7. Set the constant a_0 and the polynomial coefficients a_1 and a_2.
8. Select "Apply".

   The instrument loads the configured values and displays the shaping function.
9. To store the defined shaping function:
   a) Select "Save/Recall Polynomial"
   b) Navigate throughout the file system and enter a "File Name", e.g. *MyPolynomial_2thOrder*
   c) Select "OK".
10. Select "Polynomial Coefficients > OK" to close the dialog.

Save/Recall Polynomial

Accesses the "Save/Recall" dialog, i.e. 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 it is stored in are user-definable; the file extension is however predefined.

The polynomial files are files with extension `*.iq_poly`, see "File format of the polynomial function file" on page 150.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:CATalog?` on page 445
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:STORe` on page 445
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:LOAD` on page 445

Polynomial Order

Defines the polynomial order `n`, that is the number of polynomial coefficients (see "About the Polynomial Function" on page 150).

Select "Apply" to confirm the settings.

Remote command:
See `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients` on page 444

Polynomial constant and coefficients

Sets the polynomial constant a_0 and the polynomial coefficients a_1 to a_n.

The polynomial constant and coefficients influence the envelope shape.

Remote command:
`[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients` on page 444

Apply, OK

Triggers the instrument to adopt the selected function.

Use "OK" to apply the setting and exits the dialog.

Remote command:
See `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients` on page 444

7.6 Applying Digital Predistortion

Digital predistortion (DPD) is one of the methods, used to improve the efficiency of RF power amplifiers. In the R&S SGT, the generated digital signal can be deliberately AM/AM and AM/PM predistorted.

7.6.1 Required Options

The equipment layout for digital predistortion includes:

- Option AM/AM AM/PM Predistortion (R&S SGT-K541)
- Optional option Envelope Tracking (R&S SGT-K540)

7.6.2 About Digital Predistortion

Power amplifiers are an essential part of any telecommunication systems. While amplify the transmitted signal, power amplifiers may also distort this signal and change its amplitude and/or phase characteristics. Such distortions result in undesired effects like spectrum regrowth, harmonic generation, intermodulation (IM) products, or increased bit error rate.

The principle of the digital predistortion

To compensate for the distortions caused by the transmission system, the signal is deliberately digitally predistorted. Digital predistortion (DPD) is a method to apply wanted and well-defined predistortion on the signal to be transmitted so that when this signal is amplified, the resulting signal features the identical characteristics, as the initial signal before the predistortion.

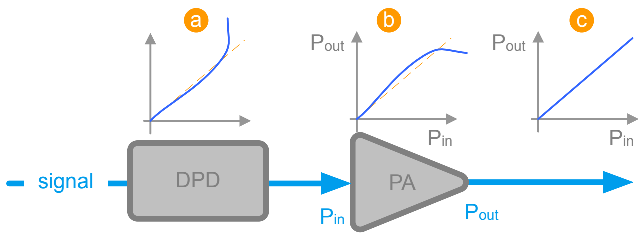


Figure 7-21: Illustration of predistortion principle

DPD = digital predistortion
PA = power amplifier
a = predistortion function
b = characteristic of the power amplifier, for example the non-linear input power vs. output power (AM/AM) function
c = ideal linearized characteristic of the amplified signal

Digital predistortion models

When testing power amplifiers, it is important to measure and analyze signal distortions.

There are several known models used to describe distortions. This implementation focuses on the following two types of distortion:

- The AM/AM (amplitude-to-amplitude) distortion and
- The AM/PM (amplitude-to-phase) distortion.

An AM/AM representation is a standard method that shows the signal power level at the input of the DUT against the power level at the output of the DUT. The default unit for both axes is dBm but the AM/AM representation can also be normalized.

An AM/PM curve shows the phase difference in degrees (y-axis) for every input power level (x-axis).

If your R&S SGT is equipped with the required option R&S SGT-K541, you can define both, an AM/AM and an AM/PM predistortion and apply them separately or superimposed on each other on the generated digital baseband signal.

If your instrument is equipped with the option R&S SGT-K540, you can also apply predistortions on the generated envelope signal.

Refer to Chapter 7.5, "Generation of Envelope Tracking Signals", on page 146 for more information.

7.6.2.1 Defining the Power Level of the Generated Signal

You can define the level of the generated signal in one of the following ways:

- **Level Reference > Before DPD**
  In this mode, the "Level" parameter in the status bar of the instrument defines the signal level before the DPD is applied.
  Signal with selected level is pre-distorted and depending on the selected AM/AM and AM/PM functions, attenuated or boosted.
- **Level Reference > After DPD**
  In this mode, you define the resulting signal level. Based on this value and depending on current predistortion function, the R&S SGT calculates the level of the signal to be pre-distorted.
  The level calculation requires several interaction cycles; the number of iterations is a trade-off between level accuracy and speed.

7.6.2.2 Defining the Correction Values

In the R&S SGT, you can select the way you define the predistortion function and choose between:

- A polynomial function with up to 10 polynomial coefficients
  (see "Polynomial Function" on page 180)
- A predistortion function defined as a look-up table
  (see "Shaping Table" on page 182)
- A normalized data
  (see "Normalized Data" on page 182)
- To set the correction values in raw format with a single remote control command
  (see "Predistortion Function in Raw Data Format" on page 183).

Polynomial Function

The polynomial function is an analytical method to describe a predistortion function. When using the polynomial function, you do not define the correction values (ΔPower and ΔPhase) directly as it is in the look-up table, but you describe the predistortion function and the R&S SGT derives the correction values out of it.

See Chapter 7.6.3.4, "Polynomial Coefficients Settings", on page 193.

This implementation uses a polynomial with complex coefficients defined as follows:

$P_{DPD}(x) = \sum[(a_n+j*b_n)*x^n]$,

where:

- n = "Polynomial Order" ≤ 10
- $x = P_{in}/P_{in}Max$
- a_n and b_n are user-defined coefficients, defined as Cartesian (polar) or Cylindrical coordinates.
  In Cartesian coordinates system, the coefficients b_n are expressed in degrees.

The R&S SGT calculates the AM/AM and AM/PM predistortion functions as follows:

- $AM/AM(x) = abs[P_{DPD}(x)]$
- $AM/PM(x) = \tan^{-1}\{Im[P_{DPD}(x)]/Re[P_{DPD}(x)]\}$

A dedicated graphical display visualizes the resulting functions, see Figure 7-23.

The R&S SGT calculates the correction values (ΔAM/AM and ΔAM/PM functions) as follows:

- $\Delta AM/AM(x) = AM/AM(x) - x = abs[P_{DPD}(x)] -x$
- $\Delta AM/PM(x) = AM/PM(x) = \tan^{-1}\{Im[P_{DPD}(x)]/Re[P_{DPD}(x)]\}$

A dedicated graphical display visualizes the calculated correction functions, see Figure 7-24 and compare with Figure 7-23.

File format of the polynomial file

You can store a polynomial function in a file or even define the polynomial coefficients, store them as a file and load this file into the instrument. The polynomial files are files with the extension `*.dpd_poly`.

The file contains an optional header `# Rohde & Schwarz - Digital Predistortion Polynomial Coefficients # a0,b0, a1,b1, a2,b2, ...` and a list of comma-separated coefficient value pairs, stored in Cartesian coordinates.

For values above the selected Input Range (PEP_{in}), the predistortion function assumes a linear ratio of the input to output power.

Example: Polynomial function file content

```
# Rohde & Schwarz - Digital Predistortion Polynomial Coefficients
# a0,b0, a1,b1, a2,b2, ...
0,0,-0.25,0.2,0.6,-0.3,0.3,0.3,0.5,-0.4
```

Shaping Table

In the R&S SGT, there are two ways to define the predistortion function in form of a shaping table:

- **Externally**
  Create a correction table file as a CSV file with Microsoft Excel, with a Notepad or a similar tool, save it with the predefined extension, transfer it to and load it into the instrument.
  See also "File format of the correction table file" on page 182.
- **Internally**
  Use the built-in editor table editor, see Chapter 7.6.3.3, "Edit Predistortion Table Settings", on page 191.

File format of the correction table file

The correction table files are files with predefined extension and simple file format, see Table 7-12.

Table 7-12: Shaping table files: format and extensions

Predistortion model	File extension	Header (optional)
AM/AM	`*.dpd_magn`	`# Rohde & Schwarz - Digital AM/AM Predistortion` `Table Pin[dBm],deltaPower[dB]`
AM/PM	`*.dpd_phase`	`# Rohde & Schwarz - Digital AM/PM Predistortion` `Table Pin[dBm],deltaPhase[deg]x`

The header is optional. The file content is a list of up to 4000 comma-separated value pairs, describing the delta values for amplitude or phase related to the absolute input power P_{in}; a new line indicator separates the pairs.

For values above the selected Input Range (PEP_{in}), the predistortion function assumes a linear ratio of the input to output power.

Example: Shaping table file content (*.dpd_magn file)

```
# Rohde & Schwarz - Digital AM/AM Predistortion Table
Pin[dBm],deltaPower[dBm]
-30,0.5
3,-0.01
```

Normalized Data

In the R&S SGT, there are two ways to define the predistortion function as normalized data:

- **Externally**
  We recommend that you calculate the normalized correction data by a connected R&S®FSW equipped with R&S®FSW-K18 Power Amplifier and Envelope Tracking Measurements option.
  You can also create the correction table file as a CSV file with Microsoft Excel, with a Notepad or a similar tool, save it with the predefined extension, transfer it to and load it into the instrument.

See also "File format of the correction table file" on page 182.

- **Internally**
  Use the built-in editor table editor, see Chapter 7.6.3.3, "Edit Predistortion Table Settings", on page 191.

File format of the normalized data

The normalized data files are files with predefined extension `*.dpd_norm` and simple file format, see "File format of the normalized data" on page 183.

The file contains an optional header `# Rohde & Schwarz - Digital Predistortion Normalized Table Data # PinMax [dBm] # number of points # Vin/Vmax, deltaV/V, deltaPhase [deg]`, the values of the Pin_{max}, the number of the subsequent points and a list of comma-separated groups of three values.

Example: Normalized data file content

```
# Rohde & Schwarz - Digital Predistortion Normalized Table Data
# PinMax [dBm]
# number of points
# Vin/Vmax, deltaV/V, deltaPhase [deg]
10
4096
0,0,0
0.0002442,-0.00018246,0.28052
0.0004884,-0.00036487,0.28041
0.0007326,-0.00054723,0.2803
0.0009768,-0.00072954,0.28019
0.001221,-0.00091181,0.28008
0.0014652,-0.001094,0.27996
...
```

Predistortion Function in Raw Data Format

The predistortion values are defined directly, with a single remote control command:

- Define the up to 4000 comma-separated value pairs, describing the absolute input power P_{in} and the delta values for amplitude or phase (ΔPower and ΔPhase).
  Example:
  `SOURce1:IQ:DPD:SHAPing:TABLe:AMAM:FILE:DATA -30.4,-5.2, -25.1,-4.5, -18.5,-2.5, -10.5,-1`
  See:
  – `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:DATA` on page 455
  – `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:DATA` on page 455
  – `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:NEW` on page 455
  – `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:NEW` on page 455

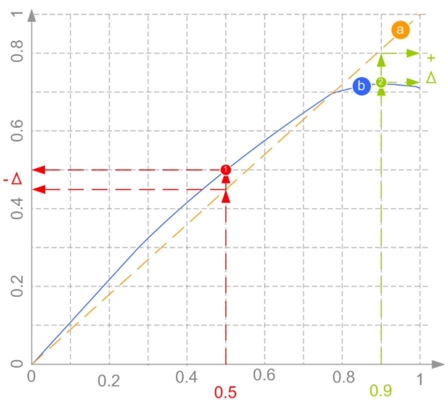
- Define the absolute maximum input power Pin_{max}, the number of subsequent points, and the normalized values Vin/Vmax, ΔV/V, ΔPhase [deg] as binary data.
  See `[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA` on page 457.

7.6.2.3 Finding Out the Correction Values

If you know the properties of the used power amplifier, you can calculate suitable correction values.

To explain the principle, we assume that the characteristics of a power amplifier have been measured and that the left graphic in the following table shows the AM/AM curve of this amplifier.

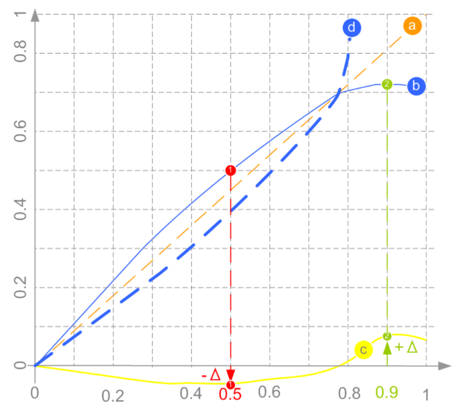
Defining correction coefficients for an AM/AM predistortion (Example)



a = ideal characteristic; if the amplifier did not distort the signal, the normalized magnitude would a line

b = measured AM/AM curve; the normalized magnitude varies as a function of input power

Resulting AM/AM predistortion function (Example)



a = ideal characteristic

b = measured AM/AM curve

c = resulting AM/AM predistortion function, i.e. correction values curve

d = ideal predistorted signal

The required correction coefficient ΔPower is the difference between the ideal and the real normalized amplitude for one particular input power. To compensate for the non-linearity and the deviation from the ideal line, select a negative correction value (-Δ) for any input power where the real normalized amplitude is greater than the ideal one (1). Logically, a positive correction value (+Δ) compensates for (i.e. boost) an amplitude that is smaller than the ideal one (2).

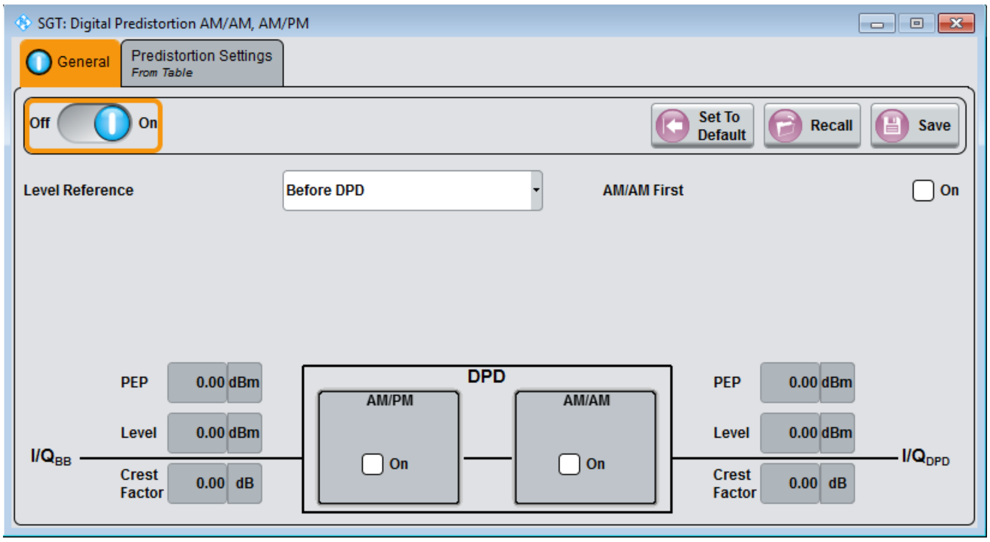
Ideally, a signal predistorted with a suitable function (c) and then amplified by the particular PA would have a linear characteristic (a).

7.6.3 Digital Predistortions AM/AM and AM/PM Settings

You can add digital predistortion to the generated baseband signal and thus compensate an amplitude as well as a phase distortion of the DUT, for example of the tested power amplifier (PA).

To access the required settings

► Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM".



The dialog covers the settings for digital predistortion, like select and enabling an AM/AM and/or AM/PM predistortion, select the way the predistortion function are defined and specify the correction values.

The remote commands required to define these settings are described in Chapter 11.14.14, "SOURce:IQ:DPD Subsystem", on page 447.

7.6.3.1 General Settings

State

Enables/disables the generation of digital predistorted signals.

Remote command:

`[:SOURce<hw>]:IQ:DPD:STATe` on page 450

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"
"Level Reference"	Before DPD
"AM/PM, AM/AM"	Off

Remote command:
`[:SOURce<hw>]:IQ:DPD:PRESet` on page 450

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 filename and the directory, in which the settings are stored, are user-definable; the file extension is however predefined.

Remote command:
`[:SOURce<hw>]:IQ:DPD:SETTing:CATalog?` on page 450
`[:SOURce<hw>]:IQ:DPD:SETTing:STORe` on page 451
`[:SOURce<hw>]:IQ:DPD:SETTing:LOAD` on page 451
`[:SOURce<hw>]:IQ:DPD:SETTing:DELete` on page 450

AM/AM First
Toggles the order the AM/AM and AM/PM predistortions are applied.

Remote command:
`[:SOURce<hw>]:IQ:DPD:AMFirst` on page 451

Level Reference
Switches between dynamic and static adaptation of the range the selected DPD is applied on.

"Before DPD/After DPD"
Selects dynamic range calculation and defines whether the selected "Level" value corresponds to the signal level before or after the predistortion, see Chapter 7.6.2.1, "Defining the Power Level of the Generated Signal", on page 180.

"Static DPD" Selects static (constant) range limits. To adjust the range, use the parameter Pre-Gain.

Remote command:
`[:SOURce<hw>]:IQ:DPD:LREFerence` on page 452

Maximum Output Level Error
Sets the allowed maximum error, see Chapter 7.6.2.1, "Defining the Power Level of the Generated Signal", on page 180.

Remote command:
`[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor:MAX` on page 452

Maximum Number of Iteractions
Sets the maximum number of performed iterations to achieving the required Maximum Output Level Error.

See also Chapter 7.6.2.1, "Defining the Power Level of the Generated Signal", on page 180.

Remote command:
`[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor:MAX` on page 452

Achieved Output Level Error
Displays the resulting level error, see Chapter 7.6.2.1, "Defining the Power Level of the Generated Signal", on page 180.

Remote command:
`[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor?` on page 452

Input/Output PEP, Level and Crest Factor
Displays the calculated values the before and after the DPD

A value of -1000 indicates that the calculation is impossible or there are no measurements results available.

Remote command:
`[:SOURce<hw>]:IQ:DPD:INPut:PEP?` on page 453
`[:SOURce<hw>]:IQ:DPD:INPut:LEVel?` on page 453
`[:SOURce<hw>]:IQ:DPD:INPut:CFACtor?` on page 453
`[:SOURce<hw>]:IQ:DPD:OUTPut:PEP?` on page 453
`[:SOURce<hw>]:IQ:DPD:OUTPut:LEVel?` on page 453
`[:SOURce<hw>]:IQ:DPD:OUTPut:CFACtor?` on page 453

AM/AM and AM/PM State
Enables/disables the AM/AM and AM/PM digital predistortion.

If both predistortions are enabled simultaneously, the instrument applies the AM/AM predistortion first and compensates the phase error of the PA afterwards.

Compare the displayed signal processing chain.

Remote command:
`[:SOURce<hw>]:IQ:DPD:AMAM:STATe` on page 451
`[:SOURce<hw>]:IQ:DPD:AMPM:STATe` on page 451

7.6.3.2 Predistortion Settings

To access the "Predistortion Settings"

1. Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM".
2. Select "Digital Predistortion AM/AM, AM/PM > Predistortion Settings".

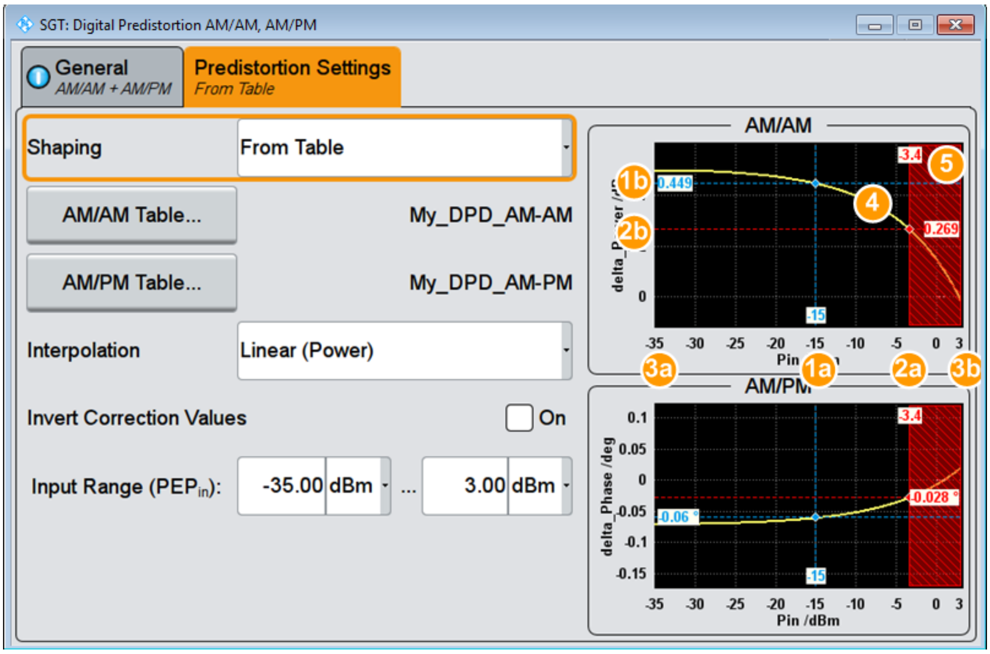


Figure 7-22: Predistortion Settings > From Table: Understanding the displayed information

1a = Normalized value of the current RF RMS power level
2a = Normalized value of the current PEP of the generated RF signal
1b, 2b = Correction values
white dashed line = Ideal zero correction function; no correction is necessary
yellow curve = Predistortion function
3a, 3b = Input Range (PEP_{in})
4 = Positive correction coefficients to compensate values below the ideal ones
5 = Values greater than the PEPin Max are ignored

The dialog covers the settings for digital predistortion, like select and enabling an AM/AM and/or AM/PM predistortion, select the way the predistortion function is defined and specify the correction values.

Shaping

Selects the method to define the correction coefficients.

"From Table" As value pairs in form of a shaping table.
Select "AM/AM or AM/PM Shaping Table" to access the settings, see Chapter 7.6.3.3, "Edit Predistortion Table Settings", on page 191

"Polynomial" By a polynomial with configurable order and coefficients.
Select "AM/AM or AM/PM Polynomial Coefficients" to access the settings, see Chapter 7.6.3.4, "Polynomial Coefficients Settings", on page 193.

"Normalized" As a normalized data.
Select "Normalized Data" to access the settings, see Chapter 7.6.3.5, "Normalized Data Settings", on page 196.

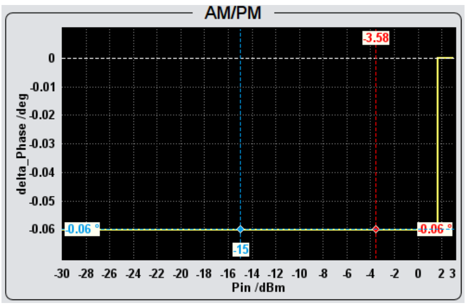
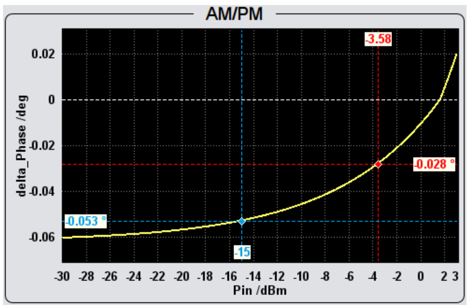
Remote command:
`[:SOURce<hw>]:IQ:DPD:SHAPing:MODE` on page 454

Interpolation

Enabled in "Shaping > From Table/Normalized".

A predistortion function defined in a table contains a limited number of value pairs. This parameter enables a linear interpolation between the defined values to prevent abrupt changes.

Table 7-13: Effect of parameter "Interpolation"

"Interpolation > Off"	"Interpolation > Linear (Power)"
	

Remote command:
`[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:INTerp` on page 455

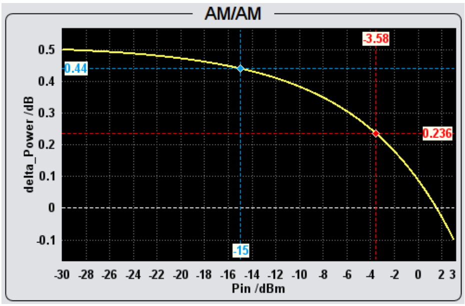
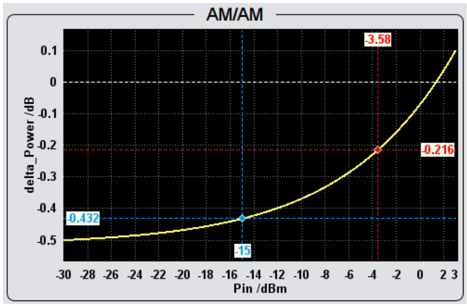
Invert correction values

Inverts the defined correction values.

Use this function to apply the exact invert predistortion coefficients without to change the defined predistortion table.

This function is also useful to toggle between predistortions with corrections related to the input power and to the output power.

Table 7-14: Effect of parameter "Invert correction values"

<table>
<tr><th>"Invert correction values > Off"</th><th>"Invert correction values > On"</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Remote command:
[:SOURce<hw>]:IQ:DPD:SHAPing[:TABLe]:INVert on page 456

Input Range (PEP$_{in}$)

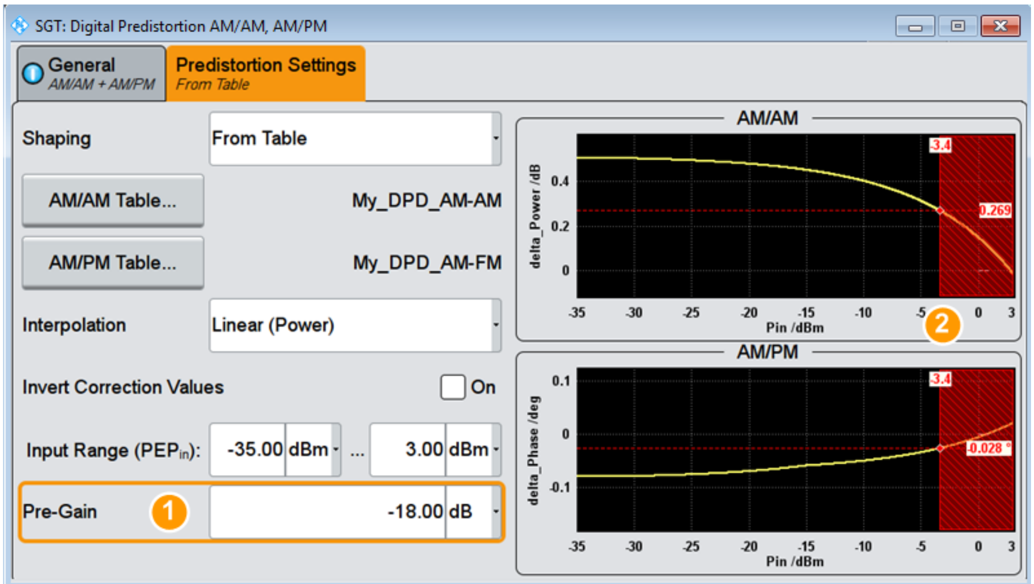
Defines the minimum and maximum input power PEP$_{in}$.

If you apply digital predistortion on signals used for power amplifier tests with envelope tracking, set the PEP$_{in}$Max value to the maximum value of the input power PEPin Max, as required by the used power amplifier (PA).

Remote command:
[:SOURce<hw>]:IQ:DPD:PIN:MIN on page 453
[:SOURce<hw>]:IQ:DPD:PIN:MAX on page 453

Pre-Gain

In "Level Reference > Static DPD" mode, sets a pre-gain (i.e. an attenuation) to define the range the DPD is applied in. The pre-gain can be used to define and test only a specific (required) part of the operating range.



1 = Pre-gain limits the effective range of the shaping function
2 = Values above this limit are ignored

In "Level Reference > Before/After DPD" mode, the range is limited by the current PEP of the signal, see Figure 7-22.

Remote command:
`[:SOURce<hw>]:IQ:DPD:GAIN:PRE` on page 454

Shaping Table
Accesses the standard "Predistortion Select" dialog with functions to define a new shaping table file, select, or edit an existing one.

The shaping table files are files with predefined extension and file format, see "File format of the correction table file" on page 182.

You can create a shaping table externally or internally.

"Select"	Selects and loads an existing file
"New"	Creates a file
"Edit"	Access a standard built-in table editor, see Chapter 7.6.3.3, "Edit Predistortion Table Settings", on page 191.

Remote command:
For AM/AM distortions:
`[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:CATalog?` on page 454
`[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE[:SELect]` on page 455
For AM/PM distortions:
`[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?` on page 454
`[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE[:SELect]` on page 455

Polynomial Coefficients
Accesses a dialog to describe the predistortion function as a polynomial function, see Chapter 7.6.3.4, "Polynomial Coefficients Settings", on page 193.

Normalized Data
Accesses a dialog to describe the predistortion function as a normalized data, see Chapter 7.6.3.5, "Normalized Data Settings", on page 196.

7.6.3.3 Edit Predistortion Table Settings

The predistortion table is an internal editor where you define the correction values, ΔPower and ΔPhase, in form of a look-up table.

To access the internal table editor

1. Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM".
2. Select "Digital Predistortion AM/AM AM/PM > Predistortion Settings".
3. Select "Shaping > From Table".
4. Select "AM/AM > Shaping Table > Predistortion AM/AM Shaping File > New"
5. Enter the "File Name", e.g. *My_DPD_AM-AM*

   The "Predistortion AM/AM Shaping File" dialog closes.

The "Shaping Table > My_DPD_AM-AM" confirms that the newly created file is assigned.

6. Select "Shaping Table > Predistortion AM/AM Shaping File > Edit"
7. Define the value pairs "Pin/dBm" and "ΔPower/dB". The order is uncritical.
8. Select "Save".

   The instrument loads the configured values automatically and displays the function of the delta correction values.
9. Select "Predistortion Settings > Interpolation > Linear".

   The display confirms the used interpolation.

Pin (dBm), Delta Power (dB)/Pin (dBm), Delta Phase (deg)
Sets the correction value pairs.

"Pin, ΔPower"
Value pairs for the AM/AM predistortion

"Pin, ΔPhase"
Value pairs for the AM/PM predistortion

Remote command:
See `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE[:SELect]` on page 455
and `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE[:SELect]` on page 455

Goto, Edit, Save As, Save
Standard functions for editing of data lists.

Changed and unsaved values are displayed on a yellow background.

Remote command:
n.a.

Fill Table Automatically
Standard function for filling a table automatically with user-defined values.

"From / Range"
Defines the start line and number of the rows to be filled.

"Select Column to Fill"
Selects the respective value, including the unit.

"Start / End Value"
Default values corresponding to the selected column.

"Increment" Determines the step size.

"Fill" Fills the table.
Fill both columns and then save the list. Otherwise the entries are lost.

7.6.3.4 Polynomial Coefficients Settings

Alternatively to the look-up table, you can define the predistortion functions as a polynomial function. The R&S SGT calculates the AM/AM and AM/PM predistortion functions and the required correction coefficients out of the defined polynomial.

To access the polynomial coefficients setting and define a higher-order polynomial

1. Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM".
2. Select "Digital Predistortion AM/AM AM/PM > Predistortion Settings".
3. Select "Shaping > Polynomial".
4. Select "AM/PM > Polynomial Coefficients"

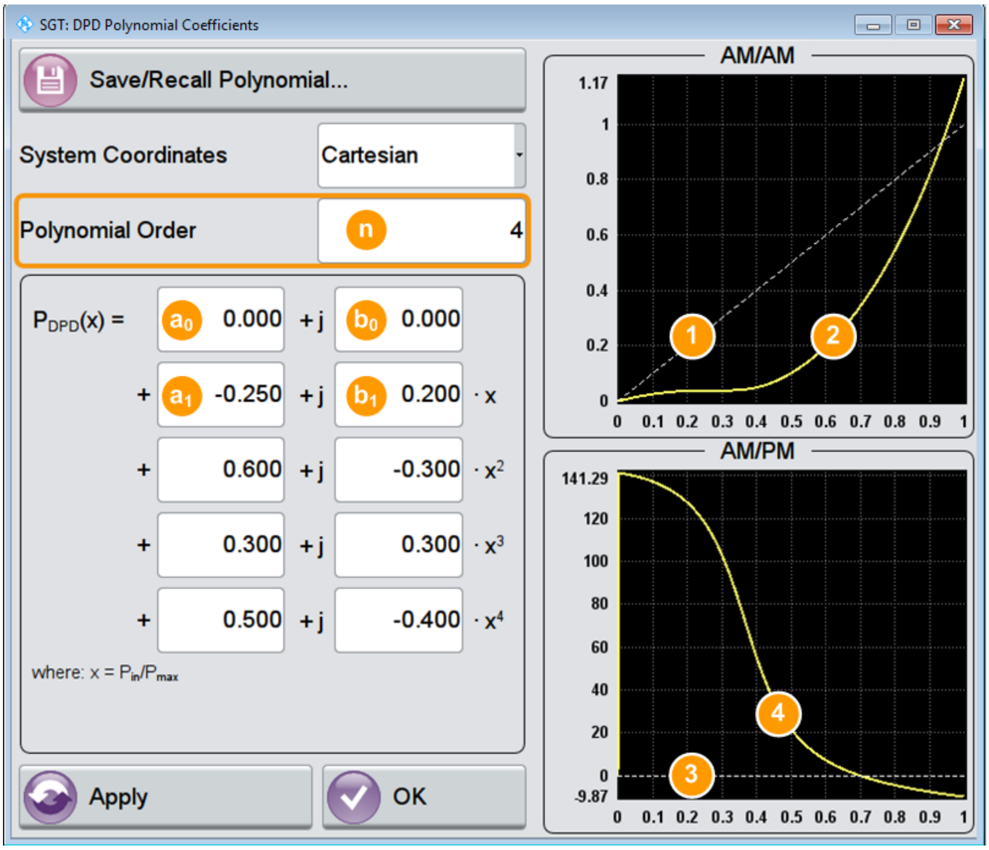


Figure 7-23: Polynomial Coefficients: Understanding the displayed information

n = Polynomial order
a0, b0, ... = Polynomial coefficients
1 = Ideal AM/AM function (the normalized amplitude is a line)

2	= Resulting AM/AM predistortion function, calculated as AM/AM(x) = abs[P_{DPD}(x)]
3	= Ideal AM/PM function (constant phase at 0 degrees)
4	= Resulting AM/PM predistortion function, calculated as AM/PM(x) = $\tan^{-1}${Im[P_{DPD}(x)]/Re[P_{DPD}(x)]}

With the provided settings, you can define a polynomial function with up to 10^{th} order to describe the predistortion function.
The graphical display updates on-the-fly and visualize of the resulting AM/AM and AM/PM functions.

5. Select "Polynomial Order = 4" (n = 4).
6. Set the polynomial coefficients a_0 to b_4.
7. Select "Apply".

   The instrument loads the configured values, calculates the correction values, and displays the predistortion functions.

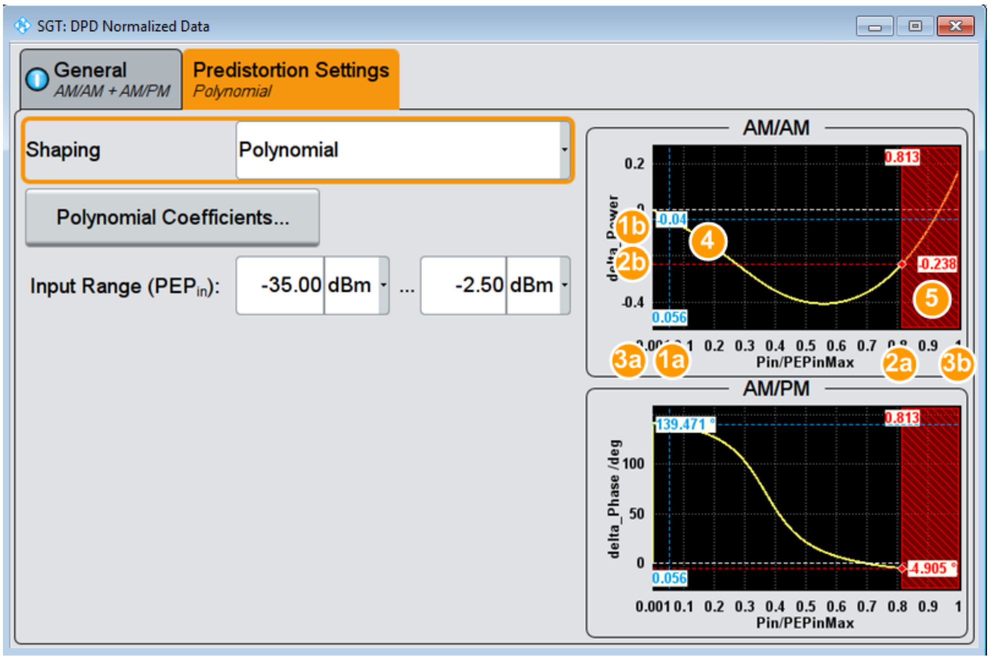


Figure 7-24: Predistortion Settings > Polynomial: Understanding the displayed information

1a	= Normalized value of the current RF RMS power level
2a	= Normalized value of the current PEP of the generated RF signal
1b, 2b	= Correction values
white dashed line	= Ideal zero function; no correction is necessary
AM/AM yellow curve	= AM/AM correction values, calculated as ΔAM/AM(x) = AM/AM(x) - x
AM/PM yellow curve	= AM/PM correction values, calculated as ΔAM/PM(x) = AM/PM(x)
3a, 3b	= X-axis scale, calculated form the Input Range (PEP_{in})
4	= Negative correction coefficients
5	= Values greater than the PEPin Max are ignored

8. To store the defined predistortion function:
   a) Select "Save/Recall Polynomial"
   b) Navigate throughout the file system and enter a "File Name", e.g. *MyPolynomial_4thOrder*

c) Select "OK".

9. Select "Polynomial Coefficients > OK" to close the dialog.

Save/Recall Polynomial

Accesses the "Save/Recall" dialog, i.e. the standard instrument function for storing and recalling the dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The file name and the directory it is stored in are user-definable; the file extension is however predefined.

The polynomial files are files with extension `*.dpd_poly`, see "File format of the polynomial file" on page 181. The polynomial function is stored in Cartesian format.

Remote command:

`[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:CATalog?`
on page 456

`[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:LOAD`
on page 456

`[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:STORe`
on page 457

System Coordinates

Defines whether the polynomial function is defined in Cylindrical (Polar) or in Cartesian coordinates.

Remote command:

n.a.

Polynomial Order

Defines the polynomial order `n`, that is the number of polynomial coefficients (see "Polynomial Function" on page 180).

The polynomial order defines the degree, complexity, and the number of terms in the polynomial function.

Remote command:

See `[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients`
on page 456

Polynomial coefficients

Sets the polynomial coefficients a_0 to a_n and b_0 to b_n.

In "System Coordinates > Cylindrical", the polynomial coefficients b_0 to b_n are expressed in degrees.

The polynomial coefficients influence the shape of the predistortion function, see Figure 7-23 for an illustration of a polynomial function.

Select "Apply" to confirm the settings.

Remote command:
See [:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients on page 456

Apply, OK
Triggers the instrument to adopt the selected function.

Use "OK" to apply the setting and exits the dialog.

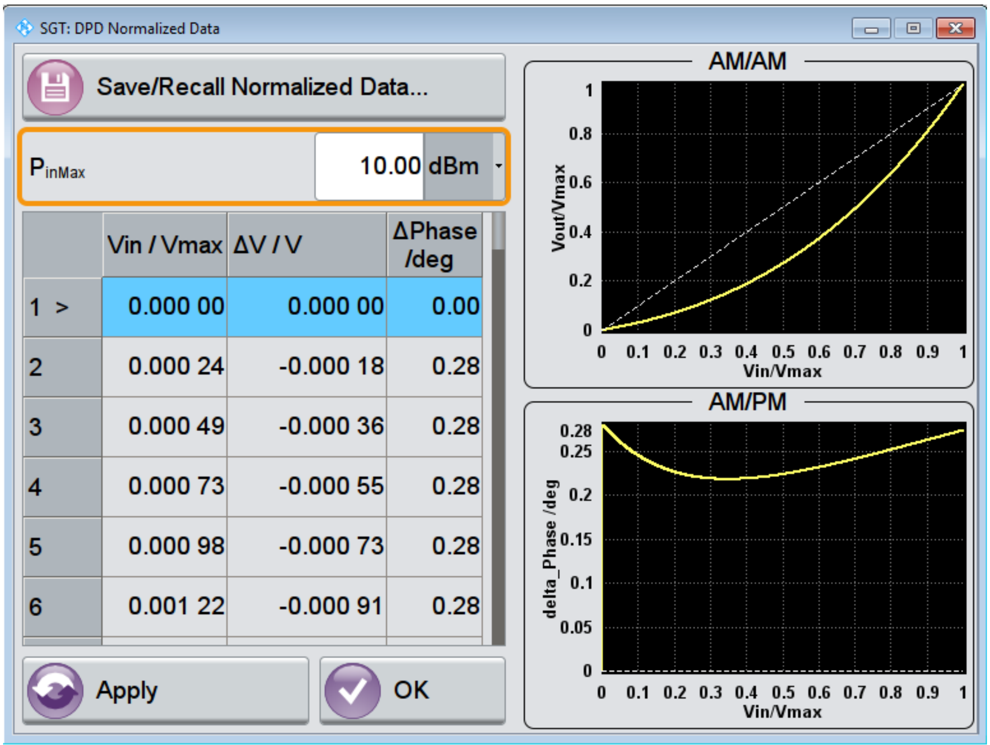
Remote command:
n.a.

7.6.3.5 Normalized Data Settings

The normalized data table is an internal editor where you define the correction values, Vin/Vmax, ΔV/V and ΔPhase, in form of a table.

To access the internal editor

1. Select "I/Q Mod > Digital Predistortion > AM/AM AM/PM".
2. Select "Digital Predistortion AM/AM AM/PM > Predistortion Settings".
3. Select "Shaping > Normalized Data".
4. Select "Normalized Data".



5. Enter the Pin_{max}.

Note: Enter the correction values in the required order. The value range of the subsequent correction values is automatically adjusted.

6. To store the setting in a file, select "Save/Recall Normalized Data > Save".
   Enter a "File Name", e.g. *My_DPD_Normalized*.

Save/Recall Normalized Data

Accesses the "Save/Recall" dialog, i.e. the standard instrument function for storing and recalling the dialog-related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The file name and the directory it is stored in are user-definable; the file extension is however predefined.

The normalized data files are files with extension `*.dpd_norm`, see "File format of the normalized data" on page 183.

Remote command:
`[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:CATalog?` on page 458
`[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:LOAD` on page 458
`[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:STORe` on page 458

Pin_{max}

Sets the value of the maximum input power level.

Pin_{max} corresponds to a normalized input power of 1, that is the max. allowed value on the x-axis.

Select "Apply" to confirm the settings.

Remote command:
See `[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA` on page 457

Vin/Vmax, ΔV/V,ΔPhase (deg)

Sets the correction as a group of three values.

Select "Apply" to confirm the settings.

Remote command:
See `[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA` on page 457

Apply, OK

Triggers the instrument to adopt the normalized data.

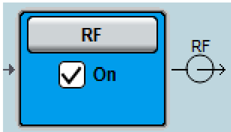
Use "OK" to apply the setting and exits the dialog.

Remote command:
n.a.

7.7 RF Settings

7.7.1 Overview of RF Signal

Settings for the RF output signal and analog modulation are made under "RF Signal" and "Analog Modulations". These settings can be accessed in the block diagram by the "RF" function block, or by the dialog with the same name which is opened through "SGMA-GUI > Instrument Name > RF ".



The function block is available for the basic unit R&S SGT without any additional equipment options.

RF On/Off

Activates and deactivates the RF output signal.

The current state of the RF output (activated and deactivated) is indicated in the main panel by the different block color (blue or grey) and the status "On/Off".

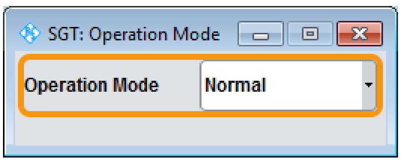
Remote command:

`:OUTPut[:STATe]` on page 328

7.7.2 Operation Mode

You can operate the R&S SGT in two modes, normal mode and baseband bypass mode. In baseband bypass mode, an external IF signal fed in at the I or Q connectors is directly routed to the RF OUT connector. The level of the signal can be adjusted.

► To access the "Operation Mode" dialog, select "SGMA-GUI > Instrument Name > RF > Operation Mode".



Operation Mode

Sets the operation mode.

"Normal" The complete signal processing chain is used.

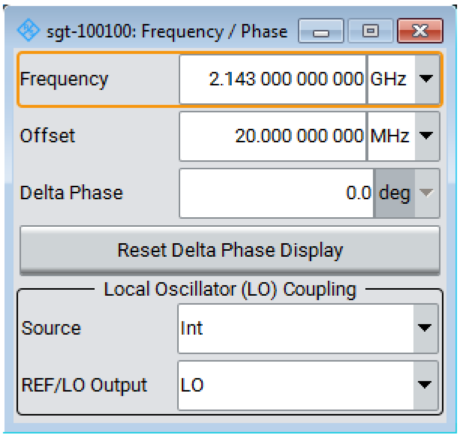
"Baseband Bypass"
The IF signal fed in at the I or Q connectors is directly routed to the RF OUT connector.

Remote command:
[:SOURce]:OPMode on page 341

7.7.3 Frequency/ Phase

The frequency and phase related settings are provided in the "Frequency/Phase" dialog.

► To access this dialog, select "SGMA-GUI > Instrument Name > RF > Frequency/ Phase".



Configuring the RF frequency

1. To change the RF frequency of the selected instrument, perform one of the following:
   a) Select "SGMA-GUI > Instrument Name > Frequency/Phase > Frequency" and set the frequency at the RF output.
   b) Select "SGMA-GUI main panel > Freq" and set the frequency.
      The value includes possible frequency offset.
2. To enable frequency offset for example to consider the frequency shift of a downstream instrument, set the parameter "Frequency/Phase > Offset".

   Changes of the RF frequency have an immediate effect on the output signal.

Frequency
Sets the RF frequency *at the RF output connector* of the selected instrument.

The displayed value does not consider an enabled frequency offset (Offset).

Remote command:
See [:SOURce]:FREQuency[:CW|FIXed] on page 340

Offset
Sets a frequency offset.

The frequency offset value represents the frequency shift of a downstream instrument, as for example an attenuator or an amplifier.

Enabled frequency offset does not change the frequency at the RF output (Frequency). It influences the value of the parameter "SGMA-GUI main panel > Freq".

The following applies:

"Freq" = Frequency + "Offset"

In the "SGMA-GUI main panel", enabled frequency offset is also indicated with the keyword "Freq (Offs)".

Remote command:
`[:SOURce]:FREQuency:OFFSet` on page 341

Delta Phase
Sets the phase of the RF signal. The current phase of the signal is used as the reference. This function allows, for example, the phase of the output signal to be synchronized with the phase of a signal from a second signal generator.

Remote command:
`[:SOURce]:PHASe` on page 460

Reset Delta Phase Display
Resets delta phase value. The set phase is adopted as the new current phase, i.e. the delta phase value is reset to 0.

Remote command:
`[:SOURce]:PHASe:REFerence` on page 460

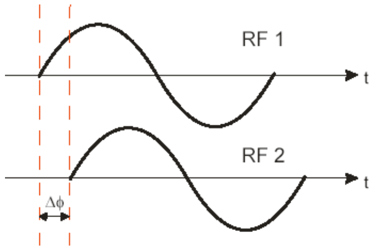
7.7.4 Local Oscillator (LO) Coupling

The LO coupling function allows you to distribute the local oscillator signal in a way that multiple R&S SGTs or other R&S signal generators can be driven by the same LO signal. This is mandatory for phase coherent application, e.g. the generation of beamformed signals, and for phase coherent demodulation.

The LO coupling function is available only for instruments equipped with the option R&S SGT-K90 (Phase Coherence). This option enables phase coherent RF outputs of two or more RF signals. The local oscillator signal is provided at the REF/LO OUT connector. An external signal can be input at the REF/LO IN connector.

7.7.4.1 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 exactly the same frequency but only in the long-term perspective. Having a closer look into the instantaneous differential phase ("delta phase") of these two RF signals, this is quite instable due to:

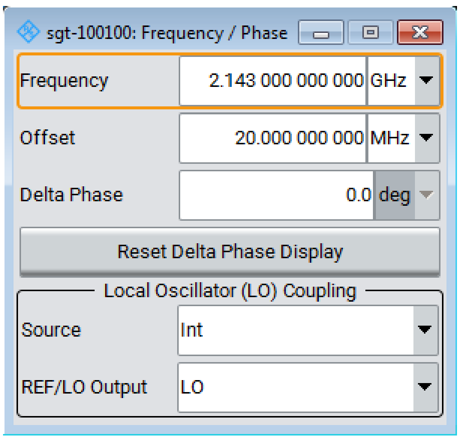
- Phase noise of the two synthesizers
- "Weak" coupling at 10 MHz and a long synthesis chain up to the RF domain
- Temperature differences which cause slightly different phase drifts for the different synthesizers

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 (common local oscillator (LO) signal) for all RF carriers.

7.7.4.2 Local Oscillator (LO) Coupling Settings

The LO coupling settings are provided in the "Frequency/Phase" dialog.

► To access this dialog, select "SGMA-GUI > Instrument Name > Frequency/Phase > Local Oscillator (LO) Coupling".



Source

Selects the source of the local oscillator signal.

"Int" The instrument uses the built-in local oscillator.

"Ext" The signal fed-in at the REF/LO IN input connector is used as signal source.

An icon in the block diagram indicates that an external LO source is used.

Note: The local oscillator input/output requires the additional software option R&S SGT-K90.

Remote command:
[:SOURce]:LOSCillator:SOURce on page 341

REF/LO Output

Determines the signal provided at the output connector REF/LO OUT.

"OFF" No signal is provided.

"LO" The signal of the local oscillator (LO) is available at the REF/LO OUT connector.

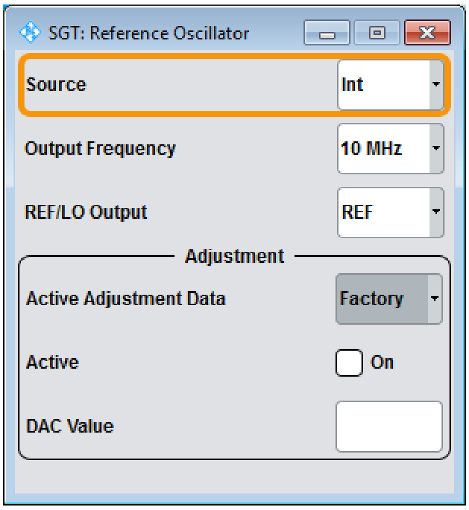
"REF" The signal of the reference oscillator is available at the REF/LO OUT connector.

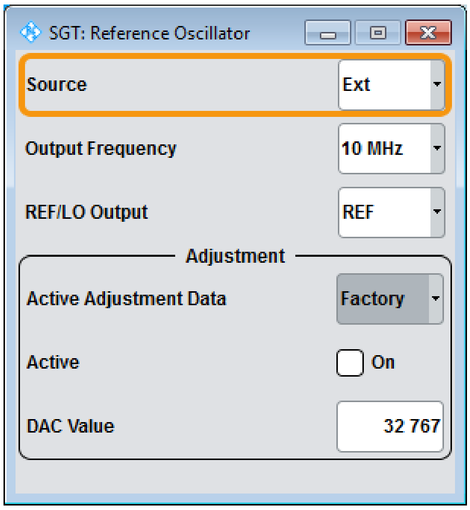
Remote command:
:CONNector:REFLo:OUTPut on page 314

7.7.5 Reference Oscillator

The R&S SGT is equipped with an internal TXCO reference oscillator. If equipped with the additional HW option R&S SGT-B1, an OXCO can be used as an internal reference frequency source for the synthesizer. Moreover, an external reference signal source can be connected to the REF/LO IN connector of the instrument.

► To access this dialog, select "SGMA-GUI > Instrument Name > RF > Reference Oscillator".





Ref. Oscillator Source/Ext Ref On/Off

Determines whether the internal built-in oscillator (TXCO or OXCO) is used as a reference source or if an external reference is used.

The internal reference oscillator OCXO requires the additional option R&S SGT-B1.

To feed in an external instrument reference, use the input connector REF/LO IN. To output the reference frequency at the output REF/LO OUT, select "SGMA-GUI > Instrument Name > RF > Ref. Oscillator > REF/LO Output > REF".

"Int"	The internal reference signal of 10 MHz is used.
"Ext"	An external reference signal is used. The frequency of the external reference signal must be selected with the parameter "SGMA-GUI > Instrument Name > RF > Ref. Oscillator > Ex. Ref. Input Frequency".

Remote command:
`[:SOURce]:ROSCillator:SOURce` on page 470

Ext. Ref. Input Frequency

Available only for "Source > Ext".

Selects the frequency of the external reference signal.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:FREQuency` on page 470

Synchronization Bandwidth

Available only for "Source > Ext".

Selects the synchronization bandwidth for an external reference signal. The wideband setting is provided for using good reference sources of high spectral purity.

"Wide"	Synchronization bandwidth is app. 250 Hz.
"Narrow"	Synchronization bandwidth is app. 40 Hz.

Remote command:
`[:SOURce]:ROSCillator:EXTernal:SBANdwidth` on page 470

Output Frequency
Selects the output for the reference oscillator signal. The available values depend on the input frequency and the reference oscillator source.

Table 7-15: Output frequency

Reference oscillator source	Input frequency	Output frequency
"Internal"	10 MHz	10 MHz 1 GHz
"External"	10 MHz 13 MHz 100 MHz 1 GHz	10 MHz, 1 GHz 13 MHz, 1 GHz 100 MHz, 1 GHz 1 GHz

Support of 13 MHz reference frequency requires that the instrument is equipped with hardware module RF board with part number 1419.5308.02.

To find out the RF board installed in the instrument:
- Select "SGMA-GUI > instrument name > Setup > Hardware Config" > "RF Assembly"
- Observe the part number of the assembly "RfBoard".

Remote command:
`[:SOURce]:ROSCillator:OUTPut:FREQuency` on page 470

REF/LO Output
Determines the signal provided at the output connector REF/LO OUT.

"OFF"	No signal is provided.
"LO"	The signal of the local oscillator (LO) is available at the REF/LO OUT connector.
"REF"	The signal of the reference oscillator is available at the REF/LO OUT connector.

Remote command:
`:CONNector:REFLo:OUTPut` on page 314

Active Adjustment Data
Displays whether the factory or user defined (custom) calibration value is currently used for the external calibration of the reference oscillator.

Adjusting the calibration value for the OCXO adjustments is a protected service procedure, that requires a Protection Level 2 password.

Adjustment Active
Available only for "Source > Int".

Selects adjustment mode.

"OFF"	Uses the calibrated internal reference frequency. This value is determined at one of the R&S service centers during calibration.

"ON" A user-defined adjustment value is used. The value is entered under DAC Value.
This allows the frequency to be impaired freely, for example, to simulate a frequency error.
The instrument is no longer in the calibrated state. However, the calibration value is not changed and the instrument resumes the calibrated state after disabling the adjustment.

Remote command:
`[:SOURce]:ROSCillator[:INTernal]:ADJust[:STATe]` on page 471

DAC Value

Enters a user-defined adjustment value for the internal reference frequency. This value is not used unless "Adjustment Active > On" is selected. "0" represents the calibrated state. The setting range depends on the reference oscillator type and its factory calibration value.

Remote command:
`[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue` on page 471

7.7.6 RF Level Settings

This section explains the level settings of the R&S SGT.

Configuring RF level

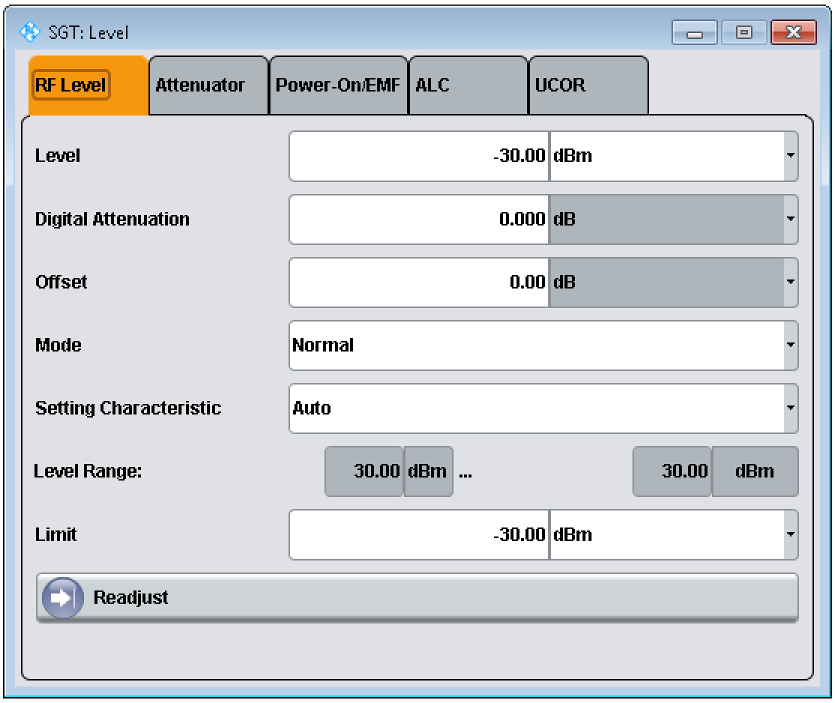
► To change the RF level of the selected instrument, perform one of the following:

a) Select "SGMA-GUI main panel > Level" and enter the desired value.
b) Select "SGMA-GUI > Instrument Name > RF > Level Settings > RF Level > Level" and enter the desired value.

Changes of the RF level have an immediate effect on the output signal.

7.7.6.1 RF Level Settings

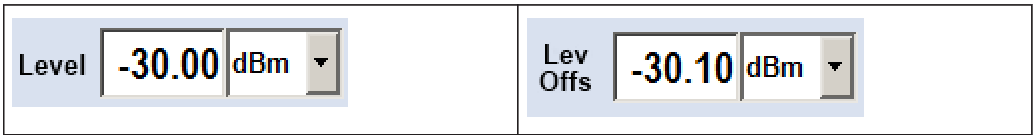
► To access the RF level settings, select "SGMA-GUI > Instrument Name > RF > Level > RF Level".



This dialog comprises settings like the RF level and level limit.

Level/Level Offset
Sets the RF level at the RF output connector of the selected instrument.

If you set a digital attenuation, while "I/ Q Mod > Modulation Source > Internal Baseband" and "I/ Q Mod > Modulation State > ON", it will be indicated in the R&S SGMA-GUI main panel by a change in the name of this parameter from "Level" to "Level Offset".



Note: The SCPI command `[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]` sets the level of the "Level" display, that means the level containing offset while `[:SOURce]:POWer:POWer` sets the level at the RF output connector.

Remote command:
`[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]` on page 468
`[:SOURce]:POWer:POWer` on page 468

Digital Attenuation
Available only for "I/Q Mod > State > On" and "I/Q Mod > Source > Internal Baseband".

Attenuates 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, but it has no effect on externally provided I/Q signals.

Note: If you specify a digital attenuation value, the R&S SGT still shows the level as set with "Level/Level Offset" on page 60. That is, the calculated signal level is not displayed, but the level at the RF signal output is higher or lower according to the digital attenuation.

Remote command:
`[:SOURce]:POWer:ATTenuation:DIGital` on page 466

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.

Remote command:
`[:SOURce]:POWer[:LEVel][:IMMediate]:OFFSet` on page 469

Mode

Allows you to optimize the RF output signal for applications, where improved harmonic distortion or improved wideband noise is required.

"Normal" In normal mode, the generator provides an RF output signal with high signal to noise ratio and low distortion, according to the data sheet.

"Low Noise" This setting forces the generator to further optimize the signal to noise ratio.

"Low Distortion"
In this mode, the generator reduces distortions of the RF signal to a minimum.

Remote command:
`[:SOURce]:POWer:LMODe` on page 467

Setting Characteristic

Selects the characteristic for the level setting. For some general applications, the instrument operation can be optimized by selecting one of the predefined level setting characteristics.

"Auto" The instrument provides the highest dynamic range and the fastest setting times according to the data sheet.
The RF signal is shortly blanked during the moment the step attenuator is switched on.

"Uninterrupted Level setting"
Suppresses level blanking at frequency and level changes.
This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

"Strictly Monotone"
Provides level setting without discontinuities. All electronic switches in the RF path are clamped. The operation mode is useful for applications using level searching algorithms.
This mode further reduces the dynamic range of the instrument. The step attenuator is also fixed.

"Constant-VSWR"
Suppresses output impedance variations at the RF OUT connector due to changed level setting.
This mode reduces the dynamic range of the instrument. The step attenuator is fixed.

Remote command:
`[:SOURce]:POWer:SCHaracteristic` on page 468

Level Range

Displays the level range within which the level setting is expected to work properly. The range limits depend on several parameters like "Mode", "Setting Characteristic", the I/Q signal's crest factor etc.

Remote command:
`[:SOURce]:POWer:RANGe:LOWer?` on page 469
`[:SOURce]:POWer:RANGe:UPPer?` on page 469

Limit

Sets the level limit.

The value specifies the upper limit of the level at the RF OUT connector. A message appears if an attempt is made to set a level above this limit and the level at the RF output is confined to the upper limit. However, the level indication is not influenced.

Remote command:
`[:SOURce]:POWer:LIMit[:AMPLitude]` on page 467

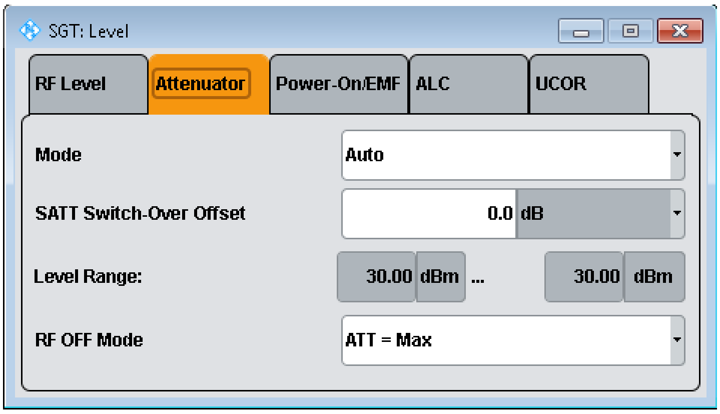
Readjust

Recalculates the instrument internal settings optimized for the current level. Not required for automatic modes.

Remote command:
`[:SOURce]:POWer:ALC:SONCe` on page 466

7.7.6.2 Attenuator

► To access the attenuator settings, select "SGMA-GUI > Instrument Name > Level >Attenuator".



This dialog comprises the settings for the power-on behavior of the instrument.

Mode
Sets the attenuator mode at the RF output.

"Auto" Standard mode.
The electronically switching attenuator switches with a ~ 6 dB step width at optimized switching points. The entire level range is available.
The level setting is performed by continuous electronic level control combined with switching the step attenuator.

"Fixed" The level settings are made without switching the attenuator.
When this operating mode is switched on, the attenuator is fixed in the current position to provide level settings without interruption. The resulting variation range is defined and displayed with the parameters Level Range.

Note: The function is effective when automatic level control is activated ("ALC State = On").
If the normal variation range is overranged or underranged, level errors increase considerably. The warning "Level under/overrange" appears in the info line.

The spectral purity of the output signal decreases with high attenuation.

"Auto Passive" The attenuator is switched automatically.
The level settings are made only for the passive reference circuits.
The high-level ranges are not available.

Remote command:
`:OUTPut:AMODe` on page 327

SATT Switch-Over Offset
Sets the switch-over offset value of the attenuator.

Remote command:
[:SOURce]:POWer:ATTenuation:SOVer[:OFFSet] on page 467

Level Range
Displays the level range in which the level is set without interruption for the "Attenuator Mode Fixed" setting.

Remote command:
:OUTPut:AFIXed:RANGe:LOWer? on page 327
:OUTPut:AFIXed:RANGe:UPPer? on page 327

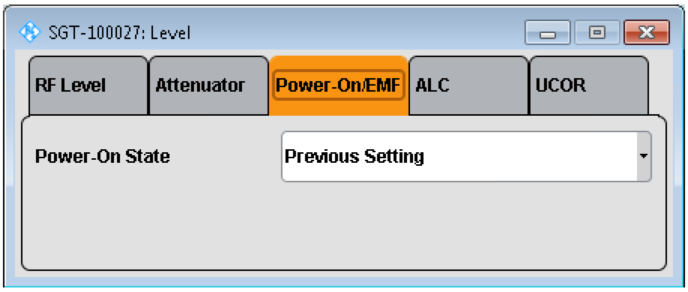
RF-Off-Mode
Determines the attenuator's state after the instrument is switched off.

In default setting, the electronic step attenuator switches to highest attenuation when RF is off. By setting the RF-Off mode, the electronic step attenuator can be fixed to keep the output impedance constant during RF off.

Remote command:
[:SOURce]:POWer:ATTenuation:RFOFf:MODE on page 467

7.7.6.3 Power-On Settings

► To access the power- on/EMF settings, select "SGMA-GUI > Instrument Name > RF > Level > Power-On/EMF".



This dialog comprises the settings for the power-on behavior of the instrument.

Power-On State
Selects the state which the RF output takes after the instrument is switched on.

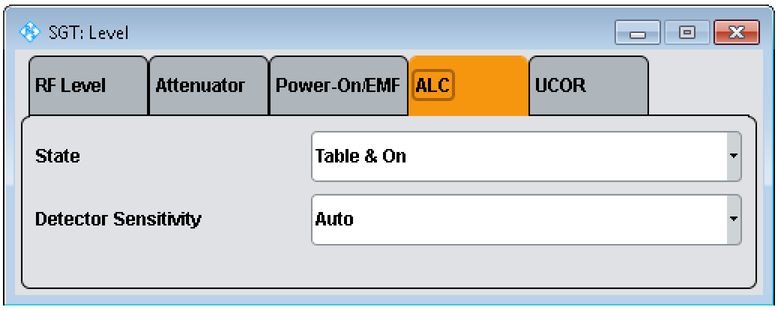
"RF Off" The output is deactivated when the instrument is switched on.

"Previous Setting"
When the instrument is switched on, the output takes the same state as it had when the instrument was switched off.

Remote command:
:OUTPut[:STATe]:PON on page 328

7.7.6.4 ALC

► To access the automatic level control (ALC) settings, select "SGMA-GUI > Instrument Name > Level > ALC".



Automatic level control can be used with almost all applications, especially I/Q modulation. It only has to be deactivated for certain settings in the baseband and when I/Q impairments ("Impairments State On") are activated. This is indicated under the respective function.
By default, the instrument operates in "Table & On" mode to provide the highest level accuracy and fastest setting time. Level control can be switched to "Off (Table)" or "On" for particular applications. The "Off (Table)" state (level control Off) is recommended if in CW mode the signal/intermodulation ratio is to be improved for multi-transmitter measurements.

State

Sets the internal level control.

"Table & On"	Default mode. First sets the level to the target value using the internal level table. Then activates the level control circuit to achieve maximum level accuracy.
"On"	Internal level control is permanently activated. If "On" and "Attenuator Mode Fixed" is selected, the level is recalibrated for every level and frequency setting.
"Off (Table)"	Internal level control is performed according to the ALC table.

Remote command:
`[:SOURce]:POWer:ALC[:STATe]` on page 466

Detector Sensitivity

Allows you to fix the internal level detector. It is recommended to use the Auto mode (default).

"Auto"	Automatic detector selection. Recommended mode of operation.
"Low"	Low sensitivity detector selected. This setting is intended for signals with high internal electronic levels.
"Med"	Medium sensitivity detector selected. This setting corresponds to normal mode. It is intended for signals with medium internal electronic levels.

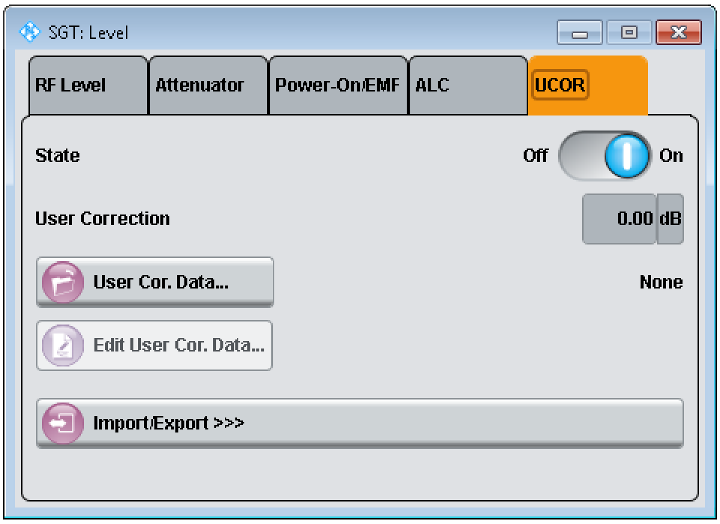
"High"	High sensitivity detector selected. Selects the detector path with high sensitivity, intended for signals with low internal electronic levels.
"Fix"	Fixes the last set sensitivity setting.

Remote command:

`[:SOURce]:POWer:ALC:DSENsitivity` on page 466

7.7.6.5 User Correction Settings

► To access the user correction level settings, select "SGMA-GUI > Instrument Name > RF > Level > UCOR".



The "User Correction" function is used to create and activate lists in which level correction values predefined by the user are freely assigned to RF frequencies. Correction is performed by the user-defined table 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.

The lists are created in the "List Editor". Each list is stored in its own file with the predefined file extension `*. uco`. The name of the "User Correction" file can be freely selected. The files are loaded from the "Lists..." file manager. Externally created tables with pairs of frequency and level values can be converted into "User Correction" files using the import function. The external files must have the file extension `*.txt` or `*.csv`. These file formats are provided e.g. by the Microsoft Excel program. The separators for table columns and for decimal floating-point numerals can be set. In addition, internally created "User Correction" data can be exported into ASCII files using the export function.

If user correction is activated, the "UCOR" display ("User Correction") is shown in the header together with the "Level" display. The RF output level is the sum of both values.

"Level" + "UCOR" = Output level

If activated, user correction is effective in all operating modes.

State
Activates/deactivates user correction.

Remote command:
[:SOURce<hw>]:CORRection[:STATe] on page 422

User Correction
Indicates the current value for level correction.

Remote command:
[:SOURce<hw>]:CORRection:VALue? on page 422

User Cor. Data - User Correction
Calls the "File Select" menu for selecting and creating a list or the "File Manager".

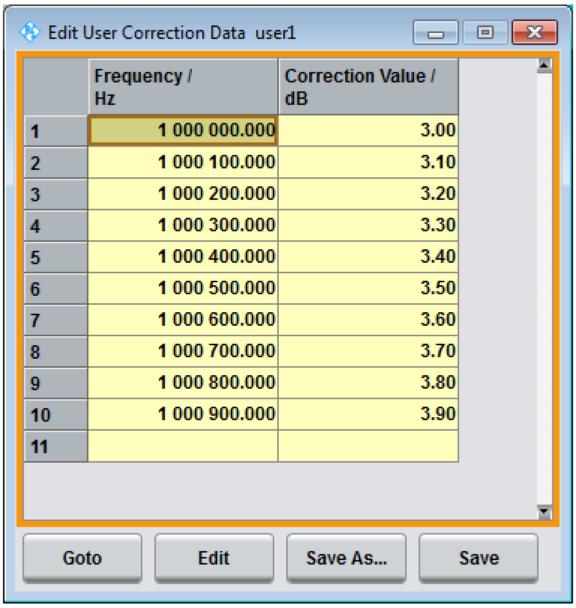
Remote command:
[:SOURce]:CORRection:CSET:DELete on page 417
[:SOURce<hw>]:CORRection:CSET[:SELect] on page 421

Edit User Cor. Data
Calls the editor for editing the selected user correction list.

A list consists of any number of frequency/level value pairs. The currently selected list is displayed.

Each list is saved as a separate file with extension *.uco. The file name and the directory to which the file is saved are user-selectable.

Note: Save list only after filling both columns (frequency and level), otherwise the entries are lost.



	Frequency / Hz	Correction Value / dB
1	1 000 000.000	3.00
2	1 000 100.000	3.10
3	1 000 200.000	3.20
4	1 000 300.000	3.30
5	1 000 400.000	3.40
6	1 000 500.000	3.50
7	1 000 600.000	3.60
8	1 000 700.000	3.70
9	1 000 800.000	3.80
10	1 000 900.000	3.90
11		

"Frequency /Hz"

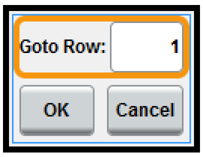
Enters the frequency to which the level correction value applies.

Note: The "Fill..." function allows you to automatically enter any number of frequencies with freely selectable range and increment.

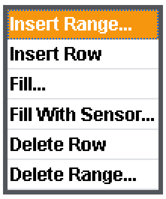
"Power/dB" Enters the level correction value to which the specified frequency applies.

"Goto" Selects row for editing.

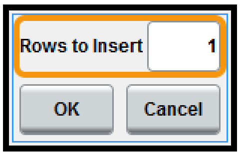
If "Goto Row" is selected, a window opens for entering the requested row.



"Edit" Calls a selection of possible actions described below.



"Insert Range" Insert new rows before the marked row. The number of rows to be inserted can be defined in an entry window.



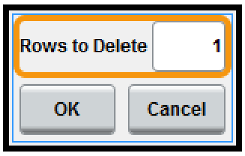
"Insert Row" Insert a new row before the marked row.

"Fill...." Opens a sub menu for defining a set of list values to be automatically entered in the ucor list, see Filling the Correction List Automatically).

"Fill with sensor..."
Opens a dialog to configure the settings for automatic filling of user correction data with an R&S NRP power sensor, see Chapter 7.7.6.7, "Fill with Sensor", on page 218.

"Delete Row" Deletes the marked row.

"Delete Range..."
Allows you to delete any number of rows starting with the marked row. The number of rows to be deleted can be defined in an entry window.



"Save as" Open the file menu to save the list under a new name.

Note: Save list only after filling both columns (frequency and level), otherwise the entries are lost.

Each list is saved to the R&S SGT hard disk as a separate file with the file prefix `*.uco`. The file name and the directory to which the file is saved are user-selectable.

"Save" The list is saved under its current name.

Remote command:
`[:SOURce<hw>]:CORRection:CSET[:SELect]` on page 421
`[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency` on page 415
`[:SOURce<hw>]:CORRection:CSET:DATA:POWer` on page 416

Import/Export >>>
Expands the menu with the area for import and export of user correction files.

Externally edited Excel tables with any number of frequency/level value pairs can be imported as text or `*.csv` files and used for user correction.

Conversely, you can also export internally created user correction lists as text or `*.csv` files.

Mode - User Correction
Selects if user correction lists should be imported or exported. The settings offered depend on the selected mode.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:MODE on page 420

Extension

Selects the file extension of the ASCII file to be imported or exported. Selection "TXT" (text file) or "CSV" (Excel file) is available.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension on page 418

Decimal Point

Selects the decimal separator used in the ASCII data between '.' (decimal point) and ',' (comma) with floating-point numerals.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal on page 419

Column Separator

Selects the separator between the frequency and level column of the ASCII table the user correction list is exported to or imported from.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:COLumn on page 419

Select ASCII Source/Destination

Calls the "File Manager" for selecting the ASCII file to be imported into a user correction list (source) or the ASCII file the user correction list is exported (destination) in.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect on page 418

Select Destination/Source

Calls the "File Manager" for selecting the user correction list to be exported (source) into an ASCII file or the destination for the ASCII file to be imported (destination) in.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:SELect on page 421

Import/Export

Starts the export or import of the selected file.

When import is selected, the ASCII file is imported as user correction list.

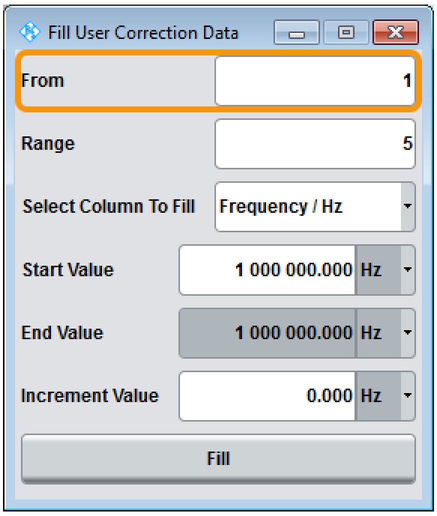
When export is selected, the user correction list is exported into the selected ASCII file.

Remote command:

[:SOURce<hw>]:CORRection:DEXChange:EXECute on page 420

7.7.6.6 Filling the Correction List Automatically

The "Fill Table" menu enables you to set the level correction values automatically.



The start line and the number of rows to be filled are defined under "From" and "Range."

The column to be filled is selected under "Select column to fill". Depending on the selection here, the default for start, end, and increment value are set. As the settings are interdependent, a change of one parameter may result in the automatic change of one or more of the other parameters. The filling of the column with the selected value settings is started with button "Fill".

The correction list entries are only computed when the "Fill" button is pressed.

From

Sets the start value of the index range.

Remote command:
n.a.

Range

Sets the range for filling the table.

Remote command:
n.a.

Select column to fill

Selects either the frequency or the level column to be filled with the value defined below.

Remote command:
n.a.

Start value

Sets the start value for the frequency or the level entries.

Remote command:
n.a.

End value
Displays the end value for the frequency or the level entries.

Remote command:
n.a.

Increment value
Sets the increment for the frequency or the level entries.

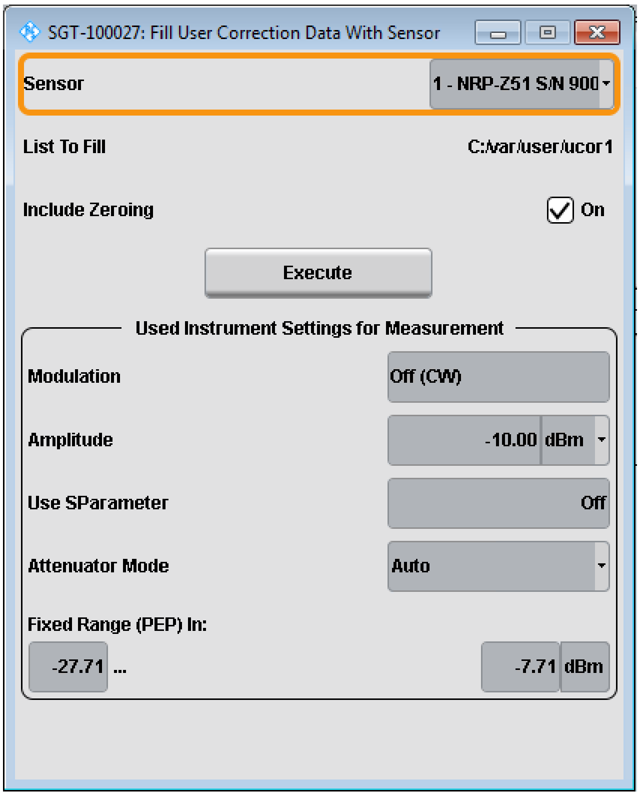
Remote command:
n.a.

Fill
Fills the selected column in the set range with values, starting with the start value and using the set increment.

Remote command:
n.a.

7.7.6.7 Fill with Sensor

► To access this dialog, select "SGMA-GUI > Instrument Name > Level > UCOR > Edit User Cor. Data> Fill With Sensor".



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 7.7.8, "NRP Power Viewer", on page 221.

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 cannot 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 422
`[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe` on page 417

Used Instrument Settings For Measurement
Displays the settings relevant for the measurement.

"Modulation" Indicates the modulation state

"Amplitude" Shows the currently set level.

"Use SParameter"
Indicates whether SParameter correction is used.

"Attenuator Mode"
Displays the selected mode of the attenuator.

"Fixed range (PEP) In"
Shows the level range.

Remote command:
n.a.

7.7.7 NRP Sensor Mapping

The "NRP Sensor Mapping" lists all R&S NRP sensors detected by the signal generator.

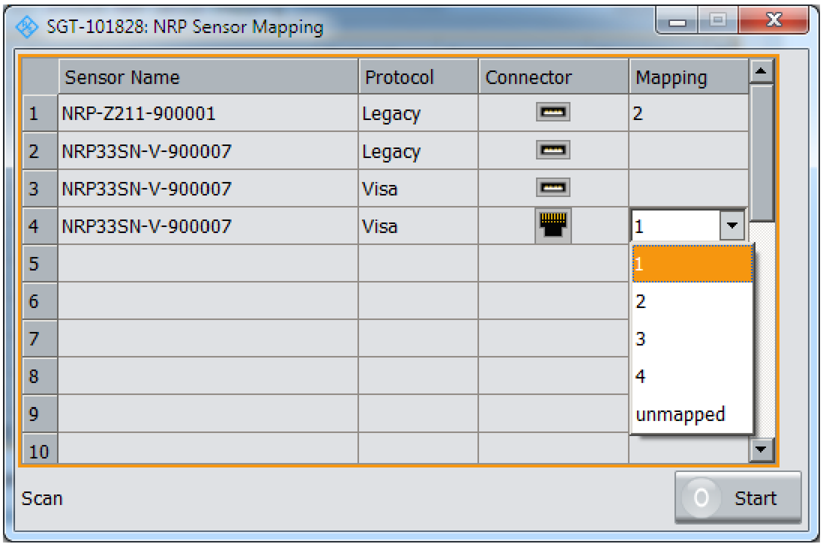
Any R&S NRP sensor that supports the USB legacy protocol and is connected to one of the USB interfaces, is detected automatically and added to the list. Vice versa, the R&S SGT removes a sensor from the list, when it is disconnected.

R&S NRP sensors that are connected via LAN or use the USBTMC protocol are not automatically detected. They are detected by the scan search function.

7.7.7.1 NRP Sensor Mapping Settings

Access:

► Select "Instrument > RF > NRP Sensor Mapping".



The dialog lists all detected R&S NRP sensors for selection and mapping. You can also browse the network for sensors.
The detected sensors are characterized by the used protocol and the corresponding icon. In the "Mapping" column, you can assign the sensor to one of the available sensor channels. The list can contain several entries but the R&S SGT can only use up to four sensors simultaneously.

The remote commands required to define these settings are described in Chapter 11.13, "SENSe, READ, INITiate and SLISt Subsystems", on page 329.

Sensor Mapping List
Displays a list of all sensor entries with information on the sensor name, the used protocol, the connector and the assigned mapping.

If a sensor is connected via LAN or uses the USBTMC protocol, its protocol is indicated as "Visa".

Remote command:
:SLISt[:LIST]? on page 338
:SLISt:ELEMent<ch>:MAPPing on page 339

Scan
Scans the network and the USB connections for sensors connected via the VISA communication protocol, i.e. sensors that are addressed via LAN or USBTMC.

Sensors communicating via the USB legacy protocol are detected automatically.

Remote command:
`:SLISt:SCAN[:STATe]` on page 339

7.7.8 NRP Power Viewer

The R&S SGT features the power viewer function for measuring or monitoring signals with R&S NRP power sensors.

The R&S SGT can perform up to four power measurements simultaneously. The measured signals can be the RF output power or other selected signal sources.

Connecting R&S NRP power sensors to the R&S SGT

R&S NRP sensors are connected to the R&S SGT in the following ways:

- Connection to the USB connector via adapter cable
  Required are the following cables:
  – Adapter cable: R&S NRP-Z3 or R&S NRP-Z4
  – USB Adapter Micro-A to A
- Connection via R&S NRP-Z5 sensor hub
  Additional cables are required, see Using the R&S NRP-Z5 sensor hub.
- Connection via USB hub with external power supply unit
  Additional cables are required, see Using USB hub.

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 sensors. It provides simultaneous internal and external triggering of all connected sensors.

Figure 7-25 illustrates the connection as principle. For details, see the description R&S®NRP®Series Power Sensors getting started.

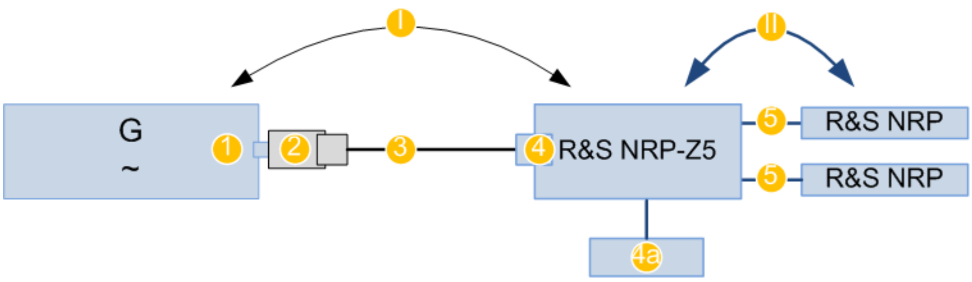


Figure 7-25: Connecting power sensors to the R&S SGT via R&S NRP-Z5 sensor hub

I, II = Connection order
G = Signal source (R&S SGT)
1 = USB type Micro-A connector

2 = USB Adapter Micro-A to A
3 = Standard USB cable with USB type A and USB type B connectors
4 = USB type B connector
4a = External power supply unit, incl. power cable (supplied with the R&S NRP-Z5)
5 = Cable R&S NRP-ZK6 per sensor

Using USB hub

Figure 7-26 illustrates the connection as principle. For details, see the description R&S®NRP®Series Power Sensors getting started.

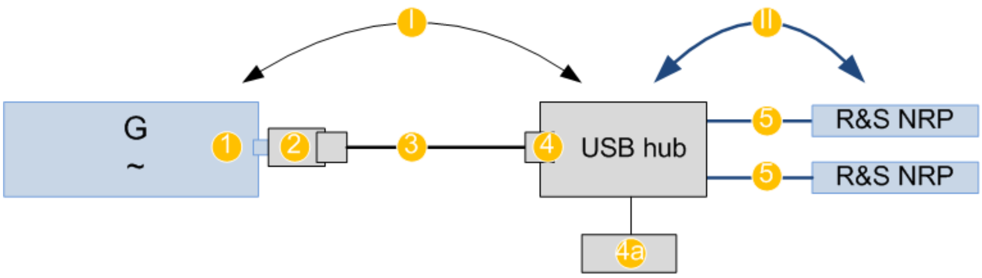


Figure 7-26: Connecting power sensors to the R&S SGT via USB hub

I, II = Connection order
G = Signal source (R&S SGT)
1 = USB type Micro-A connector
2 = USB Adapter Micro-A to A
3 = Standard USB cable with USB type A and USB type B connectors
4 = USB type B connector
4a = External power supply unit and extra power cable
5 = Adapter cable R&S NRP-Z3 or R&S NRP-Z4 per sensor

Connection order

Always connect the equipment in the following order:

1. Connect the R&S NRP-Z5 sensor hub or the USB hub to the power supply and to the R&S SGT
2. Switch on the R&S SGT
3. Connect/disconnect the R&S NRP sensors

Detection and mapping

The R&S SGT automatically detects a connected R&S NRP power sensor and indicates it in the "NRP Power Viewer" and "NRP Sensor Mapping" dialogs.

You can change the default mapping in the NRP Sensor Mapping dialog.

About the measuring principle, averaging filter, filter length, and achieving stable results

A sensor measures the average signal power of the selected source continuously. The measurement results are displayed the "NRP Power Viewer" dialog.

The power viewer function uses **averaging filters** to reduce the fluctuations of the measurement result to the desired extent. Common sources of fluctuations are inherent noise of the measuring instrument, modulation of the measurement signal or influences from the superposition of adjacent carriers. Common method for achieving more stable display is the use of longer measurements. The term longer measurements do not mean that it takes longer to display a new result. The term refers to the time it takes for the result to settle when the power varies.

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. This approach is referred as a **two-step averaging process**.

The factor of 2 in the formula arises because the output signals from the microwave detector are chopped at the same rate as the time windows to suppress low-frequency noise. An independent measured value can only be obtained from two consecutive values.

The variable N in the formula indicates the **filter length**. The filter length then directly influences the measurement time. The filter length can be selected automatically or it can be manually set to a fixed value.

Follow the following general recommendation to find out the **optimum filter length**:

- Always start a measurement in auto mode ("Filter > Auto")
  Check if the measurement results are sufficient.
- If the power is not constant, select the filter length manually ("Filter > User")
  Trigger the "Auto Once" function to search for the optimum filter length for the current measurement conditions.
  The estimated value is indicated as filter length.
- If the target measurement accuracy is known value, select "Filter > Fixed Noise"
  The averaging factor is selected automatically and so that the sensor's intrinsic noise (two standard deviations) does not exceed the specified noise content.
- Different sensor types achieve the same filtering result with different filter lengths and time window values.

  The time window length depends on the sensor type:

  – For most sensors, it is fixed to 20 ms.

  – For the R&S NRP-Z81 sensor, it is 10 µs.
    The R&S NRP-Z81 uses filter length that is 1000 times larger than the filter length for other sensors.

About 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. If a Rohde & Schwarz power sensor receives an input power during the zeroing process, it aborts zeroing and generates an error message. Zeroing takes a few seconds, depending on the sensor model. Refer to the documentation of your power sensor for more information.

Tips for zeroing

When to perform zeroing:

- 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 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, but do not disconnect it from the power sensor. This proceeding keeps the thermal equilibrium, and the zeroing process also compensates the noise that superimposes the measured signal (e.g. from a broadband amplifier).

Related settings and functions

- Measurements-related settings, like results, filter, filter length:
  NRP Power Viewer Settings
- Sensor-specific information and sensor software update:
  Chapter 8.5, "NRP Info", on page 251
- Software version of the connected power sensor:
  `:SENSe<ch>[:POWer]:TYPE?` on page 338
- Acquisition of level correction data:
  Chapter 7.7.6.5, "User Correction Settings", on page 212.

Additional information

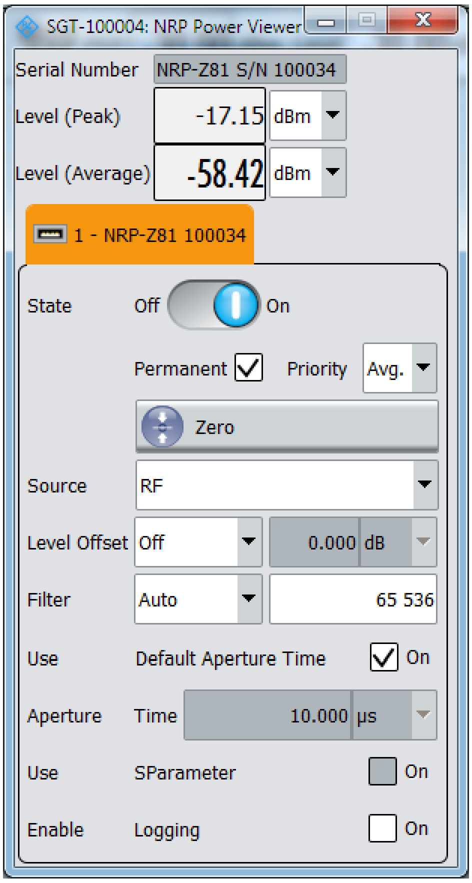
See Rohde & Schwarz website http://www.rohde-schwarz.com in section "Power Meters & Voltmeters" for:

- R&S NRP power sensor manual
- Information on the R&S NRP-Z5 sensor hub and the available accessories.

7.7.8.1 NRP Power Viewer Settings

Access:

► Select "Instrument > RF > 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 Power Viewer Settings.

The remote commands required to define these settings are described in Chapter 11.13, "SENSe, READ, INITiate and SLISt Subsystems", on page 329, including the triggering of the measurement and the retrieval of measurement results.

Serial Number
Indicates the type and the serial number of a connected R&S NRP power sensor.

The displayed Level (Peak) / Level (Average) values correspond to the particular sensor.

Remote command:
`:SENSe<ch>[:POWer]:TYPE?` on page 338
`:SENSe<ch>[:POWer]:SNUMber?` on page 336

Level (Peak) / Level (Average)
Indicates the measured peak or average level value.

You can also change the unit for the results display: Watt, dBm or dBµV.

Note: Peak level measurements are provided if the power sensor supports this feature.

Remote command:
:READ<ch>[:POWer]? on page 330
:SENSe<ch>:UNIT[:POWer] on page 331

Sensor
Indicates the connector to that the sensor is connected.

State
Activates level measurement.

Remote command:
:INITiate<ch>[:POWer]:CONTinuous on page 330
To query the availability of a sensor at a given connector, use the command :SENSe<ch>[:POWer]:STATus[:DEVice]? on page 337.

Display
Sets the display mode for power readings.

Permanent ← Display
Activates the permanent indication of the power measurement result in the block diagram. The instrument shows the type of sensor, the used 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 332

Priority ← Display
Sets the display of results on mean or peak power.

Remote command:
:SENSe<ch>[:POWer]:DISPlay:PERManent:PRIority on page 332

Zero
Activates the auto zero function.

For details, see "About zeroing" on page 223

Remote command:
:SENSe<ch>[:POWer]:ZERO on page 338

Source
Selects the source for measurement.

"RF"	Assigns the signal to the RF path of the R&S SGT. The sensor measures the power of the RF signal at the current frequency. It considers the correction factor and uses the level setting of the instrument as reference level. Frequency variations are automatically routed to the sensor.
"User"	Selects any freely selectable signal source, for example for measurement of amplifier gain with 2 sensors. Set the parameter Frequency to the measurement's frequency.

Remote command:
`:SENSe<ch>[:POWer]:SOURce` on page 337

Frequency

Defines the frequency value if "Source > User" is used.

Remote command:
`:SENSe<ch>[:POWer]:FREQuency` on page 335

Level Offset

Activates and defines a level offset which is added to the measured value. The level offset value is always expressed in dB, irrespective of the selected unit for result display.

This function allows you to consider for example an attenuator in the signal path.

Remote command:
`:SENSe<ch>[:POWer]:OFFSet` on page 336
`:SENSe<ch>[:POWer]:OFFSet:STATe` on page 336

Filter

Selects the way the length of the used filter is defined.

See also "About the measuring principle, averaging filter, filter length, and achieving stable results" on page 222.

"Auto" The filter length is selected automatically and adjusted to the measured value. The value is indicated with the parameter Filter Length
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.

"User" The filter length is defined manually, with the parameter Filter Length.
As the filter length works as a multiplier for the time window, constant filter length results in a constant measurement time.
Values 1 and 2N are allowed.

"Fixed Noise" The averaging factor is selected so that the sensor's intrinsic noise (2 standard deviations) does not exceed the specified noise content.
Set the noise content value with the parameter Noise Content.
To avoid long settling times when the power is low, limit the averaging factor with the parameter Timeout.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:TYPE` on page 335

Filter Length

For "Filter > Auto or User", indicates the used filter length.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:LENGth:AUTO?` on page 333
`:SENSe<ch>[:POWer]:FILTer:LENGth[:USER]` on page 333

Auto Once
Searches the optimum filter length for the current measurement conditions. The result is indicated with the parameter Filter Length.

See also "About the measuring principle, averaging filter, filter length, and achieving stable results" on page 222.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:SONCe` on page 334

Noise Content
For "Filter > Fixed Noise", sets the noise content.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:NSRatio` on page 333

Timeout
For "Filter > Fixed Noise", sets a time limit for the averaging process.

Remote command:
`:SENSe<ch>[:POWer]:FILTer:NSRatio:MTIMe` on page 334

Use Default Aperture Time
The sensor default setting is sufficient. Disable this parameter to specify a user-defined aperture time per sensor, if for example the readings vary.

To obtain stable readings, set the Aperture Time exactly to one modulation period.

Remote command:
`:SENSe<ch>[:POWer]:APERture:DEFault:STATe` on page 331

Aperture Time
If "Use Default Aperture Time" > "Off", defines the acquisition time per sensor.

For example, to obtain a sufficient low average value, set the aperture time exactly to one modulation period.

Remote command:
`:SENSe<ch>[:POWer]:APERture:TIMe` on page 331

Use SParameter
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 power sensor for a description of how to use the SParameter table.

Remote command:
`:SENSe<ch>[:POWer]:CORRection:SPDevice:STATe` on page 332

Enable Logging
Activates recording of R&S NRP power sensor readings in a log file.

There is 1 log file per sensor. The log files are created automatically and filled in continuously. They are text files with predefined filename `SensLog<n>.txt`, where `<n>` indicates the connected sensor. Log files are stored on the hard disk, in the directory `/var/sgt/temp/SensorLogging`.

Each log file contains the measured value (2 readings when you work with peak sensors), the sensor type, and the measurement time (timestamp). Logged data is not overwritten. When a new measurement is started, the collected logging data is appended in the log file.

Check the used disc space regularly and remove log files to maintain storage capacity.

Note: The logging function is intended for measurements with long time intervals. It is suitable source for data reconstructions if the connection to the sensor was interrupted.

Remote command:
`:SENSe<ch>[:POWer]:LOGGing:STATe` on page 336

7.7.9 Pulse Modulation

This section explains the pulse modulation settings of the R&S SGT.

To configure and perform a pulse modulation, you need to select the modulation signal source and provide the corresponding settings.

Modulation signal sources

The R&S SGT provides the following signal sources for the signal modulation:

- **Internal**: A high-performance pulse generator, that allows you to generate either single or double pulse signals
- **Externally supplied signal:** the instrument expects the pulse modulation signals at the TRIG connector.

Pulse modulation signal waveforms

The high-performance pulse generator enables you to generate single or double pulse signals.

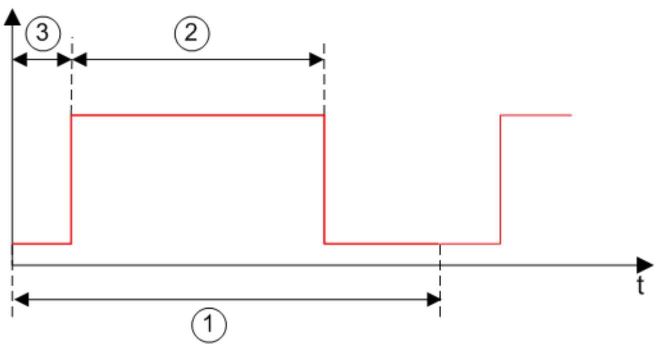


Figure 7-27: Pulse generator - single pulse mode

1 = Pulse period
2 = Pulse width
3 = Pulse delay

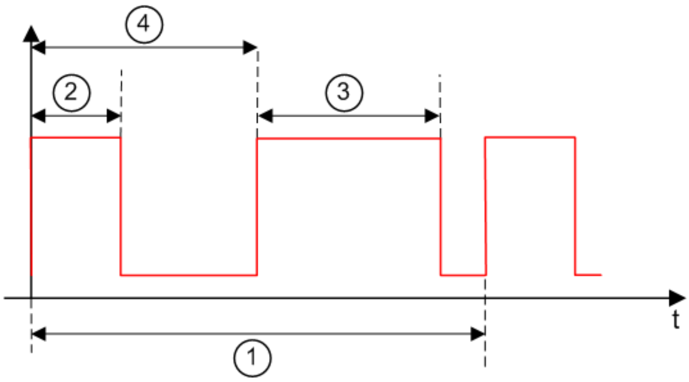
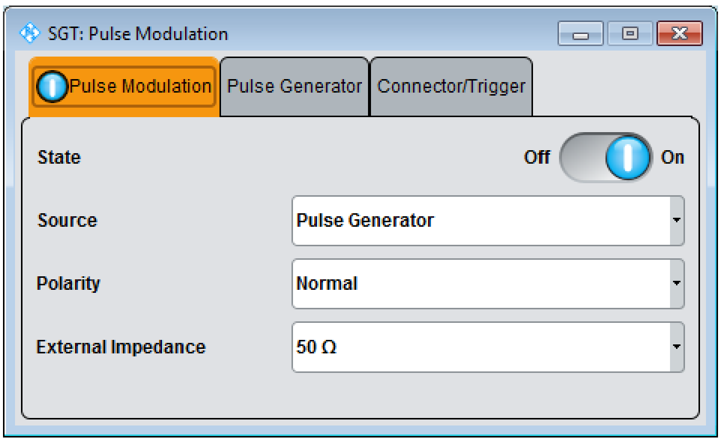


Figure 7-28: Pulse generator - double pulse mode

1 = Pulse period
2 = Pulse width
3 = Double pulse width
4 = Double pulse delay

7.7.9.1 Pulse Modulation Settings

► To access the pulse modulation settings, select "SGMA-GUI > Instrument Name > RF > Pulse Modulation".

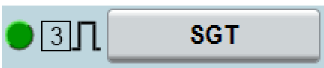


The "Pulse Modulation" dialog contains all parameters required to configure pulse modulation and pulse signal generation.

State

Activates pulse modulation.

The R&S SGMA-GUI indicates an activated pulse modulation as follows:



Remote command:
`[:SOURce<hw>]:PULM:STATe` on page 464

Source
Selects between the internal "Pulse Generator", or an "External" pulse signal for the modulation. In the later case, the instrument expects the pulse modulation signals at the USER 2 connector.

Remote command:
`[:SOURce<hw>]:PULM:SOURce` on page 463

Polarity
Sets the polarity of the active slope of the modulation signal for "Source > External".

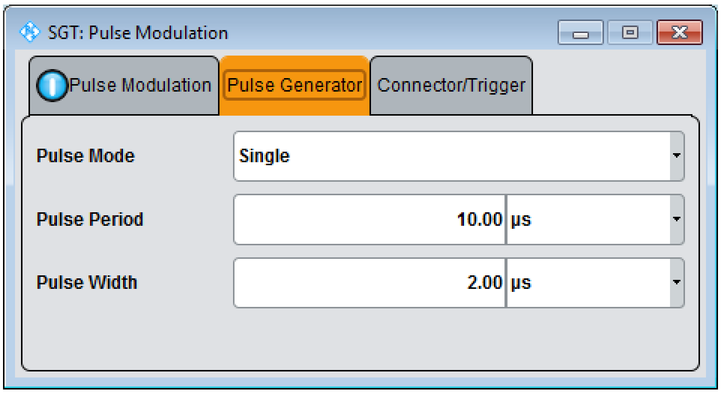
Remote command:
`[:SOURce<hw>]:PULM:POLarity` on page 463

External Impedance
Selects the input impedance for an external pulse modulation signal.

Remote command:
`[:SOURce<hw>]:PULM:TRIGger:EXTernal:IMPedance` on page 464

7.7.9.2 Pulse Generator Settings

► To access the pulse connector/trigger settings, select "SGMA-GUI > Instrument Name > RF > Pulse Modulation > Connector/Trigger".



Comprises the settings necessary to configure the internal pulse modulation signal.

Pulse Mode
Sets the operating mode of the pulse generator.

"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 462

Pulse Period
Sets the repetition rate of the generated pulse signal.

Remote command:
`[:SOURce<hw>]:PULM:PERiod` on page 463

Pulse Width
Sets the pulse duration of the generated pulse signal.

Remote command:
`[:SOURce<hw>]:PULM:WIDTh` on page 465

Double Pulse Width
Sets the width of the second pulse.

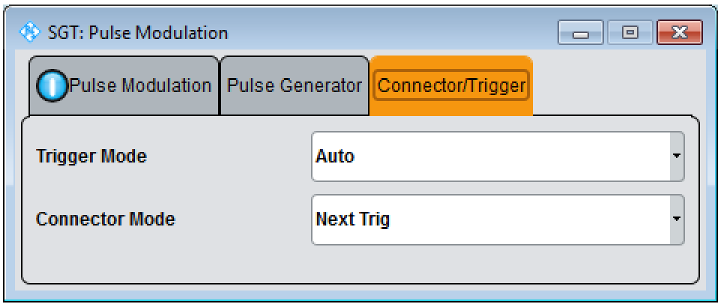
Remote command:
`[:SOURce<hw>]:PULM:DOUBle:WIDTh` on page 462

Double Pulse Delay
Sets the delay between the start of the first pulse and the start of the second pulse.

Remote command:
`[:SOURce<hw>]:PULM:DOUBle:DELay` on page 462

7.7.9.3 Pulse Connector/Trigger Settings

► To access the pulse connector/trigger settings, select "SGMA-GUI > Instrument Name > RF> Pulse Modulation > Connector/Trigger".



Comprises the settings necessary to configure the signal at the multi-purpose TRIG connector in the external trigger mode.

Mode
Selects the mode for the correspondent connector. Some settings are only available for connector USER 2.

"Marker 1/2" Output for a defined marker signal.

"Trigger/ Trigger Out"
Input/output for an external trigger signal.

"Clock In/Out" Input/Output for a clock signal.

"Sync In/Out" Input/Output for SYNC signals used for SYNC-Mode in baseband.

"Next Trigger" Input next segment for triggering of multi-segment waveform files.

"Signal Valid" Output of high signal to mark valid frequency and level settings.

"Not Signal Valid"
Output of high signal to mark the transition state when frequency and level change.

"Pulse Video Out"
Available only for USER 2.
Output of the internally generated pulse video (modulating) signal.
The video signal level corresponds to the RF envelope.

"Pulse Gen Ext Trigger"
Available only for USER 2.
Input for an external trigger signal, used to trigger the pulse generator.

"Pulse Mod Ext Source"
Available only for USER 2.
Input for an externally provided pulse modulation signal.
Used when an external pulse modulator source is provided at the connector.

Remote command:
:CONNector:USER<ch>:OMODe on page 315

Trigger Mode

Selects between continuous pulse modulation or pulse modulation triggered by an external signal.

"Auto" Generates the modulation signal continuously.

"Ext Single" Generates the signal each time an external trigger event occurs.

"Ext Gated" Generates the signal triggered by an external gate signal.

Remote command:
[:SOURce<hw>]:PULM:TRIGger:MODE on page 465

Ext. Trigger Input Slope

Available only for "Trigger Mode > Ext Triggered "

Sets the polarity of the active slope of an applied external trigger signal.

Remote command:
[:SOURce<hw>]:PULM:TRIGger:EXTernal:SLOPe on page 465

Gate Input Polarity

Available only for "Trigger Mode > Ext Gated "

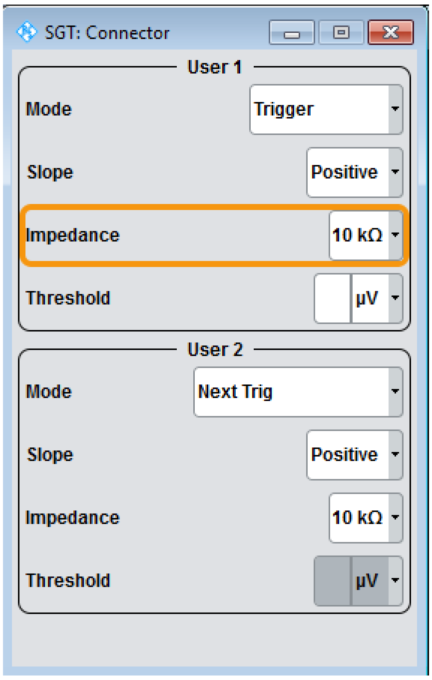
Sets the polarity of the active slope of an applied gate signal.

Remote command:
[:SOURce<hw>]:PULM:TRIGger:EXTernal:GATE:POLarity on page 464

7.8 Connectors

The USER connectors of the R&S SGT can be used for multiple purposes. In the "Connector" dialog, the correct mode for each connector can be set, and additional settings for some modes.

► To access this dialog select "SGMA-GUI > Instrument Name > Connectors"



Mode
Selects the mode for the correspondent connector. Some settings are only available for connector USER 2.

"Marker 1/2" Output for a defined marker signal.

"Trigger/ Trigger Out"
Input/output for an external trigger signal.

"Clock In/Out" Input/Output for a clock signal.

"Sync In/Out" Input/Output for SYNC signals used for SYNC-Mode in baseband.

"Next Trigger" Input next segment for triggering of multi-segment waveform files.

"Signal Valid" Output of high signal to mark valid frequency and level settings.

"Not Signal Valid"
Output of high signal to mark the transition state when frequency and level change.

"Pulse Video Out"
Available only for USER 2.
Output of the internally generated pulse video (modulating) signal.
The video signal level corresponds to the RF envelope.

"Pulse Gen Ext Trigger"
Available only for USER 2.
Input for an external trigger signal, used to trigger the pulse generator.

"Pulse Mod Ext Source"
Available only for USER 2.
Input for an externally provided pulse modulation signal.
Used when an external pulse modulator source is provided at the connector.

Remote command:
:CONNector:USER<ch>:OMODe on page 315

Trigger Slope

Sets the polarity of the active slope of the externally applied signal.

Remote command:
:CONNector:USER<ch>:TRIGger:SLOPe on page 316

Clock Slope

Sets the polarity of the active slope of the externally applied signal.

Remote command:
:CONNector:USER<ch>:CLOCk:SLOPe on page 316

Impedance

Selects the input impedance for the modulation signal.

Remote command:
:CONNector:USER<ch>:TRIGger:IMPedance on page 316
:CONNector:USER<ch>:CLOCk:IMPedance on page 316

Threshold

Sets the high/low threshold of the signal.

Remote command:
:CONNector:USER<ch>:THReshold on page 315

7.9 External Baseband Signal - Baseband Input

The R&S SGT makes it possible to feed an external digital baseband signal into the signal path.

User-specific wanted signals or interference signals can be frequency and offset shifted, detuned or loaded with noise (see Chapter 7.2, "Additive White Gaussian Noise (AWGN) - Noise Generator", on page 123).

The R&S SGT is equipped with the DIGITAL IQ IN interface at the rear of the instrument as input connector for the external digital signal.

This interface provides direct communication with other R&S instruments.

The Chapter 7.9.2, "BB Input Block", on page 237 describes the settings for configuring an input signal.

7.9.1 Important Signal Parameters

The correct signal processing of the externally supplied input signals in the instrument requires 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 input signal can be defined manually or automatically retrieved from the input signal.
- **Crest factor**
  Test setups may require feeding of external signal to the digital/analog input of the R&S SGT. As a rule, whenever an I/Q signal is transferred between two instruments, the crest factor at the outputs of the "source" instrument has to match with the crest factor at the inputs of the receiving one.
  The crest factor gives the difference in level between the peak level and RMS level value in dB. The R&S SGT uses the crest factor value for the calculation of power levels. The general principle is, that the R&S SGT compensates the RMS levels of the externally supplied signal by the crest factor.

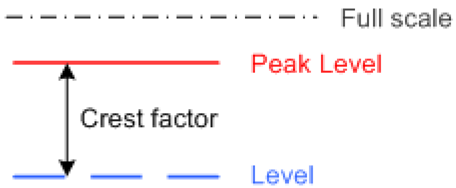


Figure 7-29: Relation between the level settings

In the instrument, level values are represented relative to the full scale.

Fulfilling the prerequisites for a correct signal processing of the externally supplied baseband signal

In the instrument, the **crest factor, peak level and RMS level** values can be adjusted in one of the following ways:

- Adjusted manually
  If you know these values, it is best to enter them directly (see Crest Factor)
- Estimated automatically by the internal measurement function
  Use the function Auto Level Set to trigger the R&S SGT to measure the input signal, estimate the peak level and RMS level and calculate the crest factor out of them.
  Tip: For accurate level measurements, set the measurement period to a time value that is long enough to capture several periods of the input signal.
- Determined automatically (digital baseband input only)
  The R&S SGT 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 RMS level of the signal over the digital input interface. To

enable the R&S SGT to receive these values, trigger the DIG IQ Auto Setting function.

In the two automatic ways, the R&S SGT 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 shown in Figure 7-30.

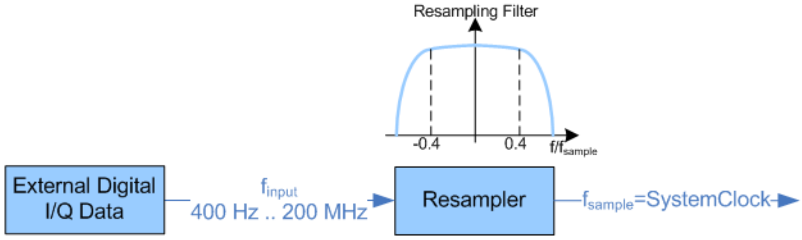


Figure 7-30: Resampling of external digital baseband signals

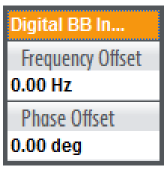
The R&S SGT can process digital signals with sample rate from 400 Hz to 200 MHz, whereas the internal signal processing is based on a sample rate with 300 MHz.

- **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

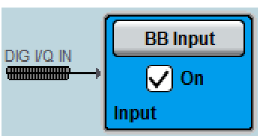
Maximum modulation bandwidth

- A baseband signal with a sample rate that is smaller than the used system clock is interpolated (see Figure 7-30). 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.

7.9.2 BB Input Block



The settings for signal routing, frequency offset and phase offset are available in the "BB Input" function block.



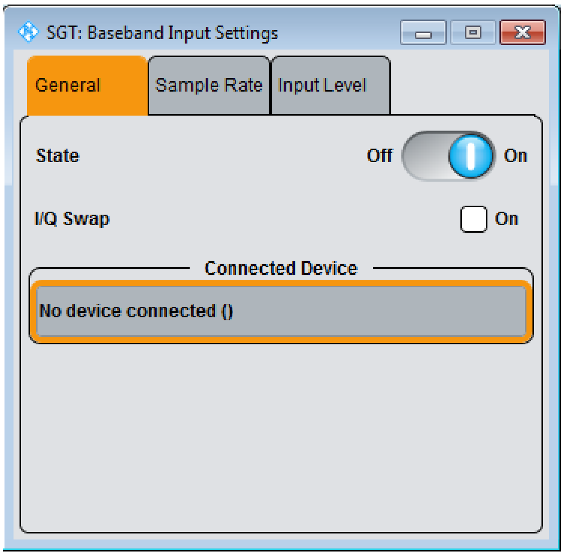
The external baseband signal is activated by switching on in the "Baseband Input Settings" dialog as well as by ticking the checkbox of the "BB Input" function block.

7.9.2.1 Baseband Input Settings Menu

This dialog comprises the settings necessary to adjust the signal parameters, like the sample rate, the baseband input level and to perform simple signal monitoring.

Baseband Input General Settings

► To access this dialog, select "SGMA-GUI > Instrument Name > BB Input > Digital BB In >General".



In this section, you can activate the baseband input and get information about the connected devices.

State

Switches On/Off the feeding of an external digital signal into the signal path.

"On" Switches On the external I/Q input signal of the "BB In" block. The input symbol displays the active signal mode.

"Off" Switches Off the external I/Q input signal.

Remote command:

`[:SOURce<hw>]:BBIN:STATe` on page 407

I/Q-Swap

Activates swapping of the I and Q signal components, which mirrors the spectrum at the f=0 line and inverts the sign of the frequency.

Remote command:

`[:SOURce<hw>]:BBIN:IQSWap[:STATe]` on page 402

Connected Device

Indicates the ID of a connected R&S Instrument or R&S device.

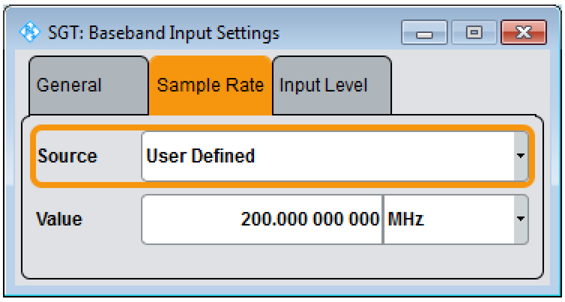
If supported by the transmitter, also the transmitter sample rate is shown.

Note: The connected instrument is indicated only, if the connection is properly established and signal transmission is active.

Remote command:
[:SOURce<hw>]:BBIN:CDEVice? on page 401

Sample Rate

► To access this dialog, select "SGMA-GUI > Instrument Name > BB Input > Digital BB In > Sample Rate".



In this section, you can set the sample rate of the external digital baseband signal.

Sample Rate Source
Selects the source for estimating the sample rate or defining it by the user.

"User Defined" Enables the user to define the sample rate in the entry field value.

"Digital I/Q In" Estimates the sample rate on the digital I/Q input and displays the value in the value field.
Note: Estimation works best if the sample rate is close to the user defined value.

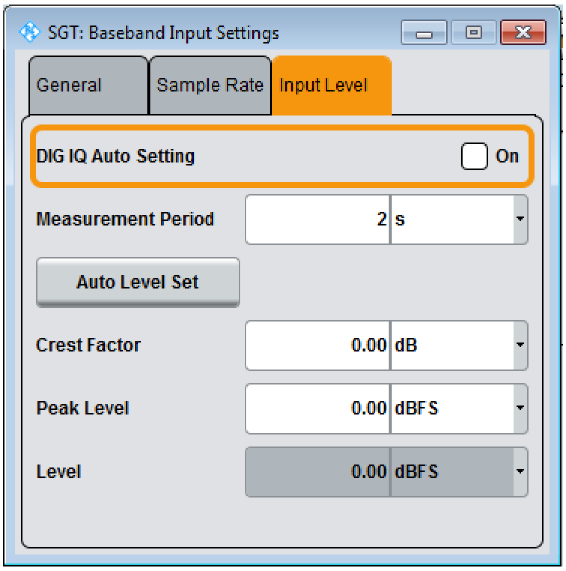
Remote command:
[:SOURce<hw>]:BBIN:SRATe:SOURce on page 406

Sample Rate Value
Sets the sample rate of the external digital baseband input signal.

Remote command:
[:SOURce<hw>]:BBIN:SRATe[:ACTual] on page 406

Baseband Input Level

► To access this dialog, select "SGMA-GUI > Instrument Name > BB Input > Digital BB In > Sample Rate".



The crest factor and the peak power of the external baseband signal are entered in the section "Baseband Input Level". These values are necessary for a correct internal signal processing in the R&S SGT. They can also be automatically estimated by a measurement using the "Auto Level Set" button.

DIG IQ Auto Setting
Activates automatic adjustment of the baseband input signal.

The R&S SGT receives peak level, level and crest factor values directly from the connected transmitter and recognizes changes automatically.

Remote command:
`[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe` on page 401

Measurement Period
Sets the recording duration for measuring the baseband input signal by "Auto Level Set". 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 403

Auto Level Set
Starts measuring the input signal. The measurement estimates the crest factor, the peak power and the rms power. The estimated values are automatically entered into the input fields "Crest Factor", "Peak Level" and "Level". Using these estimated values the internal gain control adjusts the input signal gain to achieve an optimal dynamic range.

Remote command:
[:SOURce<hw>]:BBIN:ALEVel:EXECute on page 401

Crest Factor
Sets the crest factor of the external analog or digital baseband signal. Indicates the crest factor acquired with "Auto Level Set".

Remote command:
[:SOURce<hw>]:BBIN:CFACtor on page 401

Peak Level
Enters the peak level of the external digital baseband signal relative to full scale of 0.5 V (in terms of dB full scale).

Indicates the peak level acquired with "Auto Level Set".

Remote command:
[:SOURce<hw>]:BBIN:POWer:PEAK on page 405

Level
Indicates the estimated rms level acquired with "Auto Level Set".

Remote command:
[:SOURce<hw>]:BBIN:POWer:RMS? on page 406

Signal Monitoring

The section "Signal Monitoring" indicates an overload.

Overflow
Indicates that the I/Q input is currently overloaded.

If overload is indicated either the amplitude of the external signal is too high (full scale of 0.5 V) and must be reduced or the entered "Peak Level" (in dB full scale) value does not correspond with the real value and must be corrected. It also can be evaluated automatically with button "Auto Level Set".

Remote command:
[:SOURce<hw>]:BBIN:OLOad:STATe? on page 404

Overflow Hold
Indicates an overload since last reset for evaluating the measurement.

The Overload Hold state can be reset via the "Reset" button next to the LED, or is reset automatically by starting a new measurement ("Auto Level Set") or by setting new values (Crest Factor, Peak Level, Level).

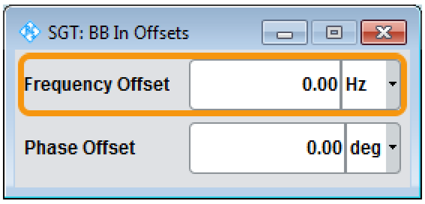
Remote command:
[:SOURce<hw>]:BBIN:OLOad:HOLD:STATe? on page 404

Reset
Executes a reset of the "Overflow Hold" state.

Remote command:
[:SOURce<hw>]:BBIN:OLOad:HOLD:STATe? on page 404

7.9.2.2 BB In Offset

► To access this dialog, select "SGMA-GUI > Instrument Name >BB Input/Output > Frequency/Phase Offsets".



A frequency and phase offset can be set in this dialog.

Frequency Offset

Enters the frequency offset for the external baseband signal and shifts the useful baseband signal in the center frequency.

Remote command:

`[:SOURce<hw>]:BBIN:FOFFset` on page 402

Phase Offset

Enters the phase offset for the external baseband signal. The offset affects the signal on the output of the "Baseband In/Out" block.

Remote command:

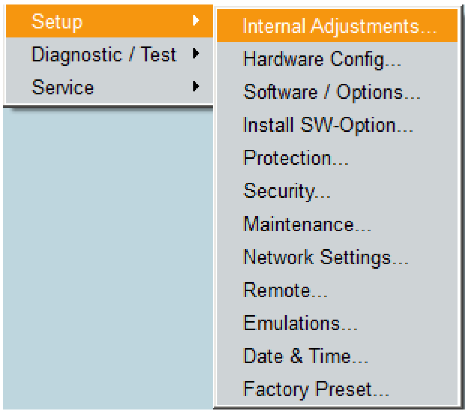
n.a.

8 General Instrument Settings and Instrument Setup

This section describes the settings which do not directly affect signal generation.

Access:

► Select "SGMA-GUI > Instrument Name > Setup" and select the required dialog.



8.1 Internal Adjustments

The R&S SGT is accurate due to the integrated procedures for adjustments.

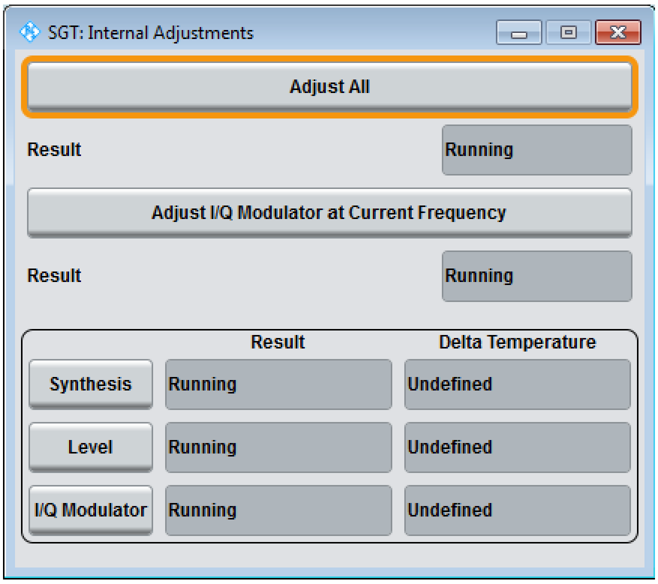
All internal adjustments for which no external measuring equipment is needed can be started in the "Internal Adjustments" dialog. The adjustments with external measuring equipment are described in the service manual.

During adjustment, a bar indicates the status of progress. If an error occurs, adjustment is terminated and an error message is output in the info line.

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.



Adjust All

Starts all internal adjustments for which no external measuring equipment is needed. The adjustments with external measuring equipment are described in the service manual.

Remote command:
`:CALibration:ALL[:MEASure]?` on page 312

Adjust I/Q Modulator at Current Frequency

Starts the adjustment for the I/Q modulator for the currently set frequency. The I/Q modulator is adjusted regarding carrier leakage, I/Q imbalance and quadrature.

The adjustment is only possible when "RF > On" and "I/Q Mod > State > On".

Adjustment for only the set frequency is considerably faster than adjustment across the entire frequency range. An adjustment of the entire range is possible with the I/Q Modulator button of this dialog.

Remote command:
`:CALibration:IQModulator:LOCal?` on page 312

Synthesis

Performs all adjustments which affect the frequency.

Remote command:
`:CALibration:FREQuency[:MEASure]?` on page 312

Level

Performs all adjustments which affect the level. The acquired correction values improve the settling time and the signal quality.

Remote command:
`:CALibration:LEVel[:MEASure]?` on page 313

I/Q Modulator
Starts the adjustment for the I/Q modulator for the entire frequency range. The I/Q modulator is adjusted regarding carrier leakage, I/Q imbalance and quadrature.

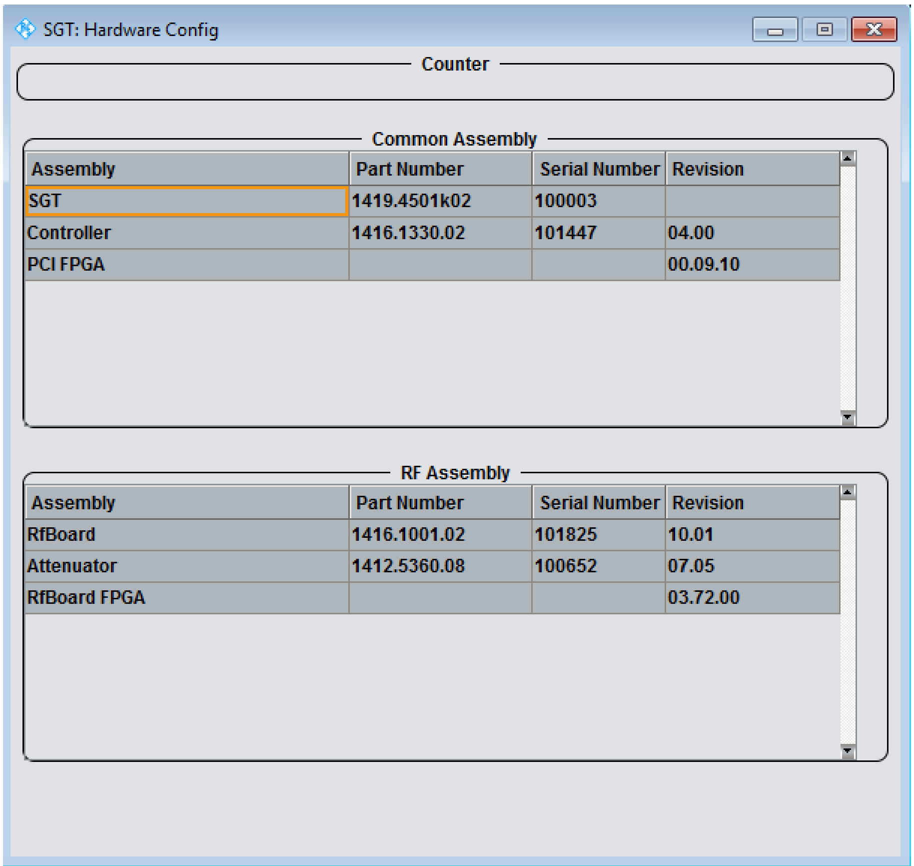
Remote command:
`:CALibration:IQModulator:FULL?` on page 312

8.2 Hardware Configuration

Querying information about the installed assemblies

► Select "SGMA-GUI > Instrument Name > Setup > Hardware Config".

In the "Hardware Config" dialog, the installed assemblies together with their variants and revision states can be displayed for servicing purposes.



The dialog is a table that lists the installed assemblies. It is divided into the sections:

- "Common Assembly"
- "RF Assembly"

Assembly
The tables list the installed assemblies.

"Assembly"	Name of the assembly
"Part Number"	Part Number of the assembly
"Serial Number"	Serial number of the assembly
"Revision"	Revision state of assembly

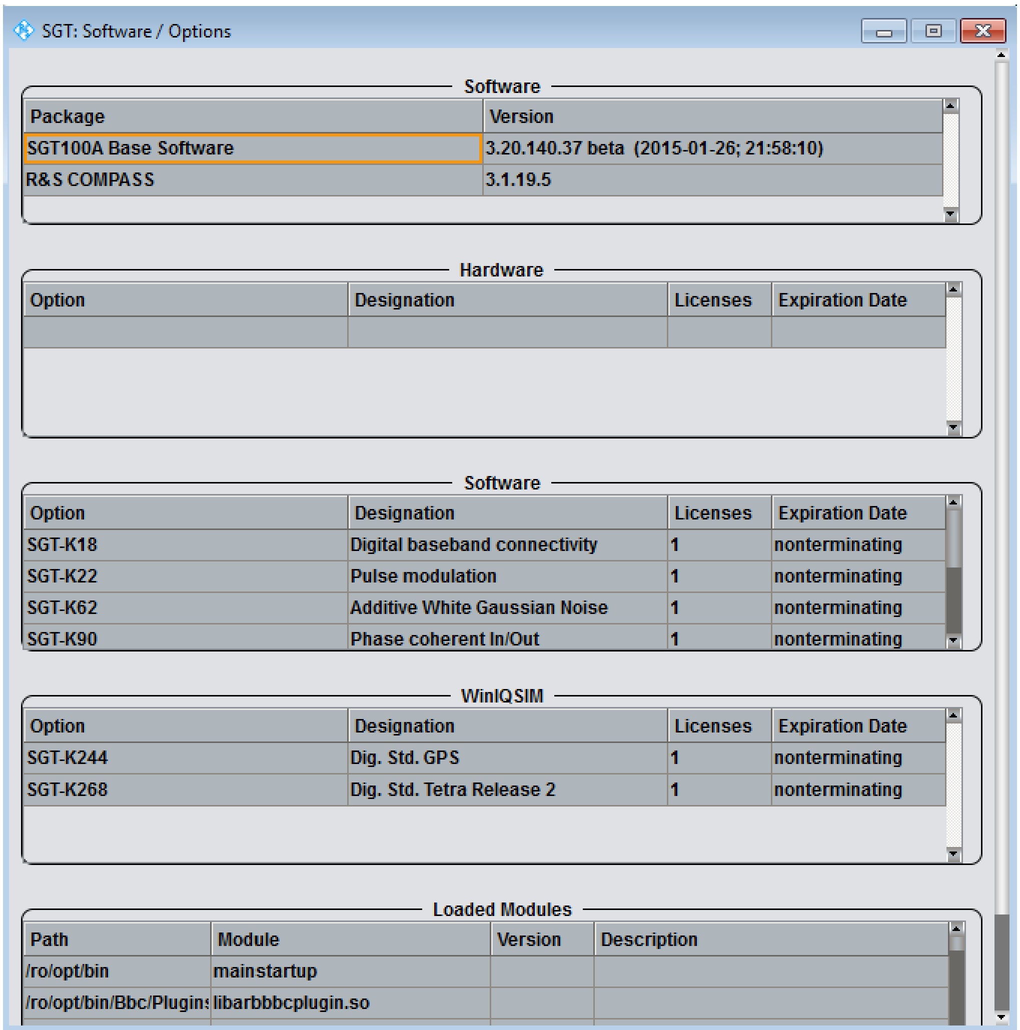
Remote command:
R&S SGT: n.a.

8.3 Software / Options

Querying information about the installed options and software version

► Select "SGMA-GUI > Instrument Name > Setup > Software/Options".

The "Software/Options" dialog shows the firmware version of the instrument software and all installed hardware and software options.



The dialog is divided into the following sections:
- "Firmware"
- "Hardware"
- "Software"
- "WinIQSIM"
- "Loaded Modules"

Software options purchased at a later stage can be activated with a keycode. The activation code is supplied with the software option. An instruction on how to install options is described in the service manual. Most hardware options need to be installed at an authorized Rohde & Schwarz service center.

Software
Shows the software/firmware version and the version of the software platform.

Note: Your instrument is delivered with the latest firmware version available. Firmware updates and the Release Notes describing the improvements and modifications are provided on the Internet at the download site of the instrument's home page. This home page always offers the latest information on your instrument, e.g. also on changes of the firmware update procedure.

Hardware / Software /WinIQSIM
The tables in the sections "Hardware" and "Software" list the installed hardware and software options.

"Option"	Short name of the option
"Designation"	Name of the option
"Licenses"	Number of licenses
"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.

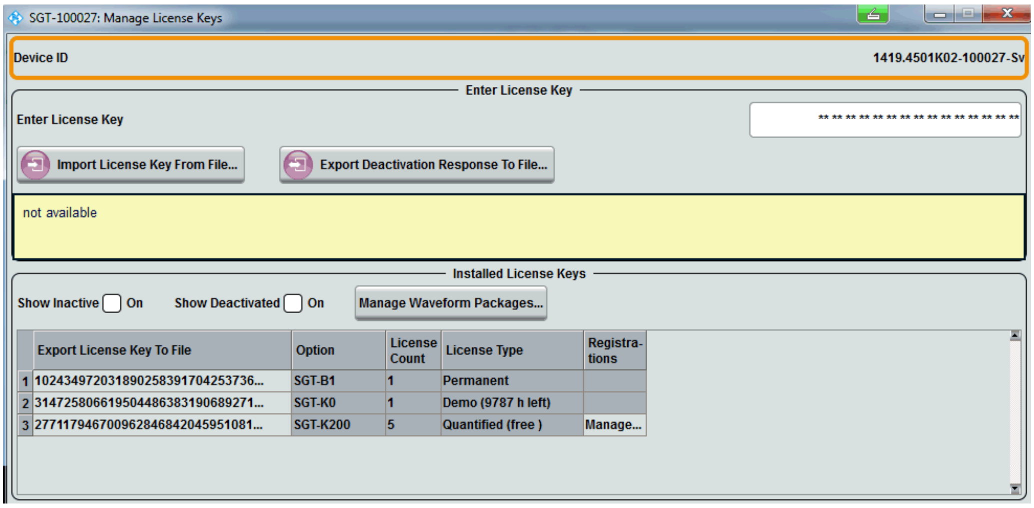
Loaded Modules
Section "Loaded Modules" is provided for service purposes. It lists all loaded software modules with their versions and offers a short description of each module.

Show Open Source Acknowledgments
Accesses the list of the used open source software packages and the corresponding verbatim license texts.

8.4 Manage License Keys

This dialog is the central dialog for managing licenses, like enabling newly purchased and/or newly registered options or performing the required instrument-related steps during the process of unregistration and/or moving of licenses.

An option is ready to operate after it is enabled by 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.



License registration

If your purchased license is delivered unregistered, you must register it before you can activate the option.

For detailed information about the license registration, refer to the installation instructions provided with the option (Supplement A) and the documentation of the online tool "Manage Licenses" (https://extranet.rohde-schwarz.com/service).

Only if the R&S SGT is equipped with an older firmware version, a firmware update before enabling the software option may be required. The information on the valid firmware versions for the purchased software option is provided together with the option.

Example: Moving a portable license

This example is intended to explain how to perform the required steps at the instrument.

Use a USB flash drive to transfer the license key files between the instrument 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. In your browser, open 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 "Setup > Manage License Keys > Device ID".

b) On the target instrument, select "Setup > 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 "Setup > Manage License Keys > Installed License Keys table".
   Navigate to the portable license you want to move and click the "Export License to File" column, e.g. R&S SGT-K540.

   A standard file manager dialog opens. Enter a user-specific filename and save the exported license key, e.g. `k540_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 "Setup > Manage License Keys > Import License Keys from File" and select the transferred deactivation key.

6. On the source instrument, select "Manage License Keys > Export Deactivation Response to File".

   The instrument confirms the deactivation of the option. The deactivation key response is exported under the selected name, e.g. `K540_portable_decat.txt`.

7. In the browser, go the step "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.

9. In the target instrument, select "Setup > Manage License Keys > Import License Keys from File" and select the created license key file.

   The portable option is installed on the target instrument.

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 Moving 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.

In case the unregistered option is a portable one, it can be afterwards registered at another instrument (see Moving a portable license).

Status Information
Displays status information.

Show Inactive Licenses
Enables/disables the display of the inactive (expire) licenses in the License Table.

Show Deactivated Licenses
Enables/disables the display of the deactivated licenses in the License Table.

See Moving a portable license for information on how to activate deactivated licenses.

Manage Waveform Packages
Opens the "Manages Waveform Packages" dialog.

The waveform packages licenses are provided for the registration of waveforms. This kind of licenses enables the instrument to play registered waveform file generated with the software R&S WinIQSIM2 even if the instrument is not equipped with the corresponding software option R&S SGT-Kxy/-K2xy.

One waveform packages license per waveform is required. Once registered license cannot be moved to another instrument.

Note: One waveform package license per segment is required for the registration of a multi-segment waveform.

"Number of Licenses/Waveforms"
Displays the number of the available and used R&S SGT-K200 licenses.

"Select Waveform"
Opens standard dialog to select the waveform to be registered.

"License Table"
Gives an overview of the registered waveforms, the registration date and the number of used licenses.

Register Selected Waveform
Registers the selected waveform to the instrument.

License Table
Provides information about the currently installed options.

"Export License Key to File"
Opens dialog to save the generated license key file. This file is required during the unregistration process. In case the unregistered option is a portable one, it can be afterwards registered at another instrument (see Moving a portable license).

"Option"
Displays the option short designation.
Tip: Open the Chapter 8.3, "Software / Options", on page 246 dialog to retrieve more information about the installed options.

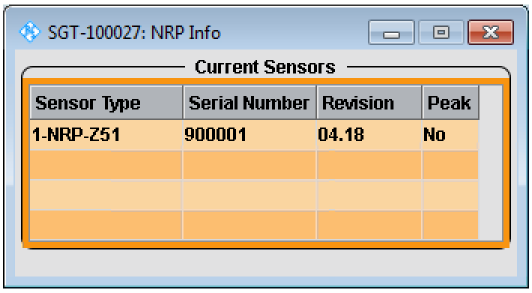
"License Count"
Displays the number of the licenses for the selected option key.

"License Type"
Display the type of license.
A license type is a joint qualification for the duration of applicability 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.

"Registrations"
Opens the "Waveform Packages License" dialog (see Manage Waveform Packages).

8.5 NRP Info

► To access this dialog, select "SGMA-GUI > Instrument Name > Setup > NRP Info"



Current Sensors
Shows the sensors that are connected to the generator with information on serial number, the revision state, and some characteristic features.

8.6 Protection

The "Protection" dialog provides access to the unlocking of protected service functions (authorized personnel of R&S Service Departments only).

Unlocking of protected service functions

1. Select "SGMA-GUI main panel > Instrument Name > Setup > Protection".

   The "Protection" dialog provides access to the unlocking of protected service functions (authorized personnel of R&S Service Departments only).

2. To deactivate the protection, the correct password has to be entered. After the instrument has been switched on, the protection levels 1 to 4 are automatically activated.
   Enter "Protection Level 1 > Password > 123456".

   Protection Level 1 is activated.

Protection Level / Password
"Protection Level 1" can be activated to expand the functionality of the internal adjustment. The password is 123456.

The other protection levels 2 to 4 provide access to protected service functions. Only the authorized personnel of R&S Service Departments can access these functions.

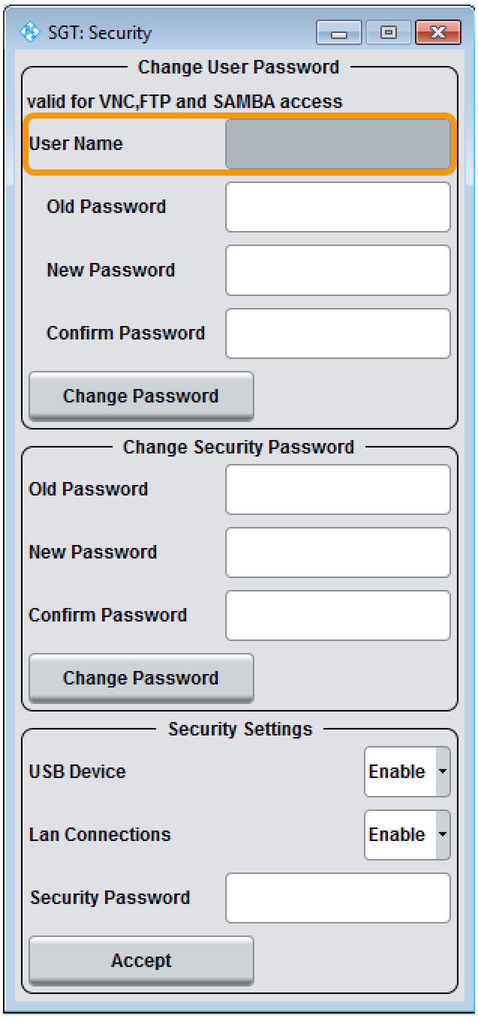
8.7 Security Setting

The R&S SGT employs a security concept based on user and security password. The security password is required for changing several critical settings, like performing firmware updates. Access to the passwords and mass storage security settings is provided in the "Security" dialog.

► To access the "Security" dialog, select "SGMA-GUI > Instrument Name > Setup > Security"

The menu is divided into the password sections and the security settings section. In the password section, the passwords for securing a controlled access to the instrument are defined and changed.

A change of passwords for the operating system and security password requires the entry of the old and new password and the conformation of the new password. All settings are only accepted after the "Change Password" button is pressed.



The settings of this dialog are not accessible over remote control (e.g. SCPI commands).

Change User Password

The user name and password are required for remote access to the instrument via VNC, FTP or SAMBA.

Note: It is highly recommended to change the default user password before connecting the instrument to the network.

User Name ← Change User Password

Indicates the user name used for access to the Linux operating system and valid for VNC, FTP and SAMBA access.

Old Password ← Change User Password

Enter the currently used user password. The default password is "instrument".

New Password ← Change User Password
Enter the new user password.

Confirm Password ← Change User Password
Enter the new password for conformation.

The new password is only valid after the "Change Password" button is pressed.

Change Password ← Change User Password
Changes the password accordingly.

Change Security Password
Note: It is highly recommended to change the default security password before connecting the instrument to the network.

The security password is for example required when changing the status of the USB and LAN interface.

Old Password ← Change Security Password
Enter the currently used security password. The default password is '123456'.

New Password ← Change Security Password
Enter the new security password. The security password may contain decimal characters only.

Confirm Password ← Change Security Password
Enter the new password for conformation.

The new password is only valid after the "Change Password" button is pressed.

Change Password ← Change Security Password
Changes the password accordingly.

Security Settings
Comprises the settings for enabling and disabling the USB and LAN interfaces. The setting requires the entry of the security password and is only accepted after the "Accept" button is pressed.

USB Device ← Security Settings
Enable/disable the USB interface.

Note: The instrument does not recognize any device connected to the USB interface when the interface is disabled.

LAN Connection ← Security Settings
Enable/disable the LAN interface.

Note: It is not possible to access the instrument via LAN while the LAN connection is disabled.
An enabled LAN connection is a prerequisite for the remote control of the instrument via VNC, FTP or SAMBA.

Security Password ← Security Settings
Enters the password that is required to enable or to disable the settings protected by a security password. The default is '123456'.

Note: It is highly recommended to change the default security password before connecting the instrument to the network. To change the security password, select "SGMA-GUI > Instrument Name > Setup > Security > Change Security Password".

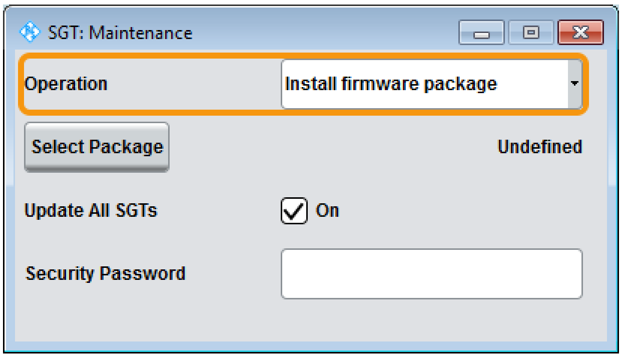
The settings are only accepted after the "Accept" button is pressed.

Accept ← Security Settings
Accept a new entry or selection and change the settings accordingly.

8.8 Maintenance

The R&S SGT provides a special dialog for performing some maintenance procedures, like installing firmware packages.

► To access this dialog, select "SGMA-GUI > Instrument Name > Setup > Maintenance".



Operation
Selects the desired maintenance operation.

"Install firmware package" Installs a selected firmware package.

"Initialize SSD" Formats the solid-state disk (SSD).

Select Package
Available only for "Operation > Install Firmware Package".

Selects the firmware package to be installed, see also Chapter 9.9, "How to Install a New Firmware Version on the Instrument", on page 272.

Update All
Available only for "Operation > Install Firmware Package".

Enable this function to perform a simultaneous firmware update on all instruments, that are in active state and are connected to this controller.

Note: A firmware update and the required subsequent restart and the automatically initiated internal adjustment process of the controller may be a time consuming operation. This feature accelerates the update process and the required restart of the external PC can be executed once after the update operation of all instruments is completed.

Security Password
Enters the password that is required to enable or to disable the settings protected by a security password. The default is '123456'.

Note: It is highly recommended to change the default security password before connecting the instrument to the network. To change the security password, select "SGMA-GUI > Instrument Name > Setup > Security > Change Security Password".

The settings are only accepted after the "Accept" button is pressed.

Accept
Accept the selected operation and perform the required procedure.

8.9 Network Settings

The instrument is equipped with a network interface and can be connected to an Ethernet LAN (local area network). The "Network Settings" dialog provides access to the network settings.

NOTICE

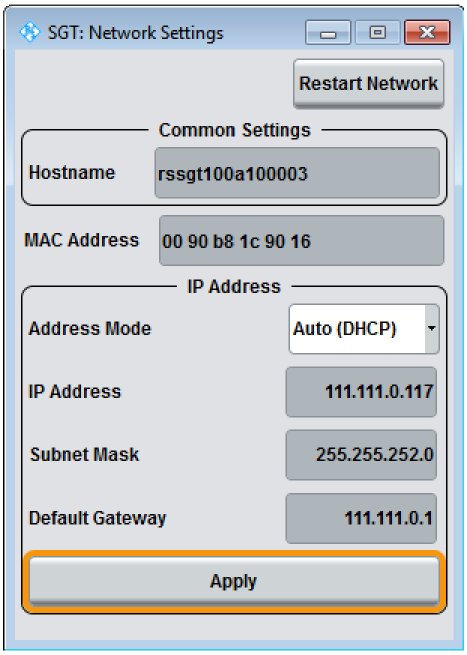
Risk of network errors!

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 "SGMA-GUI > Instrument Name > Setup > Network Settings".



The dialog provides access to the network settings, like settings about the general network environment and specific identification of the computer in the network. The dialog also displays an indication whether the instrument is connected to the network or not.

Restart Network

Shuts down the network connection of the instrument and then re-establishes the connection.

This function can be used to resolve network problems.

Note: Only the connection of the instrument to the network restarts, the network itself is not affected.

Hostname

Displays the individual computer name of the instrument.

A predefined name is indicated and can be used for network connections, see Chapter 6.5.3, "Finding Out the Default Hostname of the Instrument", on page 65.

It is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors may affect the entire network.

Remote command:

`:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname` on page 481

MAC Address

Indicates the MAC address of the network adapter.

Address Mode

Selects if the IP address is assigned automatically or manually.

It is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors may affect the entire network.

Note: Lost LAN connection to an instrument.

If the connection to an instrument configured to use static IP addresses is lost, press the LAN LED on the instrument front panel for 3 seconds.

This resets the "Address Mode" to its default value ("Auto (DHCP)").

"Auto (DHCP)" The IP address is assigned automatically.
The network used must support automatic assignment of IP address via DHCP or APIPA (Zeroconf) to use this function.

"Static" The IP address is assigned manually.

Remote command:
`:SYSTem:COMMunicate:NETWork:IPADdress:MODE` on page 480

IP Address

Displays the IP address. To enter the IP address manually, select "Address Mode > Static".

In case of manual input of the IP address, it is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors may affect the entire network.

Remote command:
`:SYSTem:COMMunicate:NETWork:IPADdress` on page 480

Subnet Mask

Displays the subnet mask. To enter the subnet mask manually, select "Address Mode > Static".

This number is used together with the IP address to identify the network segment the instrument is in.

It is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors may affect the entire network.

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK` on page 482

Default Gateway

Displays the IP address of the default gateway. To enter the default gateway 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.

It is recommended that a connection of the instrument to the network is coordinated with the network administrator. Connection errors may affect the entire network.

Remote command:
`:SYSTem:COMMunicate:NETWork[:IPADdress]:GATeway` on page 481

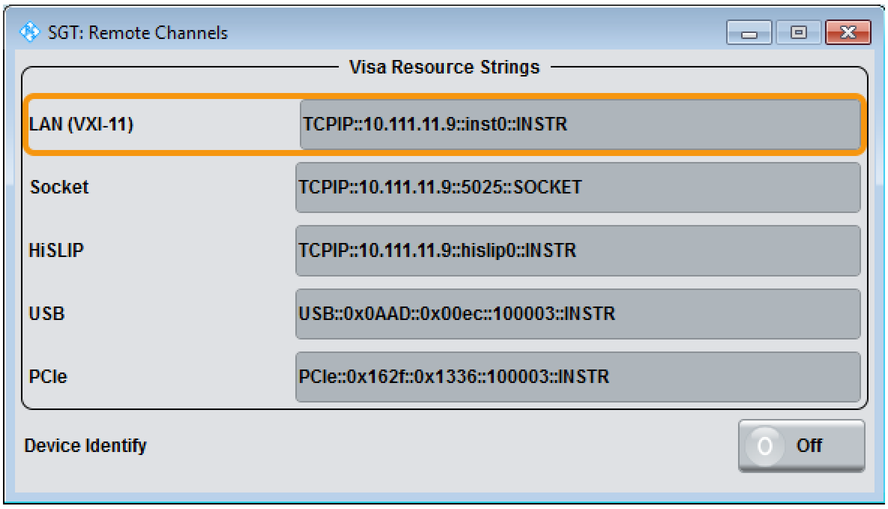
Apply

Applies the network settings to the instrument.

8.10 Remote Channels

The "Remote" dialog provides access to the settings for remote control.

► To access this dialog, select "SGMA-GUI > Instrument Name > Setup > Remote".



Visa Resource Strings
Indicates the VISA resource strings used for remote control of the instrument. A separate string is provided for remote control via the different interfaces.

Note: For background information and description of the syntax of the VISA resource strings, refer to the description of the corresponding interface in Chapter 10.1, "Remote Control Interfaces and Protocols", on page 276.

Remote command:
`:SYSTem:COMMunicate:HISLip:RESource?` on page 483
`:SYSTem:COMMunicate:NETWork:RESource?` on page 482
`:SYSTem:COMMunicate:SOCKet:RESource?` on page 484
`:SYSTem:COMMunicate:USB:RESource?` on page 484
`:SYSTem:COMMunicate:PCIexpress:RESource?` on page 483

Device Identity
Triggers the device identification function. The LAN LED on the front panel of the selected instrument blinks.

See also Chapter 6.5.4, "Bidirectional Instrument Identification ", on page 66.

8.11 Emulations

It is possible to remotely control the R&S SGT via the command set of another signal generator, for example the R&S SMATE generator. With this function you can, for example, replace a signal generator with an R&S SGT in an automated test setup, without adjusting the command scripts used.

For more information on this topic, see also application note 1GP109.

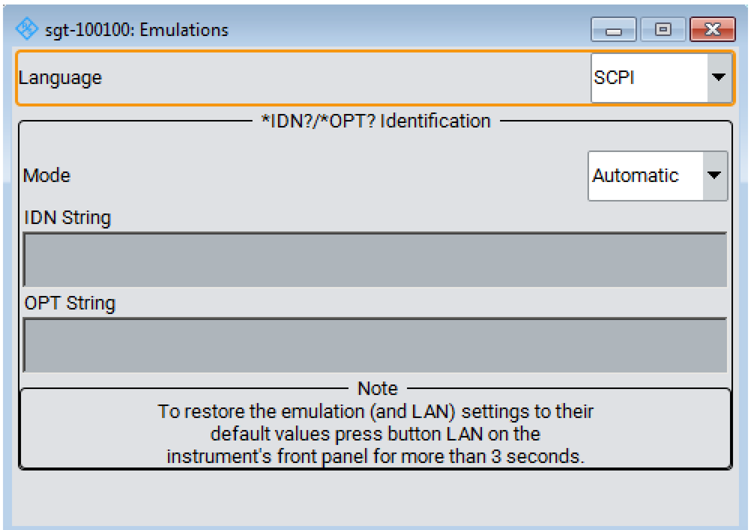
You find all the remote control command sets supported by the R&S SGT in a selection list.

The selected instrument also defines the identification string that is retrieved with query `*IDN?`. In addition to the preset values, you can enter a user-defined identification string, for example to provide individual identification for each generator, like 'MY_R&S SGT' (see Identification Mode and IDN String).

As any other parameter, you can additionally change the remote control command set to be emulated via the Language command. However, once you have switched to an emulation, the R&S SGT specific command set is disabled, that means this command is no longer effective. To return, you need to know the corresponding remote control command of the simulated instrument.

Access:

▶ Select "SGMA-GUI > Instrument Name > Setup > Emulations".



Language

Selects the instrument whose remote command set is emulated by the R&S SGT.

Remote command:
`:SYSTem:LANGuage` on page 485

Identification Mode

Selects the way the instrument identification is performed.

"Automatic" The "IDN String" and the "OPT String" are set automatically for the instrument selected with the parameter Language.

"User Defined" Enables the selection of user definable "IDN String" and "OPT String" for the instrument selected with the parameter Language.

Remote command:
`:SYSTem:IDENtification` on page 484

Set to default
Overwrites the user-defined `*IDN` and `*OPT` strings with default strings.

Remote command:
n.a.

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 SGT' for instance.

Remote command:
`*IDN?` on page 306

OPT String
Indicates the option string of the instrument as queried with the common command `*OPT?`.

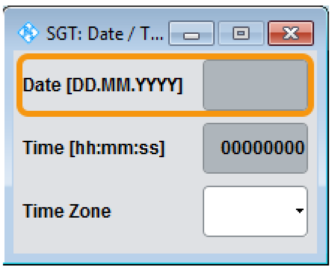
If "Mode > User Defined" is selected, a user-defined option string can be created additionally to the automatically created one.

Remote command:
`*OPT?` on page 306

8.12 Date and Time

The "Date/Time" dialog provides access to setting a date and time.

► To access this dialog, select "SGMA-GUI > Instrument Name > Setup >Date/ Time".



Date
Indicates the date in the format day.month.year.

To prevent accidental changes, this parameter is protected. It can be accessed with protection level 1, see Chapter 8.6, "Protection", on page 251.

Remote command:
`:SYSTem:DATE` on page 486

Time
Indicates the time in the format hour.minute.second.

To prevent accidental changes, this parameter is protected. It can be accessed with protection level 1, see Chapter 8.6, "Protection", on page 251.

Remote command:
`:SYSTem:TIME` on page 486

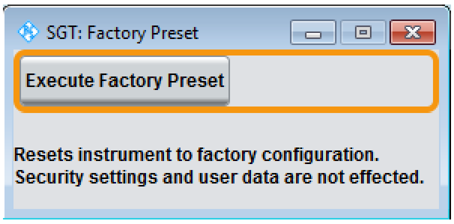
Time Zone
Selects a time zone from a list.

Remote command:
`:SYSTem:TIME:ZONE` on page 487
`:SYSTem:TIME:ZONE:CATalog?` on page 487

8.13 Factory Preset

The "Factory Preset" dialog provides a function to reset the instrument's settings to their factory states

1. To access this dialog, select "SGMA-GUI > Instrument Name > Setup > Factory Preset".



2. Select "Execute Factory Preset".

   The instrument's settings are reset to their factory states. Security settings and user data are not effected.

Execute Factory Preset
Reset the instrument's settings to their factory state.

Note: Because "Factory Preset" resets the "Remote Channel Settings" and "Network Settings" to the default values, executing factory preset via remote control may terminate the connection to the instrument, if these settings had been configured to values different to the default ones!

The factory preset function resets nearly all instrument settings. In addition to the regular preset, a "Factory Preset" resets also the following values:
- Power on settings ("Level" dialog)
- Network settings including hostname ("Setup > Network Setting" dialog)
- Remote Channel settings ("Setup > Remote Channel" dialog)

To maintain security, password settings and all settings protected by these passwords like disabled USB and LAN connections are not changed.

Not affected by the "Factory Preset" are also user data, lists or instrument settings files, created for example with the "File Save As" function and currently saved on the instrument's hard disc.

Remote command:
`:SYSTem:FPReset` on page 311

8.14 Standby and Restart

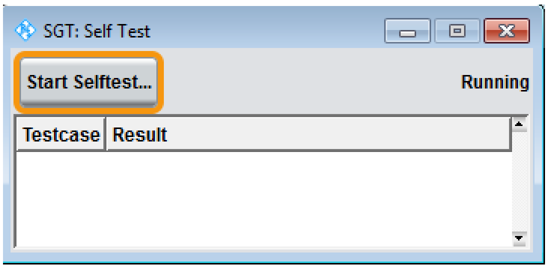
See Chapter 9.7, "How to Switch between the Operating States", on page 270.

8.15 Diagnostic and Tests

This section describes the settings provided for diagnostic and test purposes.

8.15.1 Self-test

1. To access this dialog, select "SGMA-GUI > Instrument Name > Diagnostic Tests > Self-test".



2. To trigger a self-test, select "Self-test".

   Performs a self-test on all installed hardware options.

   The result of the self-test, succeeded or failed, is displayed. The list of the numeric results of the performed test cases is protected by protection level 2.

SCPI command:

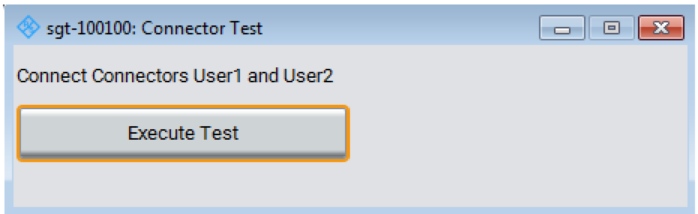
`:TEST:ALL:STARt` on page 488

`:TEST:ALL:RESult?` on page 488

8.15.2 Connection Test

The "Connection Test" dialog provides settings for testing the connection to an external IQ device and performing a self-test of the baseband input.

► To access this dialog, select "SGMA-GUI > Instrument Name > Diagnostic Tests > Connection Test".



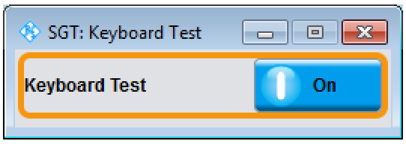
Execute Connection Test
Performs a connection test between the connectors USER1 and USER2.

Remote command:
`:TEST:BB:CONNection?` on page 489

8.15.3 Keyboard Tests

Access:

► Select "SGMA-GUI > Instrument Name > Diagnostic Tests > Keyboard Test".



Use this function to check the proper operation of all front panel elements.

If "Keyboard Test" is enabled, all front panel LEDs except the POWER ON are orange.

The exact test procedure is described in the service manual.

SCPI command:

`:TEST:KEYBoard[:STATe]` on page 489

8.15.4 Simulation

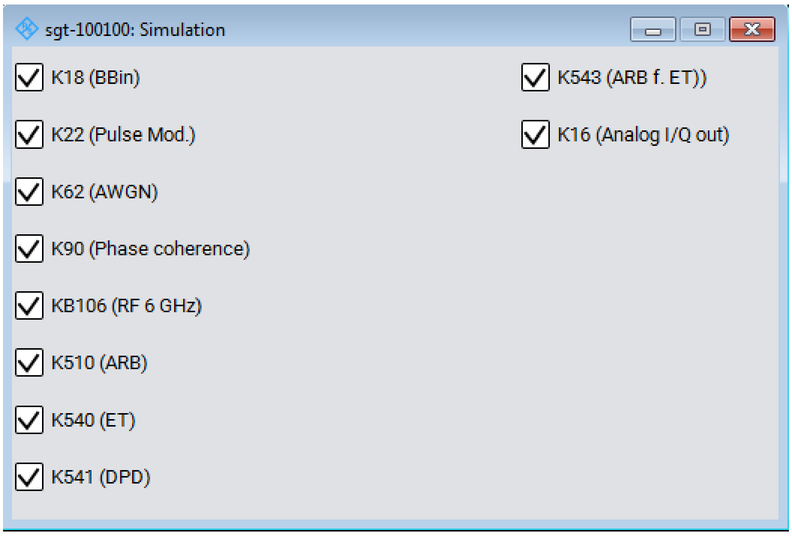
This is a protected function that can be used only in simulation mode. This function cannot be used with a physical instrument.

Access:

1. In the SGMA-GUI, create a virtual R&S SGT instrument:
   a) Select "SGMA-GUI > Setup > Instruments > New".
   b) Select "Instrument Type = SGT".

   All other settings are insignificant.
2. Select "SGMA-GUI > Setup > Protection".
3. Enter the "Protection Level 1" password *123456*.

4. Select "SGMA-GUI main panel > virtual instrument name > Setup > Diagnostic / Test > Simulation".



The dialog displays a list of software options.

5. Enable the option to be simulated.

The block diagram and the provided signal generator settings are updated accordingly. You can open dialogs, interact with functions or observe the influence of settings as if the virtual instrument is equipped with the selected options.
This is merely a display. The signal generation function is disabled. The dialog and all unlicensed settings disappear, if a connection to a physical instrument is detected.

9 Performing Configuration Tasks

This section provides a general explanation on how to operate the instrument manually via the R&S SGMA-GUI software.

We assume, that the R&S SGT is connected to a remote PC. The R&S SGMA-GUI software has to be installed on this remote PC and the instrument has to be added to the list of "Available Instruments".

For information on how to fulfill these requirements, refer to:

- Chapter 2.3.2.1, "Connecting the Instrument to the Network", on page 26
- Chapter 2.3.1, "Installing the R&S SGMA-GUI Software on an External PC", on page 25
- Chapter 2.3.2.3, "Automatically Adding Instruments to the SGMA-GUI ", on page 27

9.1 How to Configure the Reference Oscillator Source

To use the internal reference frequency source

1. To enable the instrument to use its internal reference frequency source, perform one of the following:
   a) Select "SGMA-GUI main panel > Ext Ref Off ".
   b) Select "SGMA-GUI > Instrument Name > RF > Reference Oscillator > Source > Int".
2. In the "Reference Oscillator" dialog, set the "REF/LO Out > REF".

   The "Output Frequency" can be configured to either 10 MHz or 1 GHz.

   The instrument uses the internal reference signal. The REF EXT LED at the front panel of the instrument is off.

To output the reference frequency (internal or external) at the REF/LO OUT connector of the instrument, select "Reference Oscillator > REF/LO Output > REF".

To use an external reference frequency source

To improve measurement accuracy, it is advisable to provide an external reference frequency to all the instruments in the test setup or to distribute the internal reference signal of the signal generator to the remaining instruments.

1. Provide the signal of an external reference frequency source to the REF/LO IN connector of the instrument.

2. To enable the instrument to use the external reference frequency source, perform one of the following:
   a) Select "SGMA-GUI main panel > REF > Ext Ref On ".
   b) Select "SGMA-GUI > Instrument Name > RF > Reference Oscillator > Source > Ext".
3. In the "Reference Oscillator" dialog, set the parameter "Ext. Ref. Input Frequency" to the value of the fed external reference frequency.

   Now, the instrument uses an external reference signal. The green REF EXT LED at the front panel of the instrument indicates that the instrument is synchronized to the external reference signal.

If the instrument is configured to use an external reference signal but no signal is fed in at the REF/LO IN connector, the REF EXT LED on the front panel of the instrument is red and an error message is displayed in the "Info" line.

9.2 How to Configure the Local Oscillator (LO) Coupling Source

The R&S SGT can use two frequency sources for the carrier frequency (LO signal) of the I/Q modulator, an internal and an external one. The first possibility is to use the output signal of the internal synthesizer. If an external LO signal is provided at the REF/LO IN connector, this signal can alternatively be directly routed to the LO input of the I/Q modulator.

To use an external LO source

1. Provide the signal of an external LO source to the REF/LO IN connector of the instrument.

   Note: The local oscillator input/output requires the additional software option R&S SGT-K90.
2. Select "SGMA-GUI > Instrument Name > Frequency/Phase > LO Coupling Source > Ext".

   Tip: When you select "Source > Ext", the icon LO Scr Ext appears in the R&S SGMA-GUI.

   The signal provided by the external frequency source is directly routed to the input of the I/Q modulator and used as carrier frequency.

To use the internal LO source

► Select "SGMA-GUI > Instrument Name > Frequency/Phase > LO Coupling Source > Int".

The output signal of the internal synthesizer is used.

9.3 How to Define the Signal at the REF/LO OUT Connector

The reference oscillator and the LO use the same REF/LO IN connector. Hence, it is not possible to use both an external reference source and an external LO source signal at the same time.

The signal at the REF/LO OUT connector also depends on the selected reference oscillator and LO sources. The following table gives an overview of this dependency.

Table 9-1: Selection available at the REF/LO OUT connector depending on the LO and reference oscillator sources

	LO coupling source	
Ref. oscillator source	**Int**	**"Ext"**
"Int"	"OFF/REF/LO"	"OFF/LO"
"Ext"	"OFF/REF/LO"	Combination not possible

To define the signal at the REF/LO OUT connector

1. In the "Frequency / Phase > Local Oscillator (LO) Coupling" dialog, select the "LO Source" as required.
2. In the "Reference Oscillator" dialog, select the "Ref. Oscillator Source" as required.
3. In the "Frequency / Phase > Local Oscillator (LO) Coupling" dialog, set the "REF/LO Output".
   Consider the dependencies, see Table 9-1.

9.4 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 >General"
2. Select "Create Test Signal > Sine".
3. In the "Sine Test Signals"dialog, adjust the 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 SGT stores the generated waveform file and automatically loads it in the ARB.
5. Select "ARB > State > On".

   The R&S SGT processes the waveform file.

9.5 How to Load and Play Waveform Files

Irrespective of the way a waveform file is generated, you can transfer it to the instrument, load it in the ARB and play it.

To load and play a waveform file from the instrument

1. Transfer an externally created waveform file to the instrument, see Chapter 5.2, "Managing Files on the R&S SGT", on page 46.
2. Select "Baseband > ARB > General".
3. Set "Waveform Location > Instrument".
4. Select "Load Waveform...". 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.
5. Select "ARB > State > On".

   The R&S SGT processes the waveform file.

To load and play a waveform file from an external computer

1. Connect the R&S SGT and a Windows PC with an installed R&S SGMA-GUI to the same network.
2. On the remote PC, select "SGMA-GUI > Instrument Name > Baseband > ARB > General".
3. Set "Waveform Location > Local file system ".
4. Select "Load Waveform...". Navigate to the directory the file is stored in, select the waveform file (e.g. `/var/user/lte_waveform`) and execute "Select".
   Note: You can also select an external USB connected to the PC at the available local file directories.

   The "ARB" dialog confirms that the waveform file is loaded.
5. Select "ARB > State > On".

   The R&S SGT processes the waveform file.

9.6 How to Restore the LAN Connection to an Instrument

► If the LAN connection to an instrument configured to use a static IP address is lost, press the LAN LED on the instrument's front panel for more than 3 seconds to reset the LAN settings and to set the "Address Mode" on page 257 to DHCP.

Provided the network supports automatic assignment of IP address, new IP address is automatically assigned to the instrument.

9.7 How to Switch between the Operating States

The Figure 9-1 gives an overview of the operating states of the instruments and how to trigger the switch-over between them.

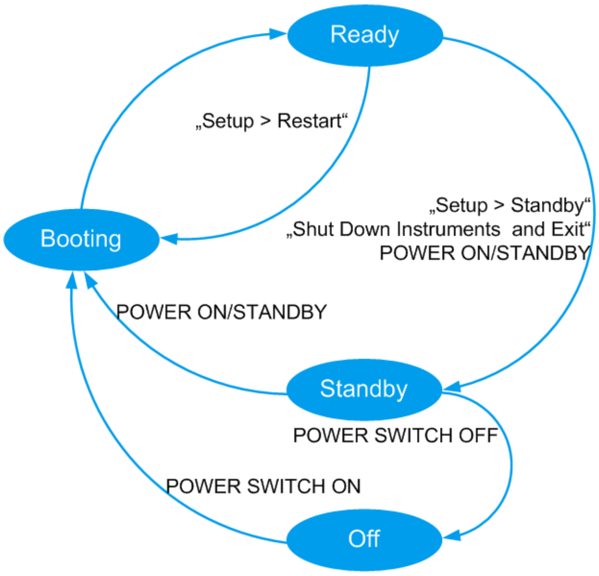


Figure 9-1: Operating states

"Setup > Standby", "Setup > Restart", "Shut Down Instruments and Exit"	= R&S SGMA-GUI controls
POWER ON/STANDBY, POWER SWITCH On/Off	= Hardkey controls on the front/rear panel of the instrument

The Table 9-2 provides a short description of the operating states and their indication.

Table 9-2: Indication of the operating states

Operating state	Description	Indication
Off	The instrument is shut down.	All LEDs on the front panel of the instrument are off.
Booting	The instrument boots the operating system and starts the instrument firmware. If the previous session was terminated reg-ularly, the instrument uses the last setup with the relevant instrument settings.	The green POWER ON/STAND BY key blinks.

Operating state	Description	Indication
Standby	The standby power mode keeps the power switch circuits and the remote control system active. In this state, it is safe to switch off the AC power and disconnect the instrument from the power supply.	In the R&S SGMA-GUI, the status indicator in front of the instrument name is red. The orange POWER ON/STAND BY key is on.
Ready (normal operation)	The instrument is ready for operation. All modules are power-supplied.	In the R&S SGMA-GUI, the status indicator in front of the instrument name is green. The green POWER ON/STAND BY key is on.

To switch the instrument to standby state

► Use one of the following:

a) On the remote PC, select "SGMA-GUI > Instrument Name > Setup > Standby".
b) Press the POWER ON/STANDBY key on the front panel of the instrument.
c) Send the SCPI command:
`:STANdby`

The current instruments settings are automatically stored. The instrument switches to a power-saving mode.
In the R&S SGMA-GUI, the standby state is indicated by the red state symbol in front of the corresponding instrument's name, on the front panel, by the orange POWER ON/STANDBY button.
The instrument can still be remote controlled.

To return the instrument from standby to ready state

► Use one of the following:

a) On the remote PC, select "SGMA-GUI > Instrument Name > Setup > Restart".
b) Press the orange POWER ON/STANDBY key on the front panel of the instrument.
c) Send the SCPI command:
`:RESTart`

The instrument loads the last setup with all instrument settings, switches to ready state and is ready for normal operation.
In the R&S SGMA-GUI, the ready state is indicated by the green state symbol in front of the instrument's name.
On the front panel, the ready state is indicated by the green POWER ON/STAND BY button.

To switch all connected instruments to standby state and close the R&S SGMA-GUI

► In the R&S SGMA-GUI main panel, select "File > Shut down instruments and exit".

The R&S SGMA-GUI quits and switches the connected instruments to standby state.

For description on how to terminate work and shut down the instrument regularly, refer to Chapter 2.1.5, "Switching the Instrument On and Off", on page 21.

9.8 How to Use Computer Names

If there is a name server in the network, alternatively to the IP address each PC or instrument connected in a LAN can be accessed via an unambiguous computer name. Each instrument is delivered with an assigned computer name, but this name can be changed.

For instruction on how to find out the default computer name, refer to Chapter 6.5.3, "Finding Out the Default Hostname of the Instrument", on page 65.

To query and change a computer name

To avoid violations and to make use of the easy identification provided by the computer name, it is recommended to keep the default hostname unchanged.

1. Open "SGMA-GUI > Instrument Name > Setup > Network Settings" dialog.

   The computer name is displayed under "Hostname".
2. Select "SGMA-GUI > Instrument Name > Setup > Protection" and enable the "Protection Level 1".

   The parameter "Hostname" in the "Network Settings" dialog is now enabled for configuration.
3. Change the "Hostname".
4. Press the POWER ON/STAND BY key to restart the instrument.

   Note: The "Factory Preset" function restores the factory value of the parameter "Hostname".

9.9 How to Install a New Firmware Version on the Instrument

You can update the firmware of the R&S SGT .

Firmware installation through the R&S SGMA-GUI

If an update to a new firmware version is required for both the R&S SGMA-GUI and the instrument, it is mandatory that the new instrument's firmware is installed before the update of the R&S SGMA-GUI to the new version.

1. Select "SGMA-GUI main panel > Instrument Name > Setup > Maintenance > Operation > Install firmware package".
2. Press "Select Package" and navigate to the directory the new firmware is stored in.
3. If several instruments have to be updated to new firmware version, enable the feature "Update All " to accelerate the update process.

   All instruments that are in active state and are connected to this controller are updated simultaneously.
4. Enter the "Security Password".
5. Confirm the update with "Accept".

   The software transfers the firmware file and automatically starts the update procedure. During the update, the message "Updating Firmware" is displayed in the "Info" line. The update process is indicated by an LED running light.

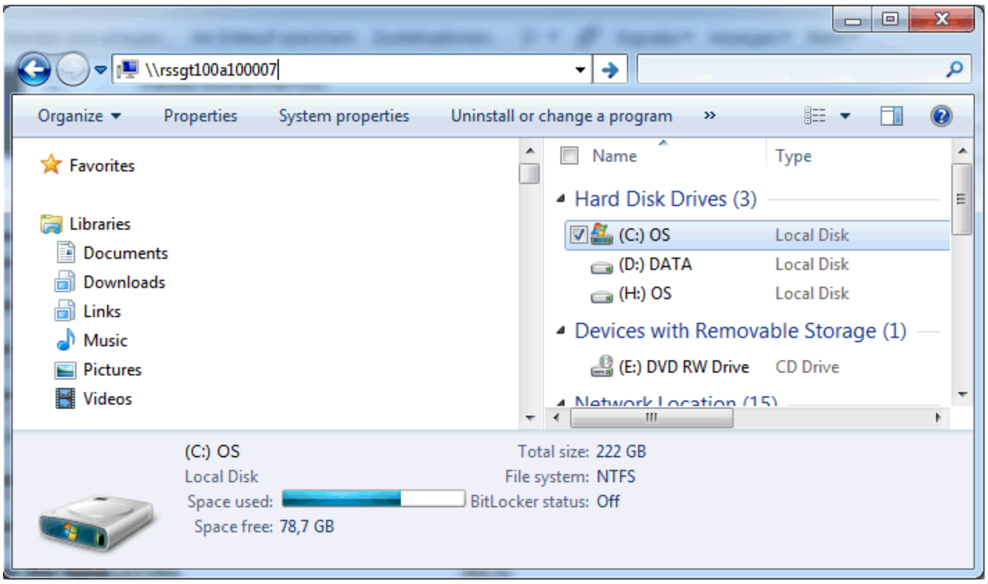
   Note: The update procedure requires a restart of the instrument. The restart is performed automatically. The instrument is not accessible during that time.
6. Wait until the message "Updating Firmware" disappears and the update is completed.

   The green POWER ON/STAND BY LED is on.
7. If necessary, install the new R&S SGMA-GUI.
   For detailed description, refer to Chapter 2.3.1, "Installing the R&S SGMA-GUI Software on an External PC", on page 25
8. If the instrument and the controller/PC are connected over the PCIe interface and the external PC does not support hot-plugging, restart the external PC.

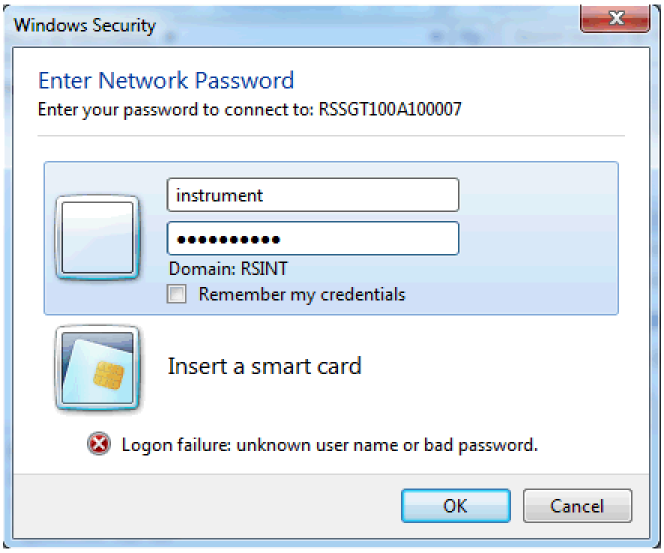
Firmware update through a session control protocol (SCP)

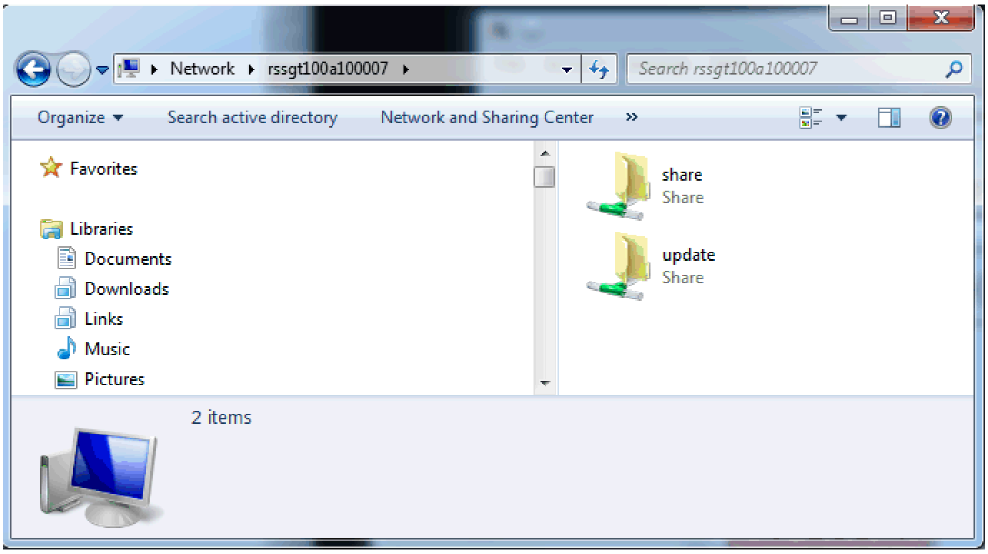
If an update to a new firmware version is required for both the R&S SGMA-GUI and the instrument, it is mandatory that the new instrument's firmware is installed before the update of the R&S SGMA-GUI to the new version.

1. Connect the R&S SGT and a Windows PC to the same network.
2. On the PC, open a windows explorer window.
3. To connect to the R&S SGT, enter the name of the instrument or its IP address in the windows taskbar.



4. Enter the user name and password to connect to the R&S SGT. The default user name is *instrument* and the password is *instrument*.





A folder opens, containing the `share` and the `update` folder.

5. Open the `update` folder and copy the new firmware update file in it.

   The update starts automatically.

Unsuccessful or erroneous firmware update

An erroneous or unsuccessful installation of firmware update package is indicated by a combination of one orange and red LEDs on the front panel.

Refer to the service manual for a description of the displayed error code or contact the customer support center.

9.10 How to Activate Options

A firmware update before the activation of the SW option may be required.

Refer to the description of the SW option for the required firmware version.

See also Chapter 9.9, "How to Install a New Firmware Version on the Instrument", on page 272 for instruction on how to update the firmware version.

1. Select "SGMA-GUI main panel > Instrument Name > Setup > Install SW-Options".
2. Select "Option Key" and enter the key code delivered with the new option.
3. Restart the instrument.

   The new option is now enabled and ready for operation.

10 Network and Remote Control Operation

As an alternative to operating the R&S SGT interactively via the R&S SGMA-GUI, one can also control the R&S SGT using programmed commands from a remote PC.

The description in this section requires basic knowledge of the remote control operation. Definitions specified in the SCPI standard are not provided.

Nevertheless, you can find some basic information to the SCPI syntax, command lists, and general programming recommendations in Chapter 15.1, "Remote Control Basics", on page 525. In addition, this chapter provides information on the status reporting system of the instrument.

Nevertheless, you can find some basic information to the SCPI syntax, command lists, and general programming recommendations in section Remote Control Basics of the user manual. In addition, this chapter provides information on the status reporting system of the instrument.

10.1 Remote Control Interfaces and Protocols

The instrument supports several interfaces for remote control. The following table gives an overview.

Table 10-1: Remote control interfaces and protocols

Interface	Protocols, VISA*) address string and Library	Remarks

Local Area Network (LAN)	• **HiSLIP** High-Speed LAN Instrument Protocol (IVI-6.1)
	`TCPIP::host address::hislip0[::INSTR]`
	• **VXI-11**
	`TCPIP::host address::inst0[::INSTR]`
	Library: VISA
	• **socket communication** (Raw Ethernet, simple Telnet, Fast Socket)
	`TCPIP::host address[::LAN device name]::<port>::SOCKET`
	Library: VISA or socket controller
		A LAN connector is located on the rear panel of the instrument.
		The interface is based on TCP/IP and supports various protocols.
		For details, see Chapter 10.1.2, "LAN Interface", on page 280

USB	**USBTMC** `USB::<vendor ID>::<product ID>::<serial number>[::INSTR]` Library: VISA	A USB connector is located on the rear panel of the instrument. For details, see Chapter 10.1.3, "USB Interface", on page 283

Interface	Protocols, VISA*) address string and Library	Remarks
PCIe	**Proprietary** PCIe::<vendor ID>::<product ID>::<serial number>[::INSTR] Library: pcie controller	A PCIe connector is located on the rear panel of the instrument. For details, see Chapter 10.1.4, "PCI Express Interface", on page 283
GPIB (IEC/IEEE Bus Interface)	– • GPIB::<address>[::INSTR] (no secondary address) VISA	The instrument is not equipped with GPIB bus interfaces. Use a GPIB-to-LAN or GPIB-to-USB adapter instead. For details, see Chapter 10.1.5, "GPIB Interface (IEC/IEEE Bus Interface)", on page 284

*) VISA 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) or USB. However, no VISA installation is necessary for remote control while using socket communication. For more information about VISA, refer to the user documentation.

Rohde & Schwarz provides the standardized I/O software library R&S VISA for communication via TCP/IP (LAN: HiSLIP, VXI-11 and raw socket) or USB (USBTMC) interfaces.

R&S VISA is available for download at the Rohde & Schwarz website http://www.rohde-schwarz.com/rsvisa.

SCPI (Standard Commands for Programmable Instruments)

SCPI commands 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.

10.1.1 Remote Control Programs and Libraries

The Figure 10-1 provides a schematic illustration of the remote control capabilities of the instrument.

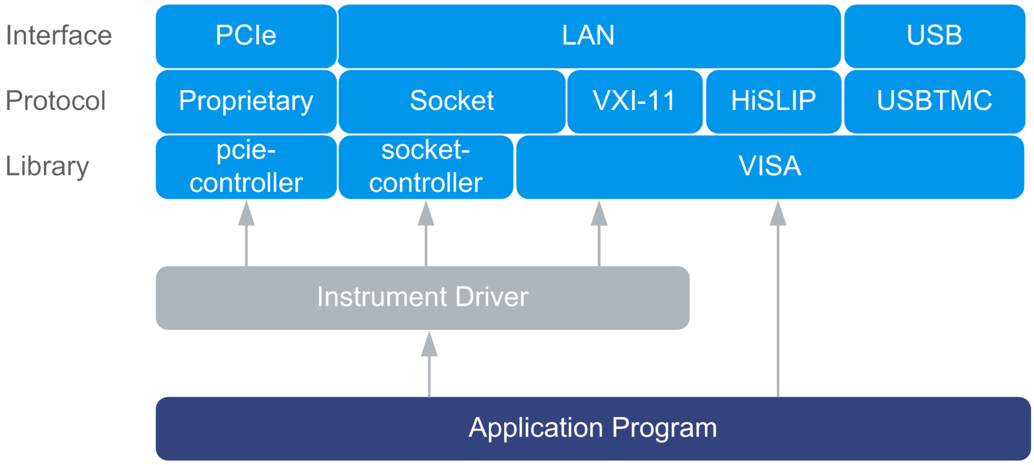


Figure 10-1: Remote control interfaces, protocols and libraries

The following examples give an overview of the dependencies between the available libraries, the possible interfaces and protocols, and whether an instrument driver is provided. The involved parts are **highlighted**.

- Remote control program using VISA

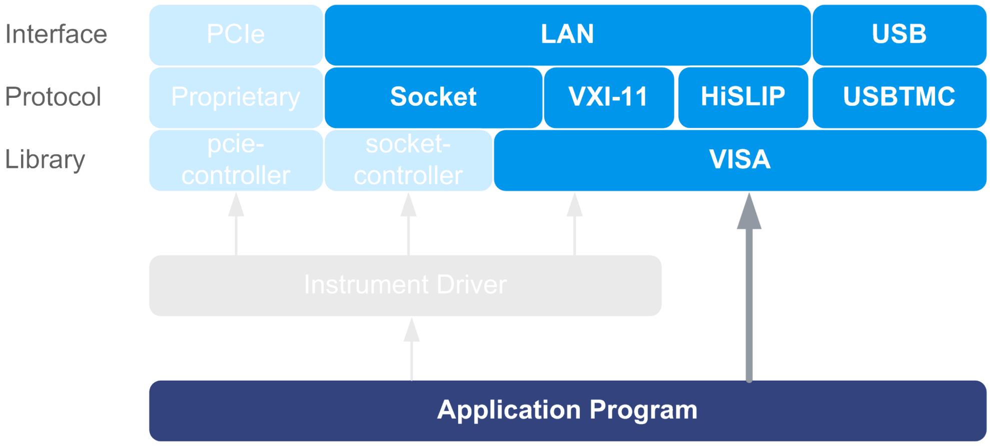


Figure 10-2: Remote control program using VISA

Protocol	Remote control program
Socket	`viOpen (..., "TCPIP:rssgt100a100010::5025::SOCKET", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
VXI-11	`viOpen (..., "TCPIP:rssgt100a100010::inst0::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
HiSLIP	`viOpen (..., "TCPIP:rssgt100a100010::hislip0::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`
USBTMC	`viOpen (..., "USB::0x0aad::0x00EC::1000010::INSTR", ...)` `viPrintf (..., "SOUR:FREQ 2GHz\n")`

- Remote control program using instrument driver (VISA available)

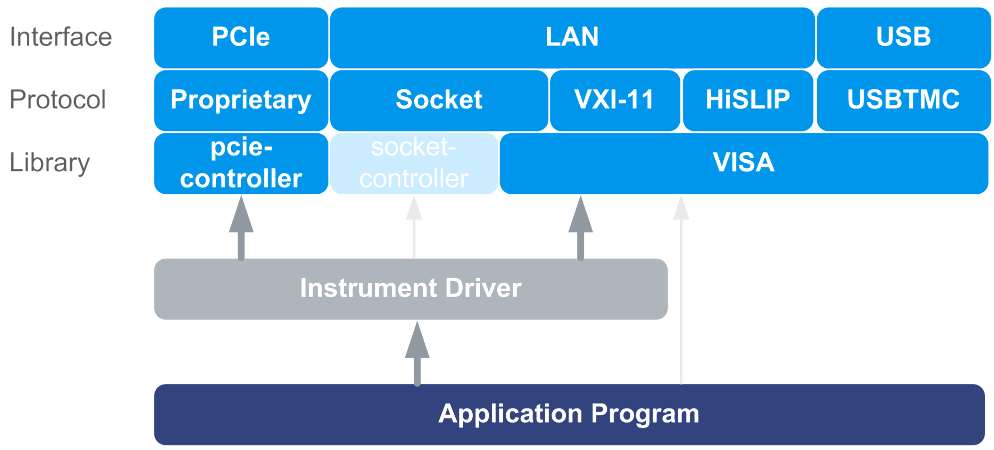


Figure 10-3: Remote control program using instrument driver (VISA available)

Protocol	Remote control program
Socket	`rssgt_init ("TCPIP:rssgt100a100010::5025::SOCKET", ...)` `rssgt_SetFrequency (..., 2e9)`
VXI-11	`rssgt_init ("TCPIP:rssgt100a100010::inst0::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`
HiSLIP	`rssgt_init ("TCPIP:rssgt100a100010::hislip0::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`
USBTMC	`rssgt_init ("USB::0x0aad::0x00EC::1000010::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`
PCIe	`rssgt_init ("PCIe::0x162f::0x1336::1000010::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`

- Remote control program using instrument driver (VISA not available)

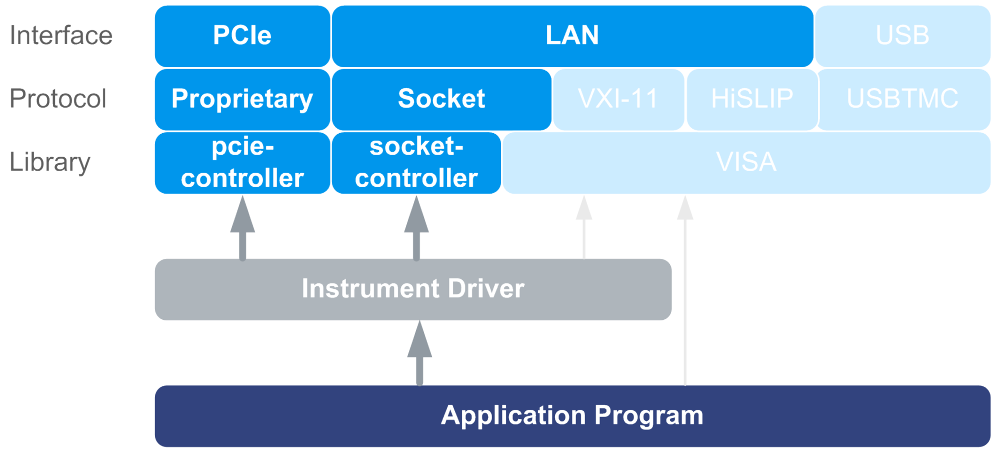


Figure 10-4: Remote control program using instrument driver (VISA not available)

Protocol	Remote control program
Socket	`rssgt_init ("TCPIP:rssgt100a100010::5025::SOCKET", ...)` `rssgt_SetFrequency (..., 2e9)`
PCIe	`rssgt_init ("PCIe::0x162f::0x1336::1000010::INSTR", ...)` `rssgt_SetFrequency (..., 2e9)`

10.1.2 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. They are connected using a RJ45 cable (shielded or unshielded twisted-pair category 5). 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.

10.1.2.1 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 used
- **host address** is the IP address or host name of the device
  See also Chapter 6.5.3, "Finding Out the Default Hostname of the Instrument", on page 65.
- **[::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 "SGMA-GUI > Instrument Name > Setup > Remote" dialog, and also adjust it manually, if necessary.

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 10.1.2.2, "HiSLIP Protocol", on page 281.

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 10.1.2.3, "VXI-11 Protocol", on page 282

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 10.1.2.4, "Socket Communication", on page 282.

Example:

- Instrument has the IP address *10.113.11.91*; the valid resource string using VXI-11 protocol is:
  `TCPIP::10.113.11.91::INSTR`
- The DNS host name is *rssgt100a100021*; the valid resource string is:
  `TCPIP::rssgt100a100021::hislip0` (HiSLIP)
  `TCPIP::rssgt100a100021::inst0` (VXI-11)
- A raw socket connection can be established using:
  `TCPIP::10.113.11.91::5025::SOCKET`

10.1.2.2 HiSLIP Protocol

The HiSLIP (**Hi**gh **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

Using VXI-11, each operation is blocked until a VXI-11 device handshake returns. However, using HiSLIP, data is sent to the device using the "fire and forget" method with immediate return. 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

10.1.2.3 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.

10.1.2.4 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 require a VISA installation on the remote controller side.

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 communication with the software on a command-by-command basis.

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 instruments 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 running on a connected PC.

The instrument also supports the fast socket channel. For details, see Chapter 10.4, "Advanced Remote Control Using Fast Socket", on page 291.

10.1.3 USB Interface

For remote control via USB connection, the PC and the instrument must be connected via the USB 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.

USB resource string

The syntax of the used USB resource string is:
`USB::<vendor ID>::<product ID>::<serial number>[::INSTR]`, where:

- **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)

You can retrieve the USB resource string from the "SGMA-GUI > Instrument Name > Setup > Remote" dialog.

Example:

`USB::0x0AAD::0x00EC::100021::INSTR`

0x0AAD is the vendor ID for Rohde&Schwarz

0x00EC is the product ID for the R&S SGT

100021 is the serial number of the particular instrument

10.1.4 PCI Express Interface

A PCI Express (PCIe) connector is provided on the rear panel of the instrument.

Refer to Chapter 10.3, "Advanced Remote Control Using PCIe", on page 286 for a description of how to set up a remote control connection via PCIe and the permitted cables.

Via PCI Express some commands can be sent to the instrument with optimized speed (memory-mapped remote control), e.g. frequency or level settings. This allows minimum setup time.

PCIe resource string

The syntax of the used PCIe resource string is:
`PCIe::<vendor ID>::<product ID>::<serial number>[::INSTR]`, where:

- **PCIe** 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)

You can retrieve the PCIe resource string from the "SGMA-GUI > Instrument Name > Setup > Remote" dialog.

Example:

`PCIe::0x162f::0x1336::100021::INSTR`

0x162f is the vendor ID for Rohde&Schwarz

0x1336 is the product ID for the R&S SGT

100021 is the serial number of the particular instrument

10.1.5 GPIB Interface (IEC/IEEE Bus Interface)

The R&S SGT is not equipped with an IEC/IEEE bus interface.

To be able to control the instrument via the GPIB bus:

1. Connect a GPIB-to-LAN or a GPIB-to-USB adapter to the instrument.
2. Use a GPIB bus cable to connect the instrument and the controller.
3. Provide the GPIB bus card, the card drivers and the program libraries for the programming language in the controller.
4. In the "SGMA-GUI > Setup > Instruments > instrument name > Remote Control", set the "GPIB Address".
   See "GPIB Address" on page 53.
5. If the controller is equipped with several GPIB bus cards, define the used "Board Number".

GPIB address

The controller must address the instrument with the GPIB bus channel. GPIB provides channel addresses from 0 to 30.

The GPIB resource string is `GPIB::<address>[::INSTR]`, where:

- **GPIB** denotes the used interface
- **<address>** indicates 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.

Any connected IEC bus cable must be terminated by an instrument or controller.

10.2 Starting a Remote Control Session

The instrument and the controller have to be connected with a 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 10.1.2, "LAN Interface", on page 280, Chapter 10.1.3, "USB Interface", on page 283 or Chapter 10.1.4, "PCI Express Interface", on page 283 for details.

The VISA resource strings are indicated in the "SGMA-GUI main panel > Instrument name > Setup > Remote Channels" dialog.

10.2.1 How to Find the VISA Resource String

To find the VISA resource strings of your instrument:

► Select "SGMA-GUI main panel > Instrument name > Setup > Remote Channels".

The "Remote Channel Settings" dialog shows all specified resource strings of the supported remote control interfaces.

10.2.2 Example: Remote Control over LAN Using Socket Communication

This section provides an example on how to establish a remote control connection over telnet protocol and a simple sockets-based program example that can be further developed (see also Chapter 15.2, "Telnet program examples", on page 546).

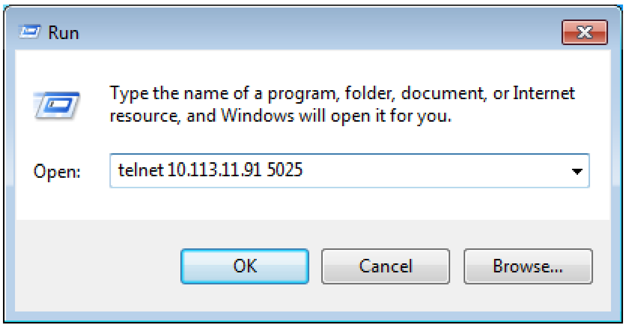
Basic knowledge of programming and operation of the controller are assumed. A description of the interface commands can be obtained from the relevant manuals.

Refer to the getting started manual for an example on how to set up remote control connection over LAN using VXI-11 protocol.

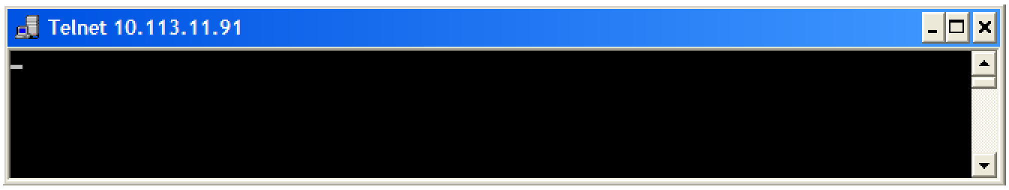
To set up a Telnet connection

To control the software, only a telnet program is required. The telnet program is part of every operating system.

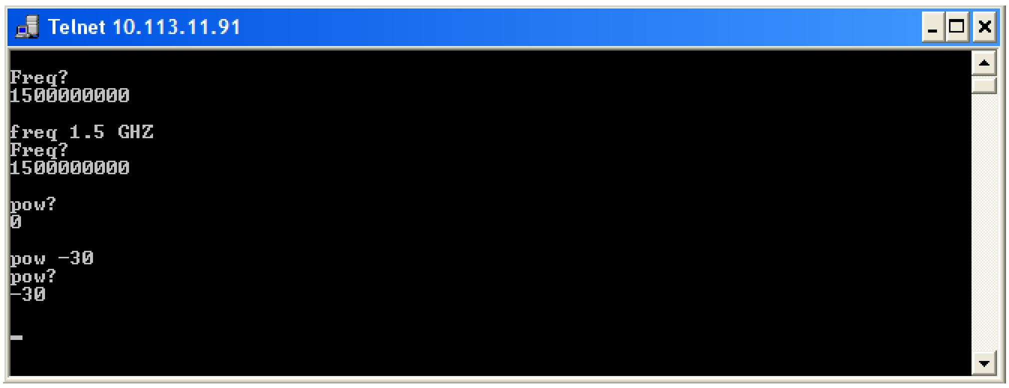
1. To establish a Telnet connection with the R&S SGT, start the telnet program. Enter the socket address.
   The socket address is a combination of the IP address or the host name of the R&S SGT and the number of the port configured for remote-control via telnet.
   Tip: The R&S SGT uses the port number 5025 for remote connection via Telnet.



   The connection to the instrument is set up and remote-control commands can be sent.



2. Even if the cursor is not visible on the screen, enter blind a remote-control command and confirm with Enter.



10.3 Advanced Remote Control Using PCIe

The PCIe bus is a high-speed serial bus, composed of point-to-point serial links. A pair of serial links, one transmitting and one receiving link, make up a lane.

Fast settings

The PCIe interface can be utilized not only to transfer text messages e.g. SCPI commands but also to carry register based remote control messages. The latter mode is called fast settings mode. The specially for this purpose provided instrument's driver is mandatory for the instrument control with fast settings. This instrument driver contains special functions for fast setup.

To use the advantage of the fast settings, the following prerequisites must be fulfilled:

- Using the PCIe interface is mandatory (see also Chapter 10.3.1, "Setting Up a Remote Control Connection via PCIe", on page 287)
- The fast settings must be enabled with the function `rssgt_useFastSettings` (see also Chapter 10.3.5, "Enabling Fast Settings", on page 291).

The instrument driver automatically uses the fast settings method whenever possible - currently only for the parameters frequency, level, RF state, modulator state - and sends SCPI messages in all other cases.

Remote control programs written for PCIe will, without modifications, also run if one of the other control channels, LAN or USB is used.

10.3.1 Setting Up a Remote Control Connection via PCIe

To set up a remote control connection vie PCIe, perform the following steps:

1. Download the drivers, see 10.3.2.
2. Configure the controller, see 10.3.3
3. Connect the controller and the instrument, see 10.3.4
4. Enable fast settings, see 10.3.5.

10.3.2 Download the Drivers

All required driver files are available for download on the product page at:

http://www.rohde-schwarz.com/product/SGT100A.html > "Downloads" > "Drivers"

Provided are the following files:

- `LabWindows/CVI, Linux/OSX driver rssgt` (`InstrumentDriver`)
  `C` source code files which provide a functional application programming interface (API) to R&S SGT instruments. Required if you want to control an instrument via PCIe.
- `Low-Level SGT drivers`
  Archive file that contains the following:
  – `KernelDriver`

C source code files from which you can build a Linux kernel mode driver for the R&S SGT PCIe remote control interface.
  - `SgtDriverDemo`
    C source code module for a demo program using the instrument driver API.
  - `SharedLibraries-Dlls`
    Shared libraries (Dlls) for remote control channels Socket and PCIe. To be used with the instrument driver.
- `VXIplug&play x64/x86 driver rssgt`

Download the required archive and extract the files on a remote PC.

10.3.3 Configuring the Controller

This section lists the steps necessary to configure a controller with Linux or Windows operating system.

10.3.3.1 Building and Installing the Hardware Driver

The hardware driver defines the way to communicate with the instrument via PCIe interface.

For Windows operating systems, the hardware driver is installed automatically together with the installation of the R&S SGMA-GUI software.

See also section "Installation of R&S SGMA-GUI Software" in the getting started manual.

For Linux operating system, the source code of the driver is included in the `Low-Level SGT drivers` file.

To build and install this driver, root authority is required.

1. Copy folder `KernelDriver` to your `hdd`
2. Go to directory `host`.
3. On the command line, enter `make`.

   The driver `sgshost.ko` is automatically built.
4. Enter `make install`.

   Device nodes `sgtX` are created under the folder `/dev` (X from 0 to 31).
   The module `sgthost` is loaded.
5. Enter `lsmod` to verify the module.

10.3.3.2 Making Shared Libraries Accessible

Two library files per operating system are included in `SharedLibraries-Dlls` file:

- For Linux operating system
  `libsocketcontroller.so` and `libpciecontroller.so`
- For Windows operating system
  `SocketController.dll` and `PCIeController.dll`

These libraries act as the dynamic link libraries for programs using the socket or PCIe interface.

Linux operating system

► To make the libraries accessible, perform one of the following:

a) Append the environment variable LD_LIBRARY_PATH with the path of these two files e.g. by changing the `/etc/environment` file.
b) Move these two files to `/usr/lib` or `/lib` directory.

Windows operating system

► To make the libraries accessible, perform one of the following:

a) Copy these two files to the folder of your executable.
b) Copy these two files to the `WINDOWS\system32` folder.

10.3.3.3 Building a Program

The help file `rssgt_vxi.chm` shows all functions of the instrument which you can use in your own remote control program.

An example file is provided (`SgtDriverDemo.c`), too.

Building the example program (Linux)

1. Copy folders `InstrumentDriver` and `SgtDriverDemo` to your hard disk.
2. Go to folder `Build`
3. On the command line, enter `cmake ..`
4. Enter `make`

   Folder `Build` contains the executable `SgtDriverDemo`.

Building the example program (Windows)

1. Copy folders `InstrumentDriver` and `SgtDriverDemo` to your hard disk.
2. Open `SgtDriverDemo.vcproj` with Visual Studio.
3. Build the program.

Running the example program

► On the command line, enter `./SgtDriverDemo RESOURCESTRING [cmd]`.

Where

- `RESOURCESTRING` is the (VISA) resource string of your instrument, e.g. `TCPIP::ipaddress::5025::SOCKET` or `PCIE::0x162f::0x1336::serialno::INSTR`.
  Where `ipaddress` is the IP address or hostname of your instrument and `serialno` is its serial number.
- `cmd` is an optional command (see table).

The following table list the available commands.

Command	Description
`?`	Usage
`q`	Quit
`f` value	Set frequency
`f?`	Query frequency
`l` value	Set level
`l?`	Query level
`r` value	Set RF state (value = `0 | 1 | ON | OFF`)
`r?`	Query RF state

If you enter an additional optional command, `SgtDriverDemo` executes it and enters a loop waiting for further commands.

Example:

`TCPIP::10.111.11.44::5025::SOCKET ?`

Lists the available commands.

10.3.4 Connecting the Controller and the Instrument

A PCIe connector is provided on the rear panel of the instrument.

NOTICE

Risk of device failure

The R&S SGT is equipped with a single lane PCIe interface that supports hot plugging.

Do not connect an external PC to the PCIe connector of the instrument during operation if this external PC does not support hot-plugging!

Permitted PCIe cables

PCIe extension cables must fulfill the following requirements:

- **Single lane connectors**
- **Max. cable length of 5 m.**

For example: OSS-PCIe-CBL-x1 cable from One Stop Systems or 74576-000x cable from Molex.

Connecting an external PC that does not support hot-plugging

1. Switch off the external PC and the instrument.
   See also chapter "Switching the instrument On and Off" in the getting started manual.
   See also Chapter 2.1.5, "Switching the Instrument On and Off", on page 21.
2. Connect the instrument and the controller with the suitable cable.
3. Switch on the instrument.
4. Wait until the instrument has completed the booting (the "POWER" LED on the instrument's front panel is constantly on).
5. Switch on the external PC.

10.3.5 Enabling Fast Settings

► To enable the special PCI express feature fast settings, enable the function `rssgt_UseFastSettings (ViSession instrumentHandle, ViBoolean fastEnabled, ViBoolean asynchronousEnabled)` included in the instrument driver.

Settings for some parameters like level and frequency accelerate.

To disable the fast settings, call the function `rssgt_UseFastSettings` with argument `fastEnabled=false`.

10.4 Advanced Remote Control Using Fast Socket

Fast settings

The socket interface can be utilized not only to transfer text messages e.g. SCPI commands but also to carry register based remote control messages. The latter mode is called fast settings mode. The fast socket communication is based on the Ethernet protocol which does not support routing. Therefore a controller PC can only control devices within its own network segment using the fast socket method.

To use the advantage of the fast settings, the following prerequisites must be fulfilled:
- On Windows operating systems, the fast socket driver must be installed.
- The application program must be run with root/administrator rights.
- The fast settings must be enabled with the function `rssgt_useFastSettings` (see also Chapter 10.3.5, "Enabling Fast Settings", on page 291).

The instrument driver uses the fast settings method whenever possible. This applies currently for the parameters frequency, level, RF state, I/Q modulator state, IQ wide-band state, digital attenuation, frequency offset, phase offset, trigger, segment trigger, next segment index. In all other cases, SCPI messages are sent.

10.4.1 Setting Up a Remote Control Connection via Fast Socket

Download the required archive and extract the files on a remote PC, as described in Chapter 10.3.2, "Download the Drivers", on page 287.

Windows operating systems

To set up a remote control connection via fast socket for Windows operating systems, perform the following steps:

1. Connect the controller and the instrument, see Chapter 2.3.2, "Connecting a Remote PC via LAN", on page 26.
2. Install the protocol driver to the controller, see Chapter 10.4.2, "Installing the Protocol Driver", on page 293.
3. On the controller start the driver by using one of the following:
   a) Start the Windows console user interface as an administrator.
      Excute the command `net start SGMANDISPROT`.
   b) Use a program for opening the driver.
      See for example the example file `SgtDriverDemo.c`.
4. Start the application with administrator rights.
5. Enable fast settings, see Chapter 10.4.3, "Enabling Fast Settings", on page 293.

Linux operating systems

To set up a remote control connection via fast socket for Linux operating systems, perform the following steps:

1. Connect the controller and the instrument, see Chapter 2.3.2, "Connecting a Remote PC via LAN", on page 26.
2. Start the application as root.
3. Enable fast settings, see Chapter 10.4.3, "Enabling Fast Settings", on page 293.

10.4.2 Installing the Protocol Driver

The protocol driver defines the way to communicate with the instrument via the LAN fast socket interface.

For Linux operating system, no special driver is needed.

For Windows operating systems, the `SGMANDISPROT` driver is required. The protocol driver is installed automatically together with the installation of the R&S SGMA-GUI software. It is also provided in the `Low-Level SGT drivers` file.

To install the driver manually on a Windows operating system:

1. Open "Control Panel > Network and Sharing Center".
2. Select the network adapter on which you want to install the driver and click it.
   The "Local Area Connection Status" dialog opens.
3. Click "Properties" to open the "Local Area Connection Properties" dialog.
4. Click "Install" to open the "Select Network Feature Type" dialog.
5. Select "Protocol" and select "Add".
6. In the "Select Network Protocol" dialog, select "Have Disk".
   Navigate to the directory where the driver is saved and click "OK" to install the driver.

10.4.3 Enabling Fast Settings

► To enable the fast settings for the fast socket, call function `rssgt_UseFastSettings (ViSession instrumentHandle, ViBoolean fastEnabled, ViBoolean asynchronousEnabled)` included in the instrument driver.

  Settings for some parameters like level and frequency accelerate.

To disable the fast settings, call the function `rssgt_UseFastSettings` with argument `fastEnabled=false`.

10.5 LXI Configuration

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.

On the R&S SGT the LXI functionality is already installed and enabled. 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 of the instrument
- Performing SCPI remote diagnostics

10.5.1 Default State of the Network Settings

According to the LXI standard, an LCI must set the following parameters to a default state.

Parameter	Value
TCP/IP mode	DHCP + Auto IP Address
Dynamic DNS	Enabled
ICMP ping	Enabled
Password for LAN configuration	LxiWebIfc

The LAN reset also resets the following parameters for the R&S SGT:

Parameter	Value
Hostname	<Instrument-specific host name>
Description	Signal generator
Negotiation	Auto detect
VXI-11 discovery	Enabled

The LAN settings are configured using the instrument's LXI Browser Settings.

10.5.2 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://10.111.0.97".
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 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 in the browser dialog. 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 Chapter 10.5.3, "LAN Configuration", on page 295.
  - "Status" displays information about the LXI status of the instrument.
  - "Utilities" provides access to the LXI event log functionality required by the LXI standard.
- "Diagnostics"
  - "SCPI Remote Trace" records messages exchanged via the remote control interface, see Chapter 10.5.3.4, "SCPI Remote Trace", on page 298.
- "Help"
  - "Glossary" explains terms related to the LXI standard.
  - www.rohde-schwarz.com opens the Rohde & Schwarz home page.

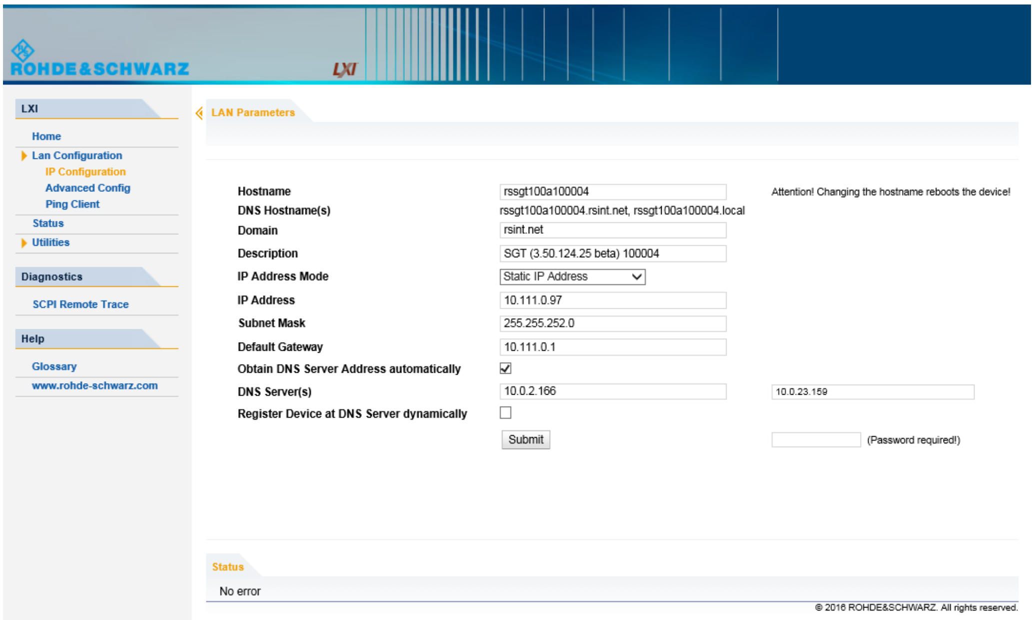
10.5.3 LAN Configuration

The "LAN Configuration" web page displays all mandatory LAN parameters and allows their modification.

It comprises the following navigation entries.

10.5.3.1 IP Configuration

The "IP configuration" web page displays all mandatory LAN parameters and allows their modification.



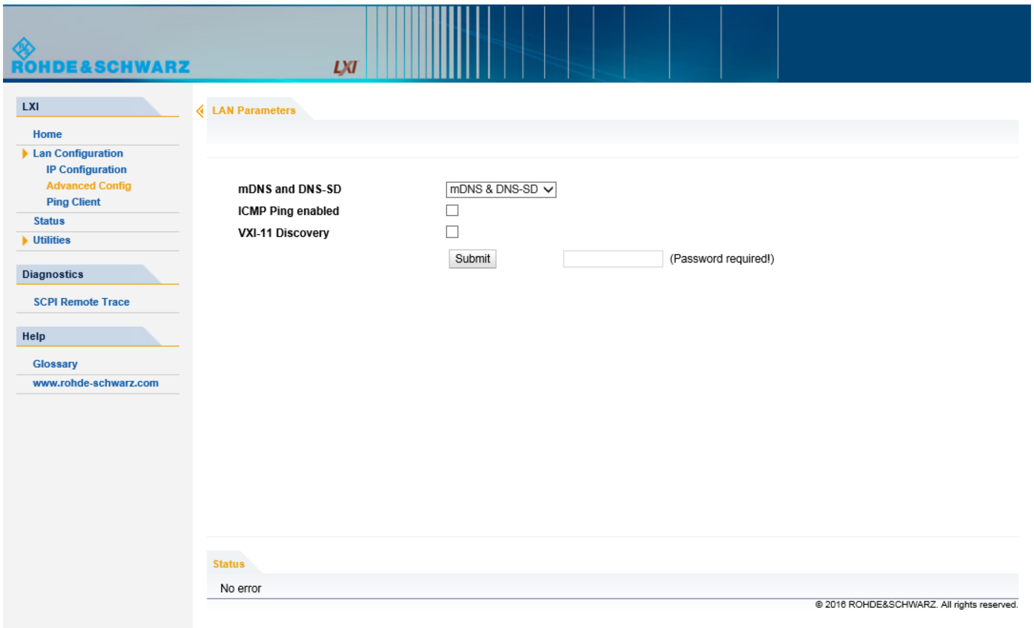
The "IP Address Mode" selects a configuration mode for the IP address of the instrument. With static configuration, the entered IP address, subnet mask, and default gateway are used. With dynamic configuration, DHCP or dynamic link local addressing (automatic IP) are used to obtain the instrument IP address.

Password protection

Changing the LAN configuration is password-protected and requires the security password. The default password is "instrument".

10.5.3.2 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".

10.5.3.3 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:

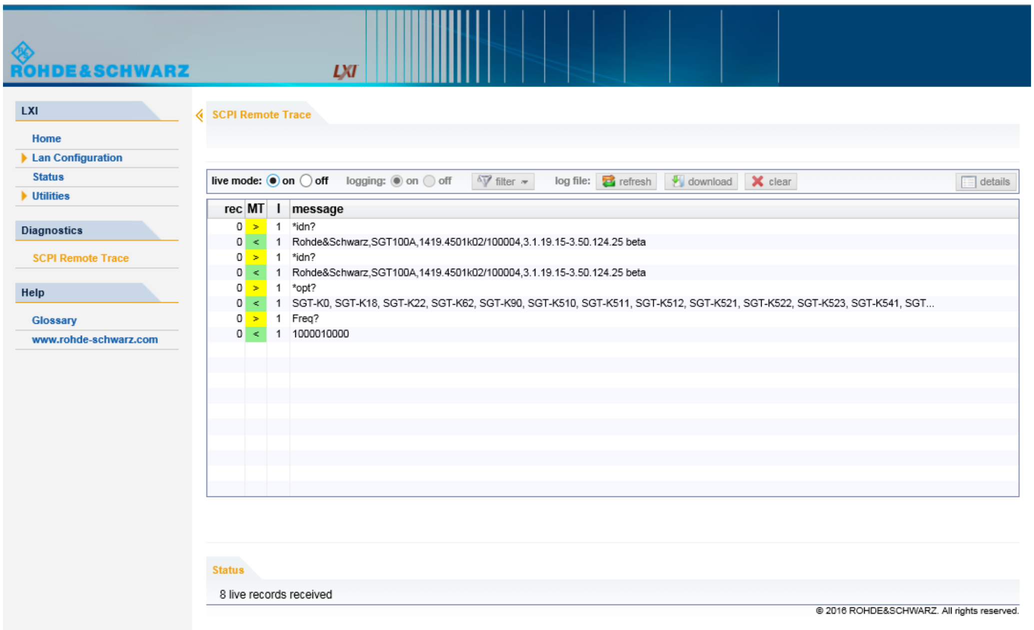
1. On the "Ping Client" page, enter the IP address of the host in the "Destination Address" field (for example 10.111.0.125).
2. Select "Submit".

10.5.3.4 SCPI Remote Trace

The remote trace functionality allows you to trace input and output strings at the remote control interface of the R&S SGT, see Chapter 10.5.4, "How to Record SCPI Commands and Messages exchanged via the LXI Web Browser Interface", on page 300.

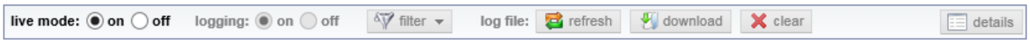
A recorded trace (message log) can be evaluated directly in the dialog. Use the highlighting and navigation functions provided by the lower toolbar to locate error messages and messages containing arbitrary search strings. You can also export the message log to a `*.csv` file and evaluate the file using a suitable program.

To trace and display messages, switch on "logging" and "live mode" in the toolbar.



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
- "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

- **I**: number of the subinstrument
- "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

10.5.4 How to Record 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 SGT.

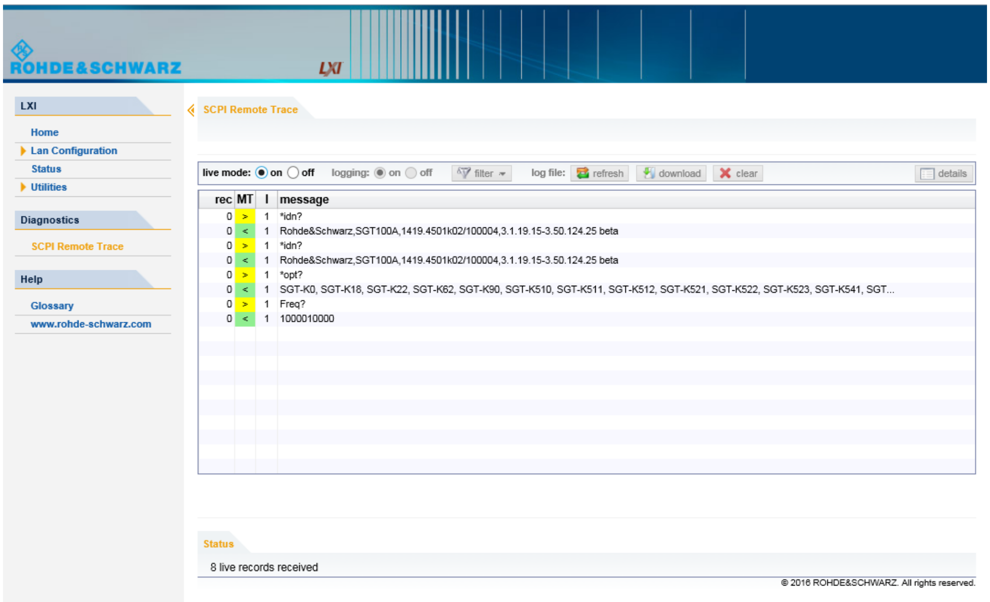
To activate the SCPI remote trace:

1. Start a web browser that supports html5 (W3C compliant).
2. Enter the IP address of the R&S SGT in the browser's address bar.

   The R&S SGT'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 SGT with SCPI commands, using an appropriate tool, the LXI function records the information sent and received.



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.

10.6 Using the R&S SGMA-GUI to Monitor the Remote Control Operation

The R&S SGMA-GUI can be used to monitor the behavior of one or more instruments while they are remote controlled.

A typical configuration consists of one monitor, controllers and instruments. The monitor is the remote PC on which the R&S SGMA-GUI is installed and the controller is the remote PC on which the application program runs.

Simultaneous control of an instrument from a controller and a monitor may lead to collisions whenever both the controller and the monitor utilize the same remote channel. These collisions are indicated by an error message in the "Info" line, e.g. "Query interrupted" or "Resource locked". Simultaneous monitoring and control over the same remote channel is only possible, if the used protocols support `viLock()/viUnlock()` and the remote program use these functions.

The Table 10-2 shows whether a collision-free communication over a particular combination of remote channels is possible or not and if there are any restrictions.

Table 10-2: Cross-reference between used remote channels and collision-free communication

Monitor/ Controller	LAN (VXI-11)	LAN (HiSLIP)	USB	LAN (Socket)	PCIe
LAN (VXI-11)	OK*	OK	OK	OK	OK
LAN (HiSLIP)	OK	OK	OK	OK	OK
USB	OK	OK	`viLock/viUnlock`	OK	OK
LAN (Socket)	OK	OK	OK	X	OK
PCIe	OK	OK	OK	OK	X

Where:

- **OK**: communication possible, no collisions
  *) the R&S SGMA-GUI always uses the LAN device name **instr1**, see also Chapter 10.1.2.3, "VXI-11 Protocol", on page 282.
- **X**: communication is not possible without collisions
- `viLock/viUnlock`: communication is only possible, if the remote control commands are enclosed in a `viLock () - viUnlock()` pair.

The R&S SGMA-GUI uses the `viLock()/viUnlock()` functions.

The figure below shows an example of configuration where the monitor and the controller are two different computers, connected to the same instrument over two different hardware interfaces.

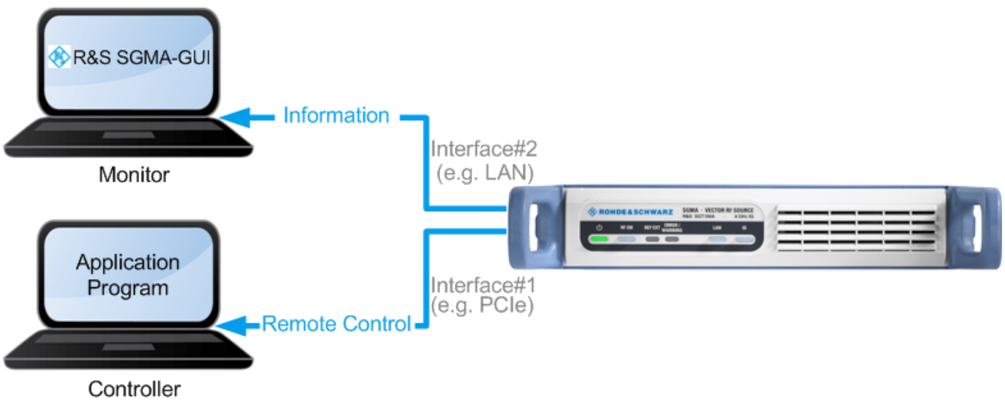


Figure 10-5: Example of a setup for remote control monitoring

Connecting and configuring the monitoring PCs

In the "Setup > Security > Security Settings" dialog, check the state of the LAN and USB interfaces and enable them if necessary.

1. Connect the monitoring PC to the instrument.

   Note: Choose the hardware interface considering the limitations described in Table 10-2.

2. Configure the instrument in the R&S SGMA-GUI, see Chapter 6.5.2, "Handling Instruments in the R&S SGMA-GUI", on page 63.

3. In the "SGMA-GUI > Setup > Instruments > Edit Instruments" dialog, disable "Exclusive Access".

   Note: The two functions "Exclusive Access" and monitoring are mutually exclusive.

4. Send remote control commands from the controller to the instrument.

5. Open the corresponding dialogs in the R&S SGMA-GUI. Observe the status of the parameters.

11 Remote Control Commands

In the following, all remote-control commands are presented in detail with their parameters and the ranges of numerical values.

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 SGT 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.

11.1 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:

***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>,<part number>/<serial number>,<firmware version>"

Example: `Rohde&Schwarz,SGT,1412.0000K02/000000,3.1.17.1-03.01.158`

Usage: Query only

Manual operation: See "IDN String" on page 261

***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 261

***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.

***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

***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`.

To transfer the stored instrument settings in a file, use the command `:MMEM:STOR:STAT`.

***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

11.2 General Commands

:RESTart

Restarts the instrument.

Usage: Event

:STANdby

Switches the instruments to stand by state. To return the instrument from standby to ready state, send the SCPI command `:RESTart`.

Usage: Event

:LOCK? <LockRequestId>

Sends a lock request ID which uniquely identifies the controller to the instrument.

Parameters:

<LockRequestId> Number

0
test query to prove whether the instrument is locked

Controller ID
request lock from the controller with the specified Controller ID

Return values:

<Value> Number

0
request refused; the instrument is already locked to other <Lock Request Id>, i.e. to another controller

1
request granted

Example:
```
:LOCK? 12345
Response: 1
:UNL 12345
```

Usage: Query only

Manual operation: See "Exclusive Access" on page 53

:UNLock <UnlockId>

Unlocks an instrument locked to a controller with Controller ID = `<Unlock Id>`.

Setting parameters:

<UnlockId> Number

Unlock ID which uniquely identifies the controller to the instrument. The value must match the Controller ID `<Lock Request Id>` set with the command `:LOCK?`.

0
Clear lock regardless of locking state

Usage: Setting only

Manual operation: See "Exclusive Access" on page 53

11.3 Preset Commands

The preset commands are not bundled into one subsystem. Therefore, they are listed separately in this section. These specific commands are described in the associated subsystems.

The following presetting actions are available:

- Activating the default state of all internal instrument functions (`*RST` on page 307). Functions that concern the integration of the instrument into a measurement setup are not changed, e.g. TCP/IP address or reference oscillator source settings.

- Activating the original state of delivery (factory reset, :SYSTem:FPReset on page 311). Only functions that are protected by a password remain unchanged and the passwords themselves.

:SOURce<hw>:PRESet
:SYSTem:PRESet

Triggers an instrument reset. It has the same effect as:

- The *RST command

Example: `SYST:PRES`
All instrument settings (also the settings 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 262

11.4 CALibration Subsystem

:CALibration<hw>:BBIN[:MEASure]?

Starts adjustment of the analog I/Q input. The I/Q input is adjusted with respect to DC offset and gain.

Return values:
<Measure> 0 | 1 | OFF | ON
*RST: 0

Example: `CAL:BBIN:MEAS?`
starts the adjustment of the analog I/Q input.
`Response: 0`
adjustment has been performed successfully.

Usage: Query only

:CALibration:ALL[:MEASure]?

Starts all internal adjustments for which no external measuring equipment is required.

Return values:
<All> 0 | 1 | OFF | ON

Usage: Query only

Manual operation: See "Adjust All" on page 244

:CALibration:FREQuency[:MEASure]?

Performs all adjustments which affect the frequency.

Return values:
<Synthesis> 0 | 1 | OFF | ON

Usage: Query only

Manual operation: See "Synthesis" on page 244

:CALibration:IQModulator:FULL?

Starts the adjustment of the I/Q modulator for the entire frequency range. The I/Q modulator is adjusted with respect to carrier leakage, I/Q imbalance and quadrature.

Return values:
<Modulator> 0 | 1 | OFF | ON

Usage: Query only

Manual operation: See "I/Q Modulator" on page 245

:CALibration:IQModulator:LOCal?

Starts the adjustment of the I/Q modulator for the current frequency. The I/Q modulator is adjusted with respect to carrier leakage, I/Q imbalance and quadrature.

This adjustment is only possible when `:OUTPut[:STATe] ON` and `[:SOURce]:IQ:STATe ON`.

Return values:
<CFRequency> 0 | 1

Usage: Query only

Manual operation: See "Adjust I/Q Modulator at Current Frequency" on page 244

:CALibration:LEVel[:MEASure]?

Starts all adjustments which affect the level.

Return values:

<Level>	0 | 1 | OFF | ON
Usage:	Query only
Manual operation:	See "Level" on page 244

:CALibration:FREQuency:TEMPerature?
:CALibration:LEVel:TEMPerature?
:CALibration:IQModulator:TEMPerature?

Queries the delta temperature since the last performed adjustment.

Return values:

<Temperature>	string
Usage:	Query only

:CALibration<hw>:ROSCillator[:DATA] <Data>

Sets the calibration value for the custom defined external adjustment.

Parameters:

<Data> integer

Range: 0 to INT_MAX
*RST: 0

11.5 CLOCk Subsystem

:CLOCk:INPut:FREQuency?

Queries the measured frequency of the external clock signal. An external clock reference must be supplied at the USER1/2 input.

Return values:

<Frequency> float

Range: 0 to max
Increment: 0.001
*RST: 0

Example: `CLOC:INP:FREQ?`
queries the measured frequency of the external clock reference.

Usage: Query only

Manual operation: See "Measured External Clock" on page 122

:CLOCk:INPut:SLOPe <Slope>

The command sets the active slope of an externally applied clock signal at the USER 1/2 connector.

Parameters:

<Slope> NEGative | POSitive

*RST: POSitive

Example: `CLOC:INP:SLOP NEG`

The active slope of the external clock signal is the falling slope.

:CLOCk:OUTPut:MODE <Mode>

The command sets the output of bit or symbol clock pulses at the USER 1/2 connector at the rear panel.

Parameters:

<Mode> SYMBol | BIT

*RST: SYMBol

Example: `CLOC:OUTP:MODE SYMB`

The internal symbol clock is output.

11.6 CONNector Subsystem

:CONNector:REFLo:OUTPut <Output>

Determines the signal provided at the output connector REF/LO OUT (rear of the instrument).

Parameters:

<Output> REF | LO | OFF

*RST: REF

Manual operation: See "REF/LO Output" on page 202

:CONNector:USER<ch>:OMODe <Omode>

Sets the operation mode of the user connector.

Parameters:

<Omode> MKR1 | MKR2 | TRIGger | CIN | COUT | SIN | SOUT | NEXT | LOW | MLATency | MARRived | HIGH | SVALid | SNValid | PVOut | PETRigger | PEMSource | TOUT

MKR1/2
marker 1/2

TRIGger
trigger

CIN
clock in

COUT
clock out

SIN
sync in

SOU
sync out

NEXT
next trigger

SVALid|SNValid
signal valid /not valid

PVOut
pulse generator video out

PETRigger
pulse generator external trigger

PEMSource
external pulse modulator source

Manual operation: See "Mode" on page 232

:CONNector:USER<ch>:THReshold <Threshold>

Sets the threshold for the user connector.

Parameters:

<Threshold> float

Range: 0 to 2
Increment: 0.1
*RST: 1

Manual operation: See "Threshold" on page 235

:CONNector:USER<ch>:CLOCk:IMPedance <Impedance>
:CONNector:USER<ch>:TRIGger:IMPedance <Impedance>

Selects the input impedance for the external trigger/clock inputs, when `:CONNector:USER<ch>:OMODe` is set to `TRIGger` or `CIN`/`COUT`.

Parameters:

<Impedance> G50 | G10K

G10K
Provided only for backward compatibility with other R&S signal generators.
The R&S SGT accepts this values and maps it automatically to G1K.

*RST: G10K

Manual operation: See "Impedance" on page 235

:CONNector:USER<ch>:CLOCk:SLOPe <Slope>
:CONNector:USER<ch>:TRIGger:SLOPe <Slope>

Sets the polarity of the active slope of an applied instrument trigger/clock.

Parameters:

<Slope> NEGative | POSitive

*RST: POSitive

Manual operation: See "Trigger Slope" on page 235

11.7 DIAGnostic Subsystem

:DIAGnostic:POINt:CATalog?

Queries the test points available in the instrument.

Usage: Query only

:DIAGnostic[:MEASure]:POINt? <Name>

Triggers voltage or temperature measurement at the specified test point and returns the measured value.

Use the command `:DIAGnostic:POINt:CATalog?` to retrieve a list of the available test points.

For description of the test points, see the service manual.

Query parameters:

<Name> string

Return values:

<Value> number

Default unit: V or °C

Usage: Query only

11.8 FORMat Subsystem

The `FORMat` subsystem contains the commands which determine the format of the data that the R&S SGT returns to the controller. This affects all query commands which return a list of numerical data or block data. Reference is made to this in the descriptions of the commands.

: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
The instrument expects (with setting commands) and sends (with queries) the least significant byte of each IEEE754 floating-point number first and the most significant byte last.

SWAPped
The instrument expects (with setting commands) and sends (with queries) the most significant byte of each IEEE754 floating-point number first and the least significant byte last.

*RST: NORMal

Example: `FORM:BORD SWAP`
The data is transferred with the most significant bit first.

:FORMat[:DATA] <Data>

Determines the data format which the R&S SGT uses to return data. When data is transferred from the control computer to the instrument, the instrument detects the data format automatically. In this case, the value set here is irrelevant.

Parameters:

<Data> ASCii | PACKed

ASCii
Numerical data is transferred as plain text separated by commas.

PACKed
Numerical data is transferred 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`
The data is transferred as ASCII data.

:FORMat:SREGister <Format>

Determines the numerical format which is returned when the status registers are queried.

Parameters:

<Format> ASCii | BINary | HEXadecimal | OCTal

ASCii
The register content is returned as a decimal number.

BINary
The register content is returned as a binary number. #B is placed in front of the number.

HEXadecimal
The register content is returned as a hexadecimal number. #H is placed in front of the number.

OCTal
The register content is returned as an octal number. #Q is placed in front of the number.

*RST: ASCii

Example: `FORM:SREG HEX`
The register content is returned as a hexadecimal number.

11.9 MMEMory Subsystem

The MMEMory subsystem (**M**ass **Mem**ory) contains the commands for managing files and directories as well as for loading and storing complete instrument settings in files.

The files are stored on the internal flash memory of the instrument or on external USB memory devices.

The default directory is determined using the command `MMEMory:CDIR`.

Use the command :SYSTem:MMEMory:PATH:USER? to query the path of the directory for user-defined data.

The /opt directory is a protected and therefore a not accessible system directory. The files on this directory contain data that must not be changed. Therefore, this directory should not be accessed, since reconstruction of the system partition will lead to data loss.

11.9.1 File Naming Conventions

To enable files in different file systems to be used, the following file naming conventions should be observed.

The file name can be of any length and is case-sensitive, meaning it is distinguished between uppercase and lowercase letters.

The file and the optional file extension are separated by a dot. All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the file name). If possible, special characters should not be used. The use of the slashes "\" and "/" should be avoided since they are used in file paths. A number of names are reserved for the operating system, e.g. CLOCK$, CON, AUX, COM1...COM4, LPT1...LPT3, NUL and PRN.

In the R&S SGT all files in which lists and settings are stored are given a characteristic extension. The extension is separated from the actual file name by a dot (see Chapter 11.9.2, "Extensions for User Files", on page 320 for an overview of the file types).

The two characters "*" and "?" function as "wildcards", meaning 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 files in a directory.

When used in conjunction with the commands, the parameter <file_name> is specified as a string parameter with quotation marks. It can contain either the complete path including the drive, only the path and the file name, or only the file name. The file name must include the file extension. The same applies 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 the drive settings in the commands.

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 subsequently used in the :MMEMory:STORe:STATe on page 326 command. Also, subsequently to loading a file with instrument settings with command :MMEMory:LOAD:STATe on page 325, these settings have to be activated with the common command *RCL <number>.

11.9.2 Extensions for User Files

Table 11-1: Automatically assigned file extensions in the instrument

Function	Contents	File suffix
R&S SGMA-GUI Save As/Open	Software settings	*.savrcl

11.9.3 Examples

In these examples, the current instrument setting is stored in the file test.savrcltxt in the directory /var/user/..

Storing and Loading Current Settings

1. Store the current setting in an intermediate memory with the number 4. This setting can be called using command *RCL and the associated number of the memory, for example *RCL 4.
   *SAV 4
2. To store the settings in a file in a specific directory, specify the complete path.
   MMEM:STOR:STAT 4,"/var/user/test.savrcltxt"
3. To store the settings in a file in the default drive, set the default drive and specify only the file name.
   MMEM:CDIR '/var/user/'*SAV 4
   MMEM:STOR:STAT 4,"test.savrcltxt"
4. Load the file test.savrcltxt in the user directory.
   MMEM:LOAD:STAT 4,'/var/user/test.savrcltxt'
5. Activate the instrument setting of the file test.savrcltxt.
   *RCL 4

Working with Files and Directories

1. Read out all files in the specified directory.
   MMEM:CAT? 'usbuser'

   Response: 127145265,175325184,"test,DIR,0","temp,DIR,0", "readme.txt,ASC,1324","state.savrcltxt,STAT,5327", "waveform.wv,BIN,2342"

   the directory usbuser contains the subdirectories test and temp as well as the files readme.txt, state.savrcltxt and waveform.wv which have different file types.

   Tip: To query only the subdirectories of the current or specified directory, perform:
   MMEM:DCAT? 'usbuser'

   Response: 'test', 'temp'

   To query only the number of subdirectories in the current or specified directory, perform:

`MMEM:DCAT:LENG? 'usbuser'`

Response: `2`

2. To query the number of files in the current or specified directory, perform:
   `MMEM:CAT:LENG? 'usbuser'`
   Response: `3`
3. Create a new subdirectory for mass memory storage in the specified directory.
   `MMEM:MDIR 'usbnew'`
4. Copy the file `state` to a new file.
   `MMEM:COPY '/var/user/state.savrcltxt','usbnew'`
5. Rename the file `state`.
   `MMEM:MOVE 'state.savrcltxt','state_new.savrcltxt'`
6. Remove the `test` directory.
   `MMEM:RDIR 'usbtest'`

11.9.4 Remote Control Commands

: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.
Usage:	Query only

: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.
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 '..' .
Usage:	SCPI confirmed

: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.
Usage:	Setting only SCPI confirmed

:MMEMory:DATA <Filename>, <BinaryBlock>
:MMEMory:DATA? <Filename>

The setting command writes the block data `<BinaryBlock>` to the file identified by `<Filename>`.

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 nine 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 one 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.

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.

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.

Usage: Event
SCPI confirmed

:MEMory:HFRee?

Returns the used and available memory in Kb.

Return values:

<TotalPhysMemKb> integer

Total physical memory.

<ApplicMemKb> integer

Application memory.

<HeapUsedKb> integer

Used heap memory.

<HeapAvailableKb> integer

Available heap memory.

Usage: Query only

: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 `*.savrcltxt`.

Usage: Setting only

: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.

Usage: Event

: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.

Usage: Event
SCPI confirmed

: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.

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`.

Usage: Event

11.10 Fast Speed Commands

This section describes special commands that allow a fast frequency and level setting.

:FFASt <Freq>

Special command to set the RF output frequency with minimum latency. No unit (e.g. Hz) allowed.

Bypasses the status system so command `*OPC?` cannot be appended.

Parameters:

<Freq> float

Example: `FFASt 12750000000`

:PFASt <Pow>

Special command to set the RF output level with minimum latency at the RF output connector. This value does not consider a specified offset. No unit (e.g. dBm) allowed.

Bypasses the status system so command `*OPC?` cannot be appended.

Parameters:

<Pow> float

Example: `:PFASt -20`

11.11 OUTPut Subsystem

:OUTPut:AFIXed:RANGe:LOWer?

Queries the minimum level which can be set without the attenuator being adjusted (Attenuator FIXed).

Return values:

<Lower> float

Usage: Query only

Manual operation: See "Level Range" on page 210

:OUTPut:AFIXed:RANGe:UPPer?

Queries the maximum level which can be set without the attenuator being adjusted (Attenuator FIXed).

Return values:

<Upper> float

Usage: Query only

Manual operation: See "Level Range" on page 210

:OUTPut:AMODe <AMode>

Switches the mode of the attenuator at the RF output.

Parameters:

<AMode> AUTO | FIXed | APASsive

AUTO
The attenuator is switched automatically. The level settings are made in the full range.

APASsive
The attenuator is switched automatically. The level settings are made only for the passive reference circuits. The high-level ranges are not available.

FIXed
The level settings are made without switching the attenuator. When this operating mode is switched on, the attenuator is fixed to its current position and the resulting variation range is defined.

*RST: AUTO

Manual operation: See "Mode" on page 209

:OUTPut[:STATe] <State>

Activates the RF output signal (RF ON/OFF).

Parameters:

<State> 0 | 1 | OFF | ON

Manual operation: See "RF On/Off" on page 60

:OUTPut[:STATe]:PON <Pon>

Selects the state of the RF output when the instrument is switched on.

Parameters:

<Pon> OFF | UNCHanged

OFF
Deactivates the output when the instrument is switched on (RF OFF).

UNCHanged
Restores the initial state of the RF output before the last turn off.

Manual operation: See "Power-On State" on page 210

11.12 SCONfiguration Subsystem

:SCONfiguration:MODE <Configuration>

Switches between standard mode and ARB mode for envelope tracking.

Parameters:

<Configuration> STANdard | AFETracking

STANdard
Standard mode used for signal generation.

AFETracking
ARB foe Envelope Tracking: enables the usage of an extra baseband for enabling the envelope tracking ARB generation.

*RST: STANdard

Manual operation: See "System Configuration" on page 77

11.13 SENSe, READ, INITiate and SLISt Subsystems

These subsystems contain the commands for configuring the power measurements with R&S NRP power sensor connected to the R&S SGT.

The local state is set with the `INIT` command. Switching off the local state enhances the measurement performance. Measurements results can be retrieved in local state on or off.

Sensor parameters are set with the `SENSe` commands.

To start the measurement and retrieve the result, use the `:READ<ch>[:POWer]?` command.

:INITiate<ch>[:POWer]:CONTinuous <Continuous>

Switches the local state of the continuous power measurement by R&S NRP 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: 0

Example: `INIT1:CONT ON`

Switches local state of continuous power measurement on.

Manual operation: See " State " on page 226

: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..3

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 225

: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 dBm as unit 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 225

: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 331.

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 228

: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
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 228

: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 " on page 228

: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 226

:SENSe<ch>[:POWer]:DISPlay:PERManent:STATe <State>

Activates the permanent display of the measured power level results. The instrument also indicates the sensor type, the connection, the measurement source and the offset if set.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `SENS1:POW:DISP:PERM:STAT ON`
The permanent viewer is switched on.

Manual operation: See " Permanent " on page 226

: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 227

: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^n.

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 227

: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 228

: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

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 228

: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 228

: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 set the filter length manually. 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 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 227

: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`
Sets the RF frequency of the source which is 2.44 GHz.

Manual operation: See " Frequency " on page 227

:SENSe<ch>[:POWer]:LOGGing:STATe <State>

Activates the recording of the power values, measured by a connected R&S NRP 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 228

:SENSe<ch>[:POWer]:OFFSet <Offset>

Sets a level offset which is added to the measured level value after activation with command `:SENSe<ch>[:POWer]:OFFSet:STATe`. The level offset allows, e.g. to consider an attenuator in the signal path.

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 227

: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: 0

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 227

: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 225

:SENSe<ch>[:POWer]:SOURce <Source>

Determines the signal to be measured.

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 | USER | RF
*RST: A

Example: `SENS1:SOUR RF`
The sensor measures the power of the RF signal

Manual operation: See " Source " on page 226

:SENSe<ch>[:POWer]:STATus[:DEVice]?

Queries if a sensor is connected to the instrument.

Return values:

<Status> 0 | 1 | OFF | ON
*RST: 0

Example: `SENS1:STAT?`
`Response: 1`
A sensor is connected

Usage: Query only

Manual operation: See " State " on page 226

:SENSe<ch>[:POWer]:SVERsion?

Queries the software version of the connected R&S NRP power sensor.

Return values:

<SVersion> string

Example: `SENS1:POW:SVER?`
Queries the software version of the power sensor.

Usage: Query only

: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 225

:SENSe<ch>[:POWer]:ZERO

Performs zeroing of the sensor.

Zeroing is required after warm-up, i.e. after connecting the sensor.

Also, it is recommended that you zero in regular intervals (at least once a day), if:

- The temperature has varied more than about 5 °C.
- The sensor has been replaced.
- You want to measure very low power.

Note: The RF power source must be switched off or disconnected from the sensor before zeroing.

Example: `SENS1:ZERO`
Executes zeroing.

Usage: Event

Manual operation: See " Zero " on page 226

:SLISt[:LIST]?

Returns a list of all detected sensors in a comma-separated string.

Return values:

<SensorList> String of comma-separated entries

Each entry contains information on the sensor type, serial number and interface.
The order of the entries does not correspond to the order the sensors are displayed in the "NRP Sensor Mapping" dialog.

Example:
```
SLISt:LIST?
// Response: "NRP33SN-V-900007-USB Legacy","NRP-Z211-900001-USB Legacy"
// list of automatically detected sensors

SLISt:SCAN:STATe 1
// searches for sensors connected in the LAN or via the USBTMC protocol

SLISt:LIST?
// Response:
// "NRP33SN-V-900007-USB Legacy","NRP-Z211-900001-USB Legacy",
// "NRP33SN-V-900005-USBTMC","NRP33SN-V-900011-LAN"
// the list contains more entries

SLISt:ELEMent3:MAPPing SENS1
// maps the third sensor from the list to the first sensor channel
```

Usage: Query only

Manual operation: See " Sensor Mapping List " on page 220

:SLISt:SCAN[:STATe] <State>

Starts the search for R&S NRP power sensors, connected in the LAN or via the USBTMC protocol.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See `:SLISt[:LIST]?` on page 338.

Manual operation: See " Scan " on page 221

:SLISt:ELEMent<ch>:MAPPing <Mapping>

Assigns an entry from the `:SLISt[:LIST]?` to one of the four sensor channels.

Parameters:

<Mapping> SENS1 | SENSor1 | SENS2 | SENSor2 | SENS3 | SENSor3 | SENS4 | SENSor4 | UNMapped

Sensor channel.

*RST: UNMapped

Example: See `:SLISt[:LIST]?` on page 338.

Manual operation: See " Sensor Mapping List " on page 220

11.14 SOURce Subsystem

The `SOURce` subsystem contains the commands for configuring the digital and analog signals.

SOURce<hw>

The R&S SGT is a one path instrument, therefore the keyword `SOURce<hw>` is optional and can be omitted.

Exception are some commands used with option R&S SGT-K540, envelope tracking. For details, see Chapter 11.14.4, "SOURce:BB:ARB Subsystem", on page 351.

11.14.1 SOURce General Commands

[:SOURce]:FREQuency[:CW|FIXed] <Cw>

Sets the RF frequency at the RF output connector of the selected instrument.

Note: Enabled frequency offset affects the result of this query. The query returns the frequency, including frequency offset.

Parameters:

<Cw> float

*RST: 1 GHz

Example: See `[:SOURce]:FREQuency:OFFSet` on page 341.

Manual operation: See "Freq/Freq (Offs)" on page 60

[:SOURce]:FREQuency:OFFSet <Offset>

Sets a frequency offset, for example include the frequency shift of downstream instrument.

Note: Enabled frequency offset affects the result of the query :SOURce:FREQuency:CW?

The query returns the frequency, including frequency offset.

Parameters:

<Offset> float

Range: -3e9 to 3e9
Increment: 1E-3
*RST: 0

Example:

```
SOURce:FREQuency:OFFSet 0
SOURce:FREQuency:CW 2143000000
SOURce:FREQuency:OFFSet 20000000
SOURce:FREQuency:CW?
// 2163000000
```

Manual operation: See "Offset" on page 199

[:SOURce]:OPMode <OpMode>

Sets the operation mode.

Parameters:

<OpMode> NORMal | BBBYpass

NORMal
normal operation

BBBYpass
Baseband bypass mode

*RST: NORMal

Manual operation: See "Operation Mode" on page 198

[:SOURce]:LOSCillator:SOURce <Source>

Selects the source of the local oscillator signal.

Parameters:

<Source> INTernal | EXTernal

`INT`: use built in oscillator; `EXT`: use signal at LO/ REF IN connector

Manual operation: See "Source" on page 201

[:SOURce]:PATH:COUNt?

Queries the number of installed RF paths.

Return values:

<Count>	integer Range: 1 to INT_MAX *RST: 1

Example:	`PATH:COUN?`
	Queries the number of RF paths.
	`Response: 1`
	The instrument is equipped with one RF path.

Usage:	Query only

11.14.2 SOURce:AWGN Subsystem

The `SOURce:AWGN` subsystem contains the commands for setting the noise generator.

These commands are available in instrument equipped with the option R&S SGT-K62 (Additive White Gaussian Noise).

[:SOURce<hw>]:AWGN:BRATe <BRate>

Sets the bit rate which is used for calculation of bit energy to noise power ratio from carrier/noise ratio for Digital Standard signals.

Valid units are bps, kbps and mabps as well as b/s, kb/s and mab/s.

Parameters:

<BRate>	float Range: 400 bps to 250E6 bps Increment: 0.001 *RST: 100000

Example: `SOURce1:AWGN:BRATe?`
queries the bit rate which is used for calculation of the Eb/N0 value from the C/N value.

Manual operation: See "Bit Rate" on page 129

[:SOURce<hw>]:AWGN:BWIDth <BWidth>

Sets the system bandwidth. The noise signal at the level which corresponds to the specified carrier/noise ratio is generated in the bandwidth specified here.

This command is available for modes Additive Noise and Noise Only (`SOUR:AWGN:MODE ADD|ONLY`).

Parameters:

<BWidth>	float Range: 1000 to depends on the installed options Increment: 100 *RST: 3.84E6

Example: `SOURce:AWGN:MODE ADD`
`SOURce:AWGN:BWIDth 10 MHz`
sets a system bandwidth of 10 MHz.

Manual operation: See "System Bandwidth" on page 126

[:SOURce<hw>]:AWGN:BWIDth:NOISe?

This command is available for modes In Additive Noise and Noise Only (`SOUR:AWGN:MODE ADD|ONLY`) modes, queries the real noise bandwidth.

Return values:

<Noise>	float Range: 0 to 200E6 Increment: 100 *RST: 0

Example: `AWGN:BWID:NOIS?`
queries the noise bandwidth.

Usage: Query only

Manual operation: See "Noise Bandwidth" on page 128

[:SOURce<hw>]:AWGN:BWIDth:RATio <Ratio>

In Additive Noise and Noise Only (`SOUR:AWGN:MODE ADD|ONLY`) modes, sets the ratio of minimum real noise bandwidth to system bandwidth.

The overall bandwidth is calculated as follows and may not exceed the total bandwidth specified in the data sheet:

Overall Bandwidth = System BW x Min Noise/System BW Ratio

Parameters:

<Ratio> float

Range: 1 to Max
Increment: 0.1
*RST: 1

Example: `AWGN:BWID:RAT 2`
sets a minimum noise/system bandwidth ratio of 2.

Manual operation: See "Minimum Noise/System Bandwidth Ratio" on page 126

[:SOURce<hw>]:AWGN:CNRatio <CnRatio>

In Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) mode, sets the carrier/interferer ratio. The value range depends on the selected AWGN mode.

Parameters:

<CnRatio> float

Range: -50 to 40
Increment: 0.01
*RST: 0
Default unit: dB

Example: `AWGN:CNR 10`
sets a carrier/noise ratio of 10 dB.

Manual operation: See "Carrier/Noise Ratio / Signal/Noise Ratio" on page 129

[:SOURce<hw>]:AWGN:DISP:MODE <Mode>

Selects the display mode to Bseband or RF.

Parameters:

<Mode> RF | BB

*RST: RF

Example: `AWGN:DISP:MODE RF`
sets the display mode to RF

Manual operation: See "Display Mode" on page 128

[:SOURce<hw>]:AWGN:DISP:ORESults <OResults>

(requires option R&S SGT-K18, Digital Baseband Connectivity)

In additive Noise and Noise Only (`SOUR:AWGN:MODE ADD|ONLY`) modes and for Display Mode set to Baseband (`AWGN:DISP:MODE BB`), selects the display of output results for the analog (DACIF) or the digital (BBOUT) signal path.

Parameters:

<OResults> ANALog | DIGital

*RST: ANALog

Example: `SOURce:AWGN:MODE ONLY`
activates the generation of a pure noise for path A.
`SOURce:AWGN:DISP:MODE BB`
sets the display mode
`SOURce:AWGN:DISP:ORESults DIGital`
displays the output results of the digital signal of path A.

[:SOURce<hw>]:AWGN:ENRatio <EnRatio>

In Additive Noise mode, sets the ratio of bit energy to noise power density.

For **Digital Standard** signals, the bit rate used for calculation of E_b/N_0 value from C/N value is defined with command `SOUR:AWGN:BRAT`.

Parameters:

<EnRatio> float

Range: -50 to depends on hardware
Increment: 0.01
*RST: 15.84
Default unit: dB

Example: `AWGN:ENR 10`
sets a ratio of bit energy to noise power density of 10 dB

Manual operation: See "E_b/N_0" on page 129

[:SOURce<hw>]:AWGN:FREQuency:RESult?

In CW inerferer mode, queries the actual frequency of the sine.

The actual frequency may differ from the desired frequency, since the resolution is limited to 0.7 Hz.

Return values:

<Result> float

Range: -40E6 to 40E6
Increment: 0.01
*RST: 0

Example: `AWGN:FREQ:RES?`
queries the actual frequency of the interfering sine

Usage: Query only

Manual operation: See "Resulting CW Frequency Offset" on page 127

[:SOURce<hw>]:AWGN:FREQuency:TARGet <Target>

Sets the desired frequency of the sine in `AWGN:MODE CW` mode.

The resulting frequency may differ from the desired frequency because of the limited frequency resolution of 0.7 Hz.

Parameters:

<Target> float

Range: -40E6 to 40E6
Increment: 0.01
*RST: 0

Example: `AWGN:FREQ:TARG 2kHz`
sets a frequency of 2 kHz for the interfering sine.

Manual operation: See "Target CW Frequency Offset" on page 127

[:SOURce<hw>]:AWGN:MODE <Mode>

Selects the mode for generating the interfering signal.

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:
```
SOURce:AWGN:MODE ONLY
SOURce:AWGN:STATe ON
```
selects the generation of a pure noise and activates it

Manual operation: See "Mode" on page 126

[:SOURce<hw>]:AWGN:POWer:CARRier <Carrier>

available for Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) modes

Sets/queries the carrier or signal power depending on the selected reference mode.

- `SOUR:AWGN:POW:RMOD CARR`
  Sets the carrier power. The power of the noise signal is derived from the entered C/N value.

- `SOUR:AWGN:POW:RMOD NOIS`
  queries the carrier power which is derived from the entered C/N value. The noise power is set with command `SOUR:AWGN:POW:NOISe`.

Parameters:

<Carrier> float

Increment: 0.01
*RST: 0
Default unit: dBm

Example: `AWGN:POW:CARR?`
queries the carrier power

Manual operation: See "Carrier Power / Signal Power" on page 130

[:SOURce<hw>]:AWGN:POWer:MODE <Mode>

In Additive Noise (`SOUR:AWGN:MODE ADD`) mode, selects the mode for setting the noise power.

Parameters:

<Mode> CN | SN | EN

CN|SN
The noise power is set on the basis of the value entered for the carrier/noise or signal/noise ratio (`SOURce:AWGN:CNRatio|SNRatio`).

EN
The noise power is set on the basis of the value entered for the ratio of bit energy to noise power density (`AWGN:ENR`).

*RST: CN|SN

Example: `SOUR:AWGN:POW:MODE CN`
the noise power is set on the basis of the value entered for the carrier/noise ratio (`AWGN:CNR`).

Manual operation: See "Set Noise Power Via" on page 128

[:SOURce<hw>]:AWGN:POWer:NOISe <Noise>

Sets or queries the noise power in the system bandwidth depending on the selected mode:

- `SOUR:AWGN:MODE ADD|CW`
- "Noise Only" mode
  The command sets the noise power.

Parameters:

<Noise> float

Increment: 0.01
Default unit: dBm

Example: `SOURce:AWGN:POWer:NOISe?`
queries the noise power in the system bandwidth.
Response: `10`
the noise power in the system bandwidth is 10 dBm.

Manual operation: See "Noise Power (System Bandwidth) / Interferer Power" on page 130

[:SOURce<hw>]:AWGN:POWer:NOISe:TOTal?

In Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) modes, queries the noise power in the total bandwidth.

Tip: Use the command `[:SOURce<hw>]:AWGN:DISP:OREsults` to define the analog or digital signal path before.

Return values:

<Total> float

Range: -145 to 20
Increment: 0.01
*RST: -30

Example: `SOURce:AWGN:POWer:NOISe:TOTal?`
queries the noise power in the total bandwidth.
Response: `15`
the noise power in the total bandwidth is 15 dBm.

Usage: Query only

Manual operation: See "Noise Power (Total Bandwidth)" on page 131

[:SOURce<hw>]:AWGN:POWer:RMODe <RMode>

In Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) modes and Display Mode set to RF (`AWGN:DISP:MODE RF`), selects the mode for setting the interfering signal.

Parameters:

<RMode> CARRier | NOISe

CARRier
The carrier power is kept constant when the C/N value or Eb/N0 value is changed. The noise power is adjusted.

NOISe
The noise power is kept constant when the C/N value or Eb/N0 value is changed. The carrier power is adjusted.

*RST: CARRier

Example: `SOURce:AWGN:MODE ADD`
selects Additive Noise mode.
`SOURce:AWGN:DISP:MODE RF`
sets the display mode to RF
`SOURce:AWGN:POWer:RMODe NOISe`
selects Reference Mode Noise. The noise power is kept constant when the C/N value or Eb/N0 value is changed. The carrier power is adjusted.

Manual operation: See "Reference Mode" on page 129

[:SOURce<hw>]:AWGN:POWer:SUM?

In Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) modes, queries the overall power of the noise signal plus useful signal.

Return values:

<Sum> float

Range: -145 to 20
Increment: 0.01
*RST: 0

Example: `SOURce:AWGN:POWer:SUM?`
queries the overall power of the noise signal plus useful signal.

Usage: Query only

Manual operation: See "Carrier + Noise Power / Signal + Noise Power (System Bandwidth) / Carrier + Interferer Power / Signal + Interferer Power " on page 131

[:SOURce<hw>]:AWGN:POWer:SUM:PEP?

In Additive Noise and CW Interferer (`SOUR:AWGN:MODE ADD|CW`) modes, 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: `SOURce:AWGN:POWer:SUM:PEP?`
queries the peak envelope power of the overall signal.

Usage: Query only

Manual operation: See "Carrier + Noise PEP / Signal + Noise PEP (Total Bandwidth) / Carrier + Interferer PEP / Signal + Interferer PEP" on page 132

[:SOURce<hw>]:AWGN:STATe <State>

Activates or deactivates the white noise (AWGN = Averaged White Gaussian Noise).

Use the command `[:SOURce<hw>]:AWGN:MODE` to define the mode the AWGN generator is working in.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `SOURce:AWGN:STATe ON`

Manual operation: See "State" on page 126

11.14.3 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 "Baseband" block output.

[:SOURce]:BB:FOFFset <Foffset>

Sets the frequency offset for the baseband signal. The offset affects the signal on the baseband block output. It shifts the useful baseband signal in the center frequency.

Parameters:

<Foffset> float

Example: `BB:FOFF 2MHZ`

sets a frequency offset of 2 MHz.

Manual operation: See "Frequency Offset" on page 123

[:SOURce]:BB:POFFset <Phoffset>

Sets the relative phase offset of the baseband signal.

The phase offset affects the signal of the "Baseband Block" output.

Parameters:

<Phoffset> float

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 123

[:SOURce<hw>]:BB:PGAin <PGain>

The command sets the relative path gain for the selected baseband signal compared to the baseband signals of the other baseband sources (external baseband). The gain affects the signal on the "baseband block" output.

Parameters:

<PGain>	float	
	Range:	-50 to 50
	Increment:	1E-3
	*RST:	0

[:SOURce]:BB:INFO:PSEQuencer?

Returns the baseband pulse sequencer information.

Return values:

<InfoXmlString> string

Usage: Query only

11.14.4 SOURce:BB:ARB Subsystem

The ARB subsystem contains the commands for setting the ARB Generator. Settings for clock and trigger interfaces and for external outputs are entered in the `SOURce:INPut` and `SOURce:OUTput` subsystems.

For option R&S SGT-K540, envelope tracking, the ARB for envelope tracking can be enabled when `:SCONfiguration:MODE` is set to `AFETracking`. Then the numeric suffix to `SOURce` distinguishes between signal generation for "Baseband 1" and the second ARB generated for the envelope tracking, "Baseband 2":

- `SOURce[1]` = Baseband 1
  The keyword `SOURce` is optional and can be omitted
- `SOURce2` = Baseband 2
  The keyword `SOURce` is mandatory, i.e. the command must contain the keyword with suffix 2.

The ARB waveform for the envelope tracking (`SOURce2`) uses the same trigger, marker and clock settings as the first ARB waveform (`SOURce1`). Therefore those commands are not defined for `SOURce2`.

11.14.4.1 Common Settings

[:SOURce<hw>]:BB:ARBitrary:PRESet

Sets all ARB generator parameters to their default values.

Example: `SOURce1:BB:ARB:PRESet`

Usage: Event

Manual operation: See "Set To Default" on page 81

[:SOURce<hw>]:BB:ARBitrary:STATe <State>

Activates the standard and deactivates all the other digital standards and digital modulation modes in the same path.

You have to selecta an waveform first.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `SOURce1:BB:ARBitrary:WAV:SELect 'wave1'`
loads waveform file from the default directory.
`SOURce1:BB:ARBitrary:TRIGger:SEQ RETR`
sets trigger mode Retrigger.
`SOURce1:BB:ARBitrary:STATe ON`
switches on the ARB generator. The selected waveform is output straight away. A trigger event causes restart.

Manual operation: See "State" on page 80

11.14.4.2 Clock Settings

The `CLOCk` subsystem contains the commands for setting the clock.

For option R&S SGT-K540, the ARB waveform for the envelope tracking (`SOURce2`) uses the same clock settings as the first ARB waveform (`SOURce1`). Therefore these commands are not defined for `SOURce2`.

[:SOURce<hw>]:BB:ARBitrary:CLOCk <Clock>

The command sets the clock rate in samples. Loading a waveform waveform (`ARB:WAV:SEL <name>`) sets the clock rate that is defined in the waveform tag 'clock'. The command subsequently changes the clock rate; see data sheet for value range.

In the case of an external clock source (selection `ARB:CLOCk:SOURce EXTernal`) the clock for the external source must be entered with this command.

Parameters:

<Clock> float

Increment: 0.001

Example: `BB:ARB:CLOC:SOUR INT`
selects the internal clock source for generating waveforms.
`BB:ARB:CLOC 0.5 MHz`
sets the clock rate to 0.5 MHz.

Manual operation: See "Clock Frequency" on page 82

[:SOURce<hw>]:BB:ARBitrary:CLOCk:MODE <Mode>

The command enters the type of externally supplied clock (`:BB:ARB:CLOCk:SOURce EXTernal`). When MSAMple is used, a multiple of the sample clock is supplied via the CLOCK connector and the sample clock is derived internally from this. The multiplier is entered with the command `:BB:ARB:CLOCk:MULTiplier`.

Parameters:

<Mode> SAMPle | MSAMple

*RST: SAMPle

Example: `BB:ARB:CLOC:MODE SAMP`
selects clock type "Sample", i.e. the supplied clock is a sample clock.

Manual operation: See "Clock Mode" on page 122

[:SOURce<hw>]:BB:ARBitrary:CLOCk:MULTiplier <Multiplier>

The command specifies the multiplier for clock type "Multiple Samples" (`:BB:ARB:CLOCk:MODE MSAM`) in the case of an external clock source.

Parameters:

<Multiplier> integer

Range: 1 to 64
*RST: 4

Example:
`BB:ARB:CLOC:SOUR EXT`
selects the external clock source. The clock is supplied via the CLOCK connector.
`BB:ARB:CLOC:MODE MSAM`
selects clock type Multiple Samples, i.e. the supplied clock has a rate which is a multiple of the sample rate.
`BB:ARB:CLOC:MULT 12`
The multiplier for the external clock rate is 12.

Manual operation: See "Sample Clock Multiplier" on page 122

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SOURce <Source>

The command selects the source for the digital modulation clock.

Parameters:

<Source> INTernal | EXTernal | AINTernal

INTernal
The internal clock reference is used.

EXTernal
The external clock reference is supplied to the connector.

*RST: INTernal

Example:
`BB:ARB:CLOC:SOUR EXT`
selects an external clock reference. The clock is supplied via the connector.
`BB:ARB:CLOC:MODE SAMP`
enters clock type sample.

Manual operation: See "Clock Source " on page 122

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SYNChronization:MODE <Mode>

Selects the synchronization mode.

This parameter is used to enable generation of very precise synchronous signal of several connected R&S SGTs.

Note: If several instruments are connected, the connecting cables from the master instrument to the slave one and between each two consecutive slave instruments must have the same length and type. Avoid unnecessary cable length and branching points.

Parameters:

<Mode> NONE | MASTer | SLAVe | DIIN

NONE
The instrument is working in stand-alone mode.

MASTer
The instrument provides all connected instrument with its synchronisation (including the trigger signal) and reference clock signal.

SLAVe
The instrument receives the synchronisation and reference clock signal from another instrument working in a master mode.

DIIN
The instrument receives the synchronisation and reference clock signal from the DIGITAL I/Q connector.

*RST: NONE

Manual operation: See "Sync Mode" on page 121

[:SOURce<hw>]:BB:ARBitrary:CLOCk:SYNChronization:EXECute

Performs automatically adjustment of the instrument's settings required for the synchronization mode, set with the command `[:SOURce<hw>]:BB:ARBitrary:CLOCk:SYNChronization:MODE`.

Example: `BB:ARB:CLOC:SYNC:MODE MAST`
the instrument is configured to work as a master one.
`BB:ARB:CLOC:SYNC:EXEC`
all synchronization's settings are adjusted accordingly.

Usage: Event

11.14.4.3 Trigger Settings

The `TRIGger` subsystem contains the commands for setting the trigger.

For option R&S SGT-K540, the ARB waveform for the envelope tracking (`SOURce2`) uses the same trigger settings as the first ARB waveform (`SOURce1`). Therefore these commands are not defined for `SOURce2`.

[:SOURce<hw>]:BB:ARBitrary:TRIGger:ARM:EXECute

The command stops waveform output for trigger modes Armed_Auto and Armed_Retrigger. A subsequent internal or external trigger event restart waveform output.

Example: `BB:ARB:TRIG:SOUR INT`
sets internal triggering.
`BB:ARB:TRIG:SEQ ARET`
sets Armed_Retrigger mode, i.e. every trigger event causes waveform output to restart.
`BB:ARB:TRIG:EXEC`
executes a trigger, waveform output is started.
`BB:ARB:TRIG:ARM:EXEC`
waveform output is stopped.
`BB:ARB:TRIG:EXEC`
executes a trigger, waveform output is started again.

Usage: Event

Manual operation: See "Arm" on page 111

[:SOURce<hw>]:BB:ARBitrary:TRIGger:EXECute

The command executes a trigger. The internal trigger source must be selected using the command `ARB:TRIGger:SOURce INTernal` and a trigger mode other than `AUTO` must be selected using the command `:ARB:SEQuence`.

Example: `BB:ARB:TRIG:SOUR INT`
sets internal triggering.
`BB:ARB:SEQ RETR`
sets Retrigger mode, i.e. every trigger event causes signal output to restart.
`BB:ARB:TRIG:EXEC`
executes a trigger.

Usage: Event

Manual operation: See "Execute Trigger" on page 111

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal]:SYNChronize:OUTPut <Output>

(enabled for "Trigger Source" External)

Enables/disables output of the signal synchronous to the external trigger event.

Parameters:

<Output> 0 | 1 | OFF | ON

ON
The signal calculation starts simultaneously with the external trigger event but because of the instrument's processing time the first samples are cut off and no signal is outputted. After elapsing of the internal processing time, the output signal is synchronous to the trigger event.

OFF
The signal output begins after elapsing of the processing time and starts with sample 0, i.e. the complete signal is outputted. This mode is recommended for triggering of short signal sequences with signal duration comparable with the processing time of the instrument.

*RST: ON

Example: `BB:ARB:TRIG:SOUR EXT`
sets external triggering.
`BB:ARB:TRIG:EXT:SYNC:OUTP ON`
enables synchronous output to external trigger

Manual operation: See "Sync. Output to External Trigger" on page 112

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MAXimum?
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay:MINimum?

The command queries the minimum marker delay for setting `:BB:ARB:TRIGger:OUTPut:DELay:FIXed ON`.

Return values:

<Minimum> float

Range: 0 to 16777215
Increment: 1E-3
*RST: 0

Example: `BB:ARB:TRIG:OUTP:DEL:FIX ON`
restricts the marker signal delay setting range to the dynamic range.
`BB:ARB:TRIG:OUTP:DEL:MIN`
queries the minimum of the dynamic range.
`Response: 0`
the minimum for the marker delay setting is 0 samples.

Usage: Query only

Manual operation: See "Current Range without Recalculation" on page 121

[:SOURce<hw>]:BB:ARBitrary:TRIGger:RMODe?

The command queries the status of waveform output or all trigger modes with ARB on.

Return values:

<RMode> STOP | RUN

RUN
The waveform is output. A trigger event occurred in the triggered mode.

STOP
The waveform is not output. A trigger event did not occur in the triggered modes, or waveform output was stopped by the command:`BB:ARB:TRIG:ARM:EXECute` (armed trigger modes only).

Example:
`BB:ARB:TRIG:SOUR EXT`
sets external triggering
`BB:ARB:TRIG:MODE ARET`
selects the Armed_Retrigger mode.
`BB:ARB:TRIG:RMOD?`
queries the current status of waveform output.
`Response: RUN`
the waveform is output, an external trigger was executed.

Usage: Query only

Manual operation: See "Running/Stopped" on page 111

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLENgth <SLength>

The command defines the length of the signal sequence to be output in the Single trigger mode. The unit is defined with command `SOUR:BB:ARB:TRIG:SLUNit`. It is possible to output deliberately just part of the waveform, an exact sequence of the waveform, or a defined number of repetitions of the waveform.

Parameters:

<SLength> integer

Range: 1 to dynamic
*RST: 1
Default unit: sample

Example:
`BB:ARB:SEQ SING`
sets trigger mode Single.
`BB:ARB:TRIG:SLUN SAMP`
sets unit Samples for the entry of sequence length.
`BB:ARB:TRIG:SLEN 200`
sets a sequence length of 200 samples. The first 200 samples of the current waveform will be output after the next trigger event.

Manual operation: See "Signal Duration " on page 111

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SLUNit <SLUnit>

The command defines the unit for the entry of the length of the signal sequence (`SOUR:BB:ARB:TRIG:SLEN`) to be output in the "Single" trigger mode (`SOUR:BB:ARB:SEQ SING`).

Parameters:

<SLUnit> SEQuence | SAMPle

*RST: SEQuence

Example: `BB:ARB:SEQ SING`
sets trigger mode Single.
`BB:ARB:TRIG:SLUN SEQ`
sets unit Sequence length for the entry of sequence length.
`BB:ARB:TRIG:SLEN 2`
sets a sequence length of 2 waveforms. The current waveforms will be output twice after the next trigger event.

Manual operation: See "Signal Duration Unit" on page 111

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SMODe <SMode>

The command selects the extended trigger mode for multi segment waveforms.

Parameters:

<SMode> SAME | NEXT | NSEam | SEQuencer

NSEam = Next Segment Seamless

*RST: NEXT

Example: `SOUR:BB:ARB:SEQ AUTO`
selects trigger mode AUTO.
`SOUR:BB:ARB:TRIG:SMOD SAME`
the same segment of the waveform is output repeatedly.

Manual operation: See "Next Segment Mode" on page 114

[:SOURce<hw>]:BB:ARBitrary:TRIGger:SOURce <Source>

Selects the trigger source.

Parameters:

<Source> INTernal|OBASeband|BEXTernal|EXTernal

`INTernal`
manual trigger or `*TRG`.
`EXTernal|BEXTernal`
trigger signal on the USER 1/2 connector.

*RST: INTernal

Example: `SOURce1:BB:ARBitrary:TRIGger:SOURce EXTernal`
sets external triggering via the USER 1/2 connector.

Manual operation: See "Trigger Source" on page 111

[:SOURce<hw>]:BB:ARBitrary:TRIGger:DELay:UNIT <TrigDelUnit>

Determines the units the trigger delay is expressed in.

Parameters:

<TrigDelUnit> SAMPle | TIME

*RST: SAMPle

Manual operation: See "External Delay Unit" on page 113

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:DELay <Delay>

The command specifies the trigger delay (expressed as a number of samples) for external triggering.

Parameters:

<Delay> float

Range: 0 to depends on other values
Increment: 0.01
*RST: 0
Default unit: sample

Example:

`BB:ARB:TRIG:SOUR EXT`
selects an external trigger
`BB:ARB:TRIG:DEL 200`
sets a delay of 200 samples for the trigger.

Manual operation: See "Trigger Delay" on page 113

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:TDELay <ExtTimeDelay>

Specifies the trigger delay for external triggering. The value affects all external trigger signals.

Parameters:

<ExtTimeDelay> float

Range: 0 to 688
Increment: 1E-9
*RST: 0
Default unit: s

Manual operation: See "Trigger Delay" on page 113

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:RDELay?

Queries the time (in seconds) an external trigger event is delayed for.

Return values:

<ResTimeDelaySec> float

Range: 0 to 688
Increment: 0.25E-9
*RST: 0

Usage: Query only

Manual operation: See "Actual Trigger Delay" on page 113

[:SOURce<hw>]:BB:ARBitrary:TRIGger[:EXTernal<1|2>]:INHibit <Inhibit>

Specifies the number of samples by which a restart is to be inhibited following a trigger event. This command applies only in the case of external triggering.

Parameters:

<Inhibit> integer

Range: 0 to 67108863
*RST: 0
Default unit: sample

Example:
`BB:ARB:TRIG:SOUR EXT`
selects an external trigger
`BB:ARB:TRIG:INH 200`
sets a restart inhibit for 200 samples following a trigger event.

Manual operation: See "Trigger Inhibit" on page 113

[:SOURce<hw>]:BB:ARBitrary[:TRIGger]:SEQuence <Sequence>

The command selects the trigger mode.

Parameters:

<Sequence> AUTO | RETRigger | AAUTo | ARETrigger | SINGle

AUTO
The waveform is output continuously.

RETRigger
The waveform is output continuously. A trigger event (internal or external) causes a restart.

AAUTo
The waveform is output only when a trigger event occurs. After the trigger event the waveform is output continuously. Waveform output is stopped with command `SOUR:BB:ARB:TRIG:ARM:EXEC` and started again when a trigger event occurs.

ARETrigger
The waveform is output only when a trigger event occurs. The device automatically toggles to RETRIG mode. Every subsequent trigger event causes a restart. Waveform output is stopped with command `SOUR:BB:ARB:TRIG:ARM:EXEC` and started again when a trigger event occurs.

SINGle
The waveform is output only when a trigger event occurs. After the trigger event the waveform is output once to the set sequence length (`SOUR:BB:ARB:TRIG:SLEN`). Every subsequent trigger event causes a restart.

*RST: RETRigger

Example: `BB:ARB:SEQ AAUT`
sets the "Armed_auto" trigger mode; the device waits for the first trigger (e.g. with `*TRG`) and then generates the signal continuously.

Manual operation: See "Trigger Mode" on page 110

11.14.4.4 Marker Settings

The `TRIGger:OUTPut` subsystem contains the commands for setting the marker.

For option R&S SGT-K540, the ARB waveform for the envelope tracking (`SOURce2`) uses the same marker settings as the first ARB waveform (`SOURce1`). Therefore these commands are not defined for `SOURce2`.

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:MODE <Mode>

The command defines the signal for the selected marker output.

Parameters:

<Mode> UNCHanged | RESTart | PULSe | PATTern | RATio

UNCHanged
A marker signal as defined in the waveform file (tag 'marker mode x') is generated.

RESTart
A marker signal is generated at every waveform start.

PULSe
A pulsed marker signal is generated. The pulse frequency (= sample rate/divider) is defined with the `SOUR:BB:ARB:TRIG:OUTP:PULS:DIV` command and can be queried with the `SOUR:BB:ARB:TRIG:OUTP:PULS:FREQ?` command.

PATTern
A marker signal is generated with the aid of a user-definable bit pattern. The bit pattern is entered with the aid of command `:BB:ARB:TRIGger:OUTPut:PATTern`. The bit pattern is a maximum of 32 bits long.

RATio
A regular marker signal corresponding to the Time Off / Time On specifications in the commands `:ARB:TRIGger:OUTPut:OFFTime` and `:ARB:TRIGger:OUTPut:ONTime` is generated.

*RST: UNCHanged

Manual operation: See "Marker Mode" on page 120

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:OFFTime <OffTime>
[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:ONTime <OnTime>

The command sets the number of samples in a period (ON time + OFF time) during which the marker signal in setting `:ARB:TRIGger:OUTPut:MODE RATio` on the marker outputs is ON.

Parameters:

<OnTime> integer

Range: 1 to 14913079
*RST: 1

Example: `BB:ARB:TRIG:OUTP2:ONT 20`
sets an ON time of 20 samples for marker 2

Manual operation: See "Marker Mode" on page 120

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PATTern <Pattern>

The command defines the bit pattern used to generate the marker signal in the setting `SOURce:BB:ARB:TRIGger:OUTPut:MODE PATTern` 0 is marker off, 1 is marker on.

Parameters:

<Pattern> <32 bits pattern>

*RST: 0

Example: `BB:ARB:TRIG:OUTP2:PATT #H39FE0000,32`
sets a bit pattern.
`BB:ARB:TRIG:OUTP2:MODE PATT`
activates the marker signal according to a bit pattern on output MARKER 2.

Manual operation: See "Marker Mode" on page 120

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

The command sets the divider for the pulsed marker signal in the setting `SOURce:BB:ARB:TRIGger:OUTPut:MODE PULSe`. The pulse frequency is derived by dividing the symbol rate by the divider.

Parameters:

<Divider> integer

Range: 2 to 1024
*RST: 2

Manual operation: See "Marker Mode" on page 120

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:PULSe:FREQuency?

The command queries the pulse frequency of the pulsed marker signal in the setting `SOURce:BB:ARB:TRIGger:OUTPut:MODE PULSe`. The pulse frequency is derived by dividing the symbol rate by the divider. The divider is defined with command `:BB:ARB:TRIG:OUTP:PULS:DIV`.

Return values:

<Frequency> float

Increment: 0.001

Example: `BB:ARB:TRIG:OUTP2:PULS:DIV 4`
sets the divider for the marker signal on the output to the value 4.
`BB:ARB:TRIG:OUTP2:MODE PULS`
enables the pulsed marker signal.
`BB:ARB:TRIG:OUTP2:PULS:FREQ?`
queries the pulse frequency of the marker signal.
`Response: 33 000`
the resulting pulse frequency is 33 kHz.

Usage: Query only

Manual operation: See "Marker Mode" on page 120

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut:DELay:FIXed <Fixed>

The command restricts the marker delay setting range to the dynamic range. In this range the delay can be set without restarting the marker and signal. If a delay is entered in setting ON but is outside this range, the maximum possible delay is set and an error message is output.

The setting always affects every marker.

Parameters:

<Fixed> 0 | 1 | OFF | ON

*RST: 0

Example: `BB:ARB:TRIG:OUTP:DEL:FIX ON`
restricts the marker signal delay setting range to the dynamic range.

Manual operation: See "Fix marker delay to current range " on page 121

[:SOURce<hw>]:BB:ARBitrary:TRIGger:OUTPut<ch>:DELay <Delay>

Sets 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

Manual operation: See "Marker x Delay" on page 120

11.14.4.5 Test Signals Settings

[: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: `BB:ARB:TSIG:SINE:CRE`
generates a test sine signal and uses it as output straight away.

Usage: Event

Manual operation: See "Generate Signal RAM" on page 107

[: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: `BB:ARB:TSIG:SINE:CRE:NAM 'sine_test'`
generates a test sine signal and saves it into the wavefile `sine_test`.

Usage: Setting only

Manual operation: See "Generate Signal File" on page 107

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:I <I>
[:SOURce<hw>]:BB:ARBitrary:TSIGnal:CIQ:Q <TSig>

Sets the value for the Q component of the test signal

Parameters:

<TSig> float

Range: -1 to 1
Increment: 0.001
*RST: 0
Default unit: FS

Example: `BB:ARB:TSIG:CIQ:Q 0.5`
sets the value for the Q component of the test signal.

Manual operation: See "Q Value" on page 109

[: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: `BB:ARB:TSIG:RECT:AMPL 0.5`
sets the amplitude of the test signal

Manual operation: See "Amplitude" on page 108

[: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: `SOURce:BB:ARBitrary:TSIGnal:RECTangle:FREQuency 100 kHz`
sets the frequency of the test signal of 100 kHz.

Manual operation: See "Frequency" on page 107

[: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: `BB:ARB:TSIG:RECT:OFFS 0.5`
sets the DC component

Manual operation: See "Offset DC" on page 108

[: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: `BB:ARB:TSIG:RECT:SAMP 400`
sets 400 samples per period

Manual operation: See "Samples per Period" on page 107

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:FREQuency <Frequency>

Sets the frequency of the simple sinusoidal test signal. This signal is used as output via the I channel. A sine wave of the same frequency but optionally phase-shifted is generated on the Q path (`ARB:TSIGnal:SINE:POFFset`).

Parameters:

<Frequency> float

Range: 100 to depends on hardware
Increment: 0.01
*RST: 1000
Default unit: Hz

Example: `BB:ARB:TSIG:SINE:FREQ 100 kHz`
sets a sine signal of 100 kHz.

Manual operation: See "Frequency" on page 106

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:PHASe <Phase>

The command 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: `BB:ARB:TSIG:SINE:PHAS 90`
sets a phase offset of 90 degrees.

Manual operation: See "Phase Offset Q" on page 106

[:SOURce<hw>]:BB:ARBitrary:TSIGnal:SINE:SAMPles <Samples>

The command sets the sample rate for the sine signal in samples per period.

The maximum value is automatically restricted by reference to the set frequency and has to fulfill the rule Frequency * Samples <= ARB clock rate.

Parameters:

<Samples> integer

Range: 4 to 1000
*RST: 100
Default unit: 100 samples per period

Example: `BB:ARB:TSIG:SINE:SAMP 100`
sets a sample rate of 100 samples per period.

Manual operation: See "Samples per Period" on page 106

11.14.4.6 SOURce:BB:ARB:MCAR Subsystem

The `MCARrrier` subsystem contains the commands for setting the Multi Carrier Waveform Generator.

CARRier<ch>

The numerical suffix under `CARRier` distinguish between the carriers. The value range is 0 .. 31.

[: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: `BB:ARB:MCAR:CARR:COUN 10`
sets 10 carriers for the multi carrier waveform.

Manual operation: See "Number of Carriers" on page 97

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:MODE <Mode>

The command sets the carrier frequency mode.

Parameters:

<Mode> EQUidistant | ARBitrary

EQUidistant
Sets an equidistant carrrier spacing. The carrier frequency in the carrier table is not configurable.

ARBitrary
Enables you to specify the carrier frequency in the carrier table. Carrier spacing is irrelevant.

*RST: EQUidistant

Example: `BB:ARB:MCAR:CARR:MODE EQU`
sets an equidistant carrier spacing. The carrier frequency can not be set.

Manual operation: See "Mode" on page 96

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier:SPACing <Spacing>

The command sets the frequency spacing between adjacent carriers of the multi carrier waveform. The carriers are generated symmetrically around the RF carrier. The maximum carrier spacing is limited to **Carrier spacing = Total baseband bandwidth / (Number of carriers - 1).**

The total baseband bandwidth is 60, 120 or 160 MHz depending on the installed options. .

Note: In order to avoid wrap-around problems, the effective "Carrier Spacing" might be slightly modified. 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:
  RoundedCarrierSpacing=1/OutputSignalDuration* round(CarrierSpacing * OutputSignalDuration);
- For even number of carriers:
  RoundedCarrierSpacing=2/OutputSignalDuration*round(0.5 *CarrierSpacing * OutputSignalDuration);

Parameters:

<Spacing> float

Range: 0.0 to 120E6
Increment: 0.01
*RST: 0
Default unit: Hz

Example: `BB:ARB:MCAR:CARR:SPAC 10 MHz`
sets a carrier spacing of 10 MHz.

Manual operation: See "Carrier Spacing" on page 97

[: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

*RST: 0

Example: `BB:ARB:MCAR:CARR2:CONF?`
queries the multi carrier conflict state.
Response: `0` no conflict has occurred.

Usage: Query only

Manual operation: See " !!! " on page 104

[: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 104

[: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: `BB:ARB:MCAR:CARR15:FILE "/var/user/IQ_wcdma"`
selects file `IQ_wcdma`. The data of the file is modulated onto carrier 15.

Manual operation: See " File " on page 104

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:FREQuency <Frequency>

Sets or indicates the carrier frequency, depending on the selected carrier frequency mode.

The carrier frequnecy can be set in "Arbitrary Carrier frequency" mode. For "Equidistant Carrier Spacing", the carrier spacing is determined automatically.

Parameters:

<Frequency> integer

Vvalue range depends on the max bandwidth, see data sheet

Range: -40E6 to 40E6
*RST: 0

Example: `BB:ARB:MCAR:CARR:MODE ARB`
activates ARB multi carrier mode.
`BB:ARB:MCAR:CARR:FREQ 5.0`
sets 5.0 MHz carrier frequency.

Manual operation: See " Carrier Freq Offs. " on page 104

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:PHASe <Phase>

The command sets the start phase of the selected carrier.

The phase settings are only valid if optimization of the crest factor is disabled (`:SOURce:BB:ARB:MCARrier:CFACtor:MODE OFF`).

Parameters:

<Phase> float

Range: 0 to 359.99
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `BB:ARB:MCAR:CARR15:PHAS 90 DEG`
sets a start phase of 90° for carrier 15.

Manual operation: See " Phase " on page 104

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:POWer <Power>

The command sets the gain of the selected carrier.

Parameters:

<Power> float

Range: -80 to 0
Increment: 0.01
*RST: 0
Default unit: dB

Example: `BB:ARB:MCAR:CARR15:POW -50 dB`
sets the power of carrier 15 to -50 dB.

Manual operation: See " Gain " on page 104

[: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 99

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CARRier<ch>:STATe <State>

Enables/disables the selected carrier.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `SOURce1:BB:ARBitrary:MCARrier:CARRier15:STATe ON`

Manual operation: See " State " on page 104

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CFACtor:MODE <Mode>

The command sets the mode for optimizing the crest factor by calculating the carrier phases.

Parameters:

<Mode> OFF | MIN | MAX

OFF
There is no automatic setting for minimizing or maximizing the crest factor. The Phase setting (command `BB:ARB:MCAR:CARR:PHAS`) is in use.

MIN
The crest factor is minimized by internally calculating optimized carrier phases. The Phase setting (command `BB:ARB:MCAR:CARR:PHAS`) is invalid.

MAX
The crest factor is maximized by internally calculating optimized carrier phases. The Phase setting (command `BB:ARB:MCAR:CARR:PHAS`) is invalid.

*RST: OFF

Example: `BB:ARB:MCAR:CFAC:MODE OFF`
switches off automatic crest factor optimization. The setting `SOUR:BB:ARB:MCAR:CARR:PHAS` has an effect.

Manual operation: See "Crest Factor Mode" on page 97

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CFACtor <CFactor>

Sets the value of the desired crest factor, if baseband clipping is enabled (`BB:ARB:MCAR:CLIP:STAT ON`).

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: `BB:ARB:MCAR:CLIP:STAT ON`
enables clipping.
`BB:ARB:MCAR:CLIP:CFAC 37 dB`
sets the target crest factor.

Manual operation: See "Target Crest Factor" on page 98

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping:CUToff <Cutoff>

Sets the cut off frequency of the final lowpass filter, if baseband clipping is enabled (`BB:ARB:MCAR:CLIP:STAT ON`).

When the cut off frequency is set as half of the output sample rate, a final lowpass filter improves the spectrum of the clipped multicarrier signal, but may also increase the resulting crest factor.

Parameters:
<Cutoff> float

Range: 0 to 50E6
Increment: 0.01
*RST: 50E6
Default unit: MHz

Example: `BB:ARB:MCAR:CLIP:STAT ON`
enables clipping
`BB:ARB:MCAR:CLIP:CUT 50 MHz`
sets the cut off frequency of the filter.

Manual operation: See "Filter Cut Off Frequency" on page 98

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLIPping[:STATe] <State>

Switches baseband clipping on and off.

Clipping reduces the peak power of the resulting multi carrier signal according to the value set with the command `BB:ARB:MCAR:CLIP:CFAC`.

The resulting clipped peak power is defined by sum of the the RMS level of the unclipped multi carrier signal and the input parameter Target Crest Factor. Note that clipping reduces also the RMS level. Hence the resulting crest factor of the clipped signal is slightly above the Target Crest Factor. In order to get the unclipped parts of the clipped multicarrier signal matched with the unclipped multicarrier signal, the RF output power should be reduced by the difference between resulting crest factor and Target Crest Factor.

Parameters:
<State> 0 | 1 | OFF | ON

*RST: 0

Example: `BB:ARB:MCAR:CLIP:STAT ON`
enables clipping
`BB:ARB:MCAR:CLIP:CFAC 37 dB`
sets the target crest factor.

Manual operation: See "Clipping" on page 98

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOad

Creates and loads a multi carrier waveform using the current entries of the carrier table.

This multi carrier waveform is saved with the file name specified with command `SOUR:BB:ARB:MCAR:OFIL`. The file extension is `*.wv`.

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:MCAR:OFIL 'mcar1_2'`
defines the file name `mcar1_2.wv` for the multi carrier waveform.
`BB:ARB:MCAR:CLO`
creates multi carrier waveform `mcar1_2.wv`.
The new multi carrier waveform is loaded.

Usage: Event

Manual operation: See "Create and Load" on page 101

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CLOCk?

The command 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 100

[:SOURce<hw>]:BB:ARBitrary:MCARrier:CREate

Creates a multi carrier waveform using the current settings of the carrier table. The multi carrier waveform is saved into the file defined with command `SOUR:BB:ARB:MCAR:OFIL`. The file extension is `*.wv`.

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:MCAR:OFIL 'multi_wv1'`
defines the file name `multi_wv1.wv` for the multi carrier waveform.
`BB:ARB:MCAR:CRE`
creates multi carrier waveform `multi_wv1.wv`.

Usage: Event

Manual operation: See "Create" on page 100

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay:STEP <Step>

The command sets the step width by which the start delays of the carriers in the defined carrier range will be 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, i.e. the first carrier has a start delay of 5us, the second a start delay of 6 us, etc.

Manual operation: See " Delay Step " on page 103

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:DELay[:STARt] <Start>

The command sets the start delay for the individual carriers in the defined carrier range. If the command `:BB:ARB:MCAR:EDIT:CARR:DEL:STEP` is used to define a step width, the delay entered here applies only to the starting carrier. The delays of the remaining carriers are stepped up or down by the delay value specified in the `:BB:ARB:MCAR:EDIT:CARR:DEL:STEP` command.

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 103

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:EXECute

The command adopts the settings for the carrier range which has been defined using the `:BB:ARB:MCAR:EDIT:CARR:...` commands.

Example:	`BB:ARB:MCAR:EDIT:CARR:STAR 4`
	the carrier range starts at carrier 2.
	`BB:ARB:MCAR:EDIT:CARR:STOP 20`
	the carrier range stops at carrier 20.
	`BB:ARB:MCAR:EDIT:CARR:STAT ON`
	sets all the carriers in the carrier range (2 to 20) to ON.
	`BB:ARB:MCAR:EDIT:CARR:EXEC`
	transfers the assistant settings for carrier 2 to 20 into the carrier table.

Usage:	Event
Manual operation:	See " Apply Assistant Settings " on page 103

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:FILE <File>

Selects input file

Parameters:

<File>	string
Example:	`BB:ARB:MCAR:EDIT:CARR:FILE "/var/user/IQ_wcdma'`
Manual operation:	See " Input Waveform File " on page 103

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe:STEP <Step>

The command sets the step width by which the start phases of the carriers in the defined carrier range will be incremented.

The phase settings are only valid if optimization of the crest factor is disabled (`:SOURce:BB:ARB:MCARrier:CFACtor:MODE OFF`).

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, i.e. the first carrier has a start phase of 90°, the second a start phase of 91°, etc.

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:PHASe[:STARt] <Start>

The command sets the start phase for the individual carriers in the defined carrier range. If the command `:BB:ARB:MCAR:EDIT:CARR:PHAS:STEP` is used to define a step width, the phase entered here applies only to the starting carrier. The phases of the remaining carriers are stepped up or down by the phase value specified in the `:BB:ARB:MCAR:EDIT:CARR:PHAS:STEP` command.

The phase settings are only valid if optimization of the crest factor is disabled (`:SOURce:BB:ARB:MCARrier:CFACtor:MODE OFF`).

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 102

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer:STEP <Step>

The command sets the step width by which the starting power of the carriers in the defined carrier range will be 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, i.e. the first carrier has -80dB, the second -79dB, etc.

Manual operation: See " Gain Step " on page 102

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:POWer[:STARt] <Start>

The command sets the power for the individual carriers in the defined carrier range. If the command `:BB:ARB:MCAR:EDIT:CARR:POW:STEP` is used to define a step width, the power entered here applies only to the starting carrier. The power of the remaining carriers is stepped up or down by the power specified in the `:BB:ARB:MCAR:EDIT:CARR:POW:STEP` command.

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 102

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STARt <Start>
[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STOP <Stop>

The command selects the last carrier in the carrier range to which the settings with the `:BB:ARB:MCAR:EDIT:CARR:..` commands 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 Stop " on page 102

[:SOURce<hw>]:BB:ARBitrary:MCARrier:EDIT:CARRier:STATe <State>

The command 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 102

[:SOURce<hw>]:BB:ARBitrary:MCARrier:OFILe <OFile>

This command defines the output file name for the multi carrier waveform. This file name is used when a waveform is calculated (command `SOUR:BB:ARB:MCAR:CLOad` or `SOUR:BB:ARB:MCAR:CREate`). The file extension is `*.wv`.

Parameters:

<OFile> string

Example: `MMEM:CDIR "/var/user/waveform"`
sets the default directory.
`BB:ARB:MCAR:OFIL 'mcar1_2'`
defines the file name `mcar1_2.wv` for the multi carrier waveform file

Manual operation: See "Output File" on page 100

[:SOURce<hw>]:BB:ARBitrary:MCARrier:PRESet

Sets all ARB multi carrier parameters to their default values.

Example: `SOURce1:BB:ARB:MCARrier:PRESet`

Usage: Event

Manual operation: See "Set to Default" on page 95

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SAMPles?

The command queries the resulting file size. The file size is returned in samples.

Return values:
<Samples> integer

Range: 0 to INT_MAX
*RST: 0

Example: `BB:ARB:MCAR:SAMP?`
queries the file size of the currently calculated multi carrier waveform.

Usage: Query only

Manual operation: See "File Size" on page 100

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:CATalog?

Queries the available settings files in the specified default directory. The settings files are used to set the ARB multi carrier submenu. Only files with the file extension `*.arb_multcarr` will be listed.

Return values:
<Catalog> string

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory
`BB:ARB:MCAR:SETT:CAT?`
reads out all the settings files in the default directory.
`Response: mcar1, mcar2`
the directory contains the configuration files
`mcar1.arb_multcarr` and `mcar2.arb_multcarr`.

Usage: Query only

Manual operation: See "Save/Recall Frame" on page 96

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:LOAD <Filename>

Loads the settings file. If a settings file with the specified name does not yet exist, it is created. The file extension may be omitted. Only files with the file extension `*.arb_multcarr` will be loaded or created.

Setting parameters:

<Filename> string

Example: `BB:ARB:MCAR:SETT:LOAD '/var/user/new'`
creates settings file `new.arb_multcarr`.

Usage: Setting only

Manual operation: See "Save/Recall Frame" on page 96

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe <Filename>

The command stores the current settings of submenu "Multi Carrier" 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: `BB:ARB:MCAR:SETT:STOR '/var/user/mcarr2'`
stores settings file `mcarr2.arb_multcarr` in the default directory.

Usage: Setting only

Manual operation: See "Save/Recall Frame" on page 96

[:SOURce<hw>]:BB:ARBitrary:MCARrier:SETTing:STORe:FAST <Fast>

Determines whether the instrument performs an absolute or a differential storing of the settings.

Enable this function to accelerate the saving process by saving only the settings with values different to the default ones.

Note: This function is not affected by the "Preset" function.

Parameters:

<Fast> 0 | 1 | OFF | ON
*RST: 1

Manual operation: See "Save/Recall Frame" on page 96

[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME <Time>

Sets the user-defined signal period. This setting is only possible for Signal Period Mode User (`BB:ARB:MCAR:TIME:MODE USER`).

Parameters:

<Time> float

Range: 0 to 1E9
Increment: 1E-9
*RST: 0
Default unit: s

Example: `BB:ARB:MCAR:TIME:MODE USER`
selects Signal Period Mode User.
`BB:ARB:MCAR:TIME 10 s`
sets a signal period of 10 seconds

Manual operation: See "Signal Period" on page 99

[: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> LONG | SHORt | LCM | USER

LONG
The resulting signal period is defined by the longest I/Q file in the carrier table. Shorter I/Q files are periodically repeated.

SHORt
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 can be set with command `[:SOURce<hw>]:BB:ARBitrary:MCARrier:TIME`. Shorter I/Q files are repeated periodically, and only the first part of longer I/Q files is used.

LCM
The output file duration is the least common multiple of all input file durations.

*RST: LONG

Example: `SPOURce1:BB:ARBitrary:MCARrier:TIME:MODE LONG`
selects signal period mode long

Manual operation: See "Signal Period Mode" on page 98

11.14.4.7 SOURce:BB:ARB:WAV Subsystem

The WAVeform subsystem contains the commands for working with waveform files.

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog?

Reads out the files in the default directory. The default directory is set using command `MMEM:CDIRectory`. When the names of the waveform files are returned they are separated by commas. Only files with the file extension `*.wv` will be listed.

Return values:

<Catalog>	string

Example:	`MMEM:CDIR '/var/user/waveform'`
	sets the default directory.
	`BB:ARB:WAV:CAT?`
	reads out all the files in the default directory.
	`Response: sin1, wave`
	the directory contains the waveform files `sin1.wv` and `wave.wv`.

Usage:	Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:CATalog:LENGth?

Reads out the files in the default directory and returns the number of waveform files in this directory. The default directory is set using command `MMEM:CDIRectory`. Only files with the file extension `*.wv` will be listed.

Return values:

<Length>	integer Number of waveform files in default directory Range: 0 to INT_MAX *RST: 0

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:WAV:CAT?`
reads out all the files in the default directory.
`Response: sin1, wave`
the directory contains the waveform files `sin1.wv` and `wave.wv`.
`BB:ARB:WAV:CAT:LEN?`
`Response: 2`

Usage: Query only

: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.

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 may 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 two bytes in MSB format (most significant byte first).
The values of the two 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, one bit per marker: Bit_0 = Marker 1, ... Bit_3 = Marker 4.
One 4 bit marker elements is required for every I/Q sample.

Example:

```
:MMEM:DATA:UNPR "NVWFM:/var/user/wave.wv",#23212345678900987654321897 8
// 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
SOURce1:BB:ARBitrary:WAVeform:CLOCk "/var/user/wave.wv",1.1E6
SOURce1: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 385.

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 385

[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA <Filename>, <Data>
[:SOURce<hw>]:BB:ARBitrary:WAVeform:DATA? <Tag>

The **setting** command writes the binary block data `<data>` to the file identified by `<filename>`. The complete content of the waveform file is transmitted as a binary data block.

The **query** command retrieves the content of the specified tag of the currently selected waveform file or the waveform file specified with the `<filename>`.

By default, the waveform files are saved in the default directory of the instrument (`/var/instrument/Lists`).

To access waveform files located in another directory, the complete file path and file name are required.

Parameters:

<Filename> string

Specifies the name of the waveform file the binary data will be copied to.
The file extension (`.wv`) may be omitted.

Setting parameters:

<Data> block data

Contents of the waveform file as a definite length binary block.

Query parameters:

<Tag> 'comment' | 'copyright' | 'date' | 'lacpfilter' | 'marker name' | 'poweroffset'

Indentifier of the tag which shall be retrieved from the waveform file.

Example: **Setting**
`BB:ARB:WAV:DATA "/var/sgt/temp/test1", <bin data block>`
writes the block data to file '`test1.wv`' in the `/var/instrument/Lists` directory.

Example: **Query**
`BB:ARB:WAV:DATA? '/var/user/wave1.wv','comment'`
queries the content of the 'comment' tag of file `wave1.wv` in directory `/var/user`
`Response: " #222Sinusoidal test signal"`

[: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` will be deleted.

Setting parameters:

<Filename> string

Example: `BB:ARB:WAV:DEL '/var/user/wave1.wv'`
deletes waveform file `wave1.wv`.

Usage: Setting only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:FREE?

Queries the free disk space on the default path of the instrument's harddisk.

Return values:

<Free> integer

Range: 0 to INT_MAX
*RST: 1

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory
`BB:ARB:WAV:FREE?`
queries the free disk space in directory

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel?

Queries the filling level of the streaming buffer.

Return values:

<BLevel> integer

Range: 0 to 100
*RST: 0

Example: `SOURce1:BB:ARBitrary:WAVeform:HDDStreaming:STATe 1`
Enables HDD streaming.
`SOURce1:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel?`
Queries the streaming buffer level.
Response: `94%`

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:STATe <State>

Enables/disables the streaming of modulation data directly from the hard drive (HDD).

HDD streaming is recommended for processing of large files that require more ARB memory than the currently installed one.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See [:SOURce<hw>]:BB:ARBitrary:WAVeform:HDDStreaming:BLEVel? on page 388

[:SOURce<hw>]:BB:ARBitrary:WAVeform:POINts?

The command queries the number of samples in the waveform file selected using command `:ARB:WAV:SEL`. Only the file name has to be entered. Only files with the file extension `*.wv` will be read out.

Return values:

<Points> <waveform filename>

Range: 0 to 1000
*RST: 1

Example: `BB:ARB:WAV:POINt?`
queries the number of I/Q values pairs in the waveform file.
`Response: 401`
the waveform file contains 401 I/Q values pairs.

Usage: Query only

[:SOURce<hw>]:BB:ARBitrary:WAVeform:SELect <Filename>

Selects the waveform file. If the file is not on the default path, the path must be specified.

The file extension may be omitted. Only files with the file extension `*.wv` will be created or loaded.

Parameters:

<Filename> string

Example: `BB:ARB:WAV:SEL '/var/user/wave1.wv'`
selects waveform file and loads it.

Manual operation: See "Load Waveform" on page 81

[:SOURce<hw>]:BB:ARBitrary:WAVeform:TAG?

The command queries the content of the specified tag of the selected Waveform file.

Return values:

<Tag> string

Example: `BB:ARB:WAV:SEL '/var/user/wave1.wv'`
selects waveform file and loads it
`BB:ARB:WAV:TAG? 'comment'`
queries the content of the `comment` tag
Response: "Sine wave for test purposes"

Usage: Query only

11.14.4.8 SOURce:BB:ARB:WSEG Subsystem

The `WSEGment` subsystem contains the commands for setting the Multi Segment Waveform Generator.

[:SOURce<hw>]:BB:ARBitrary:WSEGment?

This command queries the currently output segment of the multi segment waveform.

Return values:

<WSegment> integer

Range: 0 to 1023
*RST: 0

Example: `BB:ARB:WSEG?`
queries the currently output segment.
`Response 2`
segment 2 is currently output.

Usage: Query only

Manual operation: See "Current Segment" on page 113

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CLOad <FilenameInput>

Creates a and loads a multi segment waveform using the current entries of the specified configuration file.

This multi segment waveform is saved with the file name specified in the configuration file. The file extension is `*.wv`.

Setting parameters:

<FilenameInput> string

Example:

`MMEM:CDIR '/var/user/'`
sets the default directory.
`BB:ARB:WSEG:CONF:SEL 'multi_sin'`
creates the configuration file `multi_sin.inf_mswv` in the default directory.
`BB:ARB:WSEG:CONF:SEGM:APP 'sinus1'`
includes waveform `sinus1.wv` as segment 1 in the configuration file. The waveform must be available in the default directory.
`BB:ARB:WSEG:CONF:SEGM:APP 'sinus2'`
includes waveform `sinus2.wv` as segment 2 in the configuration file. The waveform must be available in the default directory.
`BB:ARB:WSEG:CONF:OFIL 'mseg1_2'`
defines the file name `mseg1_2.wv` for the multi segment waveform.
`BB:ARB:WSEG:CLO '/var/user/multi_sin.inf_mswv'`
creates multi segment waveform `mseg1_2.wv` using the settings of the configuration file `multi_sin.inf_mswv`.
The new multi segment waveform is loaded.

Usage: Setting only

Manual operation: See " Create " on page 86

[: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:

`SOUR:BB:ARB:WSEG:CONF:SEL "MSegFile"`
selects a multi segment file.
`SOUR:BB:ARB:WSEG:CONF:BLAN:APP 1000,100000000`
adds a blank segment with 1000 samples and 100 MHz clock rate to the selected multi segment file

Usage: Setting only

Manual operation: See " Clock Rate " on page 88

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CATalog?

Queries the available configuration files in the specified default directory. The configuration files are used to create multi segment waveform files.

Return values:

<Catalog> string

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:CAT?`
reads out all the configuration files in the default directory.
`Response: mulit1, multi2`
the directory contains the configuration files `multi1.inf_mswv` and `multi2.inf_mswv`.

Usage: Query only

Manual operation: See " Load List " on page 85

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk <Clock>

This command defines the clock rate used for multi segment waveform output in case of Clock Mode "User" (`:BB:ARB:WSEG:CONF:CLOCk:MODE USER`).

Parameters:

<Clock> float

Increment: 1E-3
*RST: max SampleRate

Example: `BB:ARB:WSEG:CONF:CLOC:MODE USER`
selects Clock Mode User.
`BB:ARB:WSEG:CONF:CLOC 50MHz`
defines a clock rate of 50 MHz.

Manual operation: See " User Clock Rate " on page 90

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk:MODE <Mode>

Selects the clock rate mode for the multi segment waveform.

Parameters:

<Mode> UNCHanged | HIGHest | USER

UNCHanged
The segments are output with the clock rate defined in the waveform file.

HIGHest
The segments are output at the highest available clock rate.

USER
The segments are output with the clock rate defined with command `[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:CLOCk`

*RST: UNCHanged

Example: `BB:ARB:WSEG:CONF:CLOC:MODE UNCH`
selects clock mode unchanged. The segments are output with the clock rate defined in the waveform file.

Manual operation: See " Clock " on page 89

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:COMMent <Comment>

This command enters a comment for the configuration file. The configuration file must be specified with command `:BB:ARB:WSEG:CONF:SEL`.

Parameters:

<Comment> string

Example: `BB:ARB:WSEG:CONF:COMM <3gpp_up>`
enters comment "3gpp_up".

Manual operation: See " Comment " on page 87

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:DELete <Filename>

Deletes the configuration file. The configuration files are used to create multi segment waveform files.

Setting parameters:

<Filename> string

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:DEL 'multi1'`
deletes configuration file `multi1.inf_mswv`.

Usage: Setting only

Manual operation: See " Delete " on page 88

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:LEVel[:MODE] <Mode>

This command selects the level mode for the multi segment waveform.

Parameters:
<Mode> UNCHanged | ERMS

UNCHanged
The segments are output exactly as defined in the files.

ERMS
The segments are output so that all segments have the same rms value.

*RST: UNCHanged

Example: `BB:ARB:WSEG:CONF:LEV:MODE UNCH`
selects level mode unchanged. The segments are output as defined in the waveform file.

Manual operation: See " Level " on page 89

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:ESEGment <Mode>

Enables/disables the generation of an additional marker restart signal in the output waveform file.

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

OFF
No additional marker is generated.

MRK1|MRK2|MRK3|MRK4
Generates a restart marker signal at the beginning of each segment for the corresponding marker.
The segment begin is defined by the low-high slope of the marker. This applies for switching between two segments as well as in case of segment replay.

*RST: OFF

Example:
```
BB:ARB:WSEG:CONF:SEL 'ConfComm'
BB:ARB:WSEG:CONF:MARK:ESEG MRK3
```

Manual operation: See " Segment Restart " on page 90

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:MARKer:FSEGment <Mode>

Enables/disables the generation of an additional marker restart signal in the output waveform file.

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

OFF
No additional marker is generated.

MRK1|MRK2|MRK3|MRK4
Generates a restart marker signal at the beginning of the first segment for the corresponding marker.
Use this setting to generate a restart marker for the complete sequence.

*RST: OFF

Example:
```
BB:ARB:WSEG:CONF:SEL 'ConfComm'
BB:ARB:WSEG:CONF:MARK:FSEG MRK3
```

Manual operation: See " Sequence Restart " on page 90

[: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

IGNore
The marker information carried in the individual segment waveform files is not considered.

TAKE
The output waveform file contains the marker information as configured in the individual waveform files.

*RST: TAKE

Example:
```
BB:ARB:WSEG:CONF:SEL 'ConfComm'
BB:ARB:WSEG:CONF:MARK:MODE TAKE
```

Manual operation: See " Segment Marker " on page 90

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:OFILe <OFile>

Defines the file name for the multi segment waveform. The file extension is `*.wv`.

Parameters:

<OFile> string

Example:
`MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:SEL 'multi1'`
creates the configuration file `multi1.inf_mswv` in default directory.
`BB:ARB:WSEG:CONF:OFIL 'mseg1_2'`
defines the file name `mseg1_2.wv` for the multi segment waveform file created using configuration file `multi1.inf_mswv`.

Manual operation: See " Save List " on page 86

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:APPend <Waveform>

Appends the specified waveform to the configuration file.

Setting parameters:
<Waveform> string

Example:
`MMEM:CDIR '/var/user/waveform'`
sets the default directory
`BB:ARB:WSEG:CONF:SEL 'new'`
creates the configuration file `new.inf_mswv` in the default directory.
`BB:ARB:WSEG:CONF:SEGM:APP 'arb1'`
appends waveform `arb1.wv` to configuration file `new`. Waveform `arb1` will be the first segment of a multi segment waveform created with configuration file `new`.

Usage: Setting only

Manual operation: See " Append " on page 88

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SEGMent:CATalog?

Queries the segments of the currently selected configuration file.

Return values:
<Catalog> string

Example:
`MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:SEL 'multi_sin'`
selects the configuration file `multi_sin.inf_mswv`.
`BB:ARB:WSEG:CONF:SEGM:CAT?`
queries the segments of the selected configuration file.
`Response: arb4, arb2`
The configuration file includes the segments `arb4.wv` and `arb2.wv`.

Usage: Query only

Manual operation: See " Append " on page 88

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CONFigure:SELect <Filename>

Selects the configuration file in the default directory.

A path can also be specified, in which case the files in the specified directory are selected. If a configuration file with the specified name does not yet exist, it is created. The file extension may be omitted. Only files with the file extension `*.inf_mswv` will be selected or created.

Parameters:

<Filename>	string

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:WSEG:CONF:SEL 'new'`
create configuration file `new.inf_mswv` in the default directory.

Manual operation: See " New List " on page 85

[:SOURce<hw>]:BB:ARBitrary:WSEGment:CREate <FilenameInput>

Creates a multi segment waveform using the current settings of the specified configuration file. The multi segment waveform is saved into the file defined in the configuration file. The file extension is `*.wv`.

Setting parameters:

<FilenameInput>	string

Example: `MMEM:CDIR '/var/user/'`
sets the default directory
`BB:ARB:WSEG:CONF:SEL 'new'`
creates the configuration file `new.inf_mswv` in the default directory.
`BB:ARB:WSEG:CONF:SEGM:APP 'arb1.wv'`
'includes waveform `arb1.wv` as segment 1 in the configuration file. The waveform must be available in the default directory.
`BB:ARB:WSEG:CONF:OFIL 'multi_wv1'`
defines the file name `multi_wv1.wv` for the multi segment waveform.
`BB:ARB:WSEG:CRE '/var/user/new.inf_mswv'`
creates multi segment waveform `multi_wv1.wv` using the settings of the configuration file `new.inf_mswv`.

Usage: Setting only

Manual operation: See " Save List " on page 86

[: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`

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NAME?

This command queries the name of the waveform of the currently output segment of the multi segment waveform.

Return values:

<Name> string

Example: `BB:ARB:WSEG:NAME?`
queries the currently output segment.

Usage: Query only

Manual operation: See "Current Segment" on page 113

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT <Next>

Selects the segment to be output.

Parameters:

<Next> float

Range: 0 to 1023
*RST: 0

Example: `MMEM:CDIR '/var/user/waveform'`
sets the default directory.
`BB:ARB:WSEG:NEXT 2`
selects segment 2 to be output.
`BB:ARB:TRIG:SMOD NEXT`
selects extended trigger mode next, i.e. the segment specified with command `:BB:ARB:WSEG:NEXT` will be output.
`BB:ARB:SEQ AUTO`
selects trigger mode Auto.
`BB:ARB:WAV:SEL 'multi_wv1'`
loads multi segment waveform `multi_wv1.wv`. Generation of segment 2 starts.
`BB:ARB:WSEG:NEXT 3`
switched at once to output of segment 3.

Manual operation: See "Next Segment" on page 114

[:SOURce<hw>]:BB:ARBitrary:WSEGment:NEXT:EXECute

Triggers manually switchover to the subsequent segment in the mutli segment file. A manual trigger can be executed only when an internal next segment source (`BB:ARB:WSEG:NEXT:SOUR INT`) has been selected.

To perform a switchover to any segment within the multi segment file, select the next segment with the command `BB:ARB:WSEG:NEXT`.

This command is disabled, if a sequencing play list is enabled.

Example: `BB:ARB:WSEG:NEXT:SOUR INT`
selects internal next segment source.
`BB:ARB:WSEG:NEXT 2`
selects segment 2 to be output.
`BB:ARB:WSEG:NEXT:EXEC`
executes a switchover to the next segment.

Usage: Event

Manual operation: See "Execute Next Segment" on page 118

[: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 .

Parameters:

<Source> INTernal | NEXT

INTernal
Switch over to any segment is triggered manually by means of the command `BB:ARB:WSEG:NEXT:EXEC`.

NEXT
The trigger event for switching to the next segment is input on the NEXT connector.

*RST: INTernal

Example: `BB:ARB:WSEG:NEXT:SOUR INT`
selects internal next segment source.

[: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 65535

<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: `BB:ARB:WSEG:SEQ:SEL '/var/user/play_list_1'`
selects the sequencing list `play_list_1.wvs`.
`BB:ARB:WSEG:SEQ:APP ON,3,15,BLANK`
appends the segment number 3 as a new segment to the sequencing list; this segment is activated and will be repeated 15 times and followed by a blank segment.

Usage: Setting only

Manual operation: See " Append " on page 93

[:SOURce<hw>]:BB:ARBitrary:WSEGment:SEQuence:SELect <Filename>

Selects the sequencing list (files with extension `*.wvs`)

Parameters:
<Filename> string

Example: `BB:ARB:WSEG:SEQ:SEL '/var/user/play_list_1'`
selects the sequencing list `play_list_1.wvs`.

Manual operation: See " Append " on page 93

11.14.5 SOURce:BBIN Subsystem

The `SOURce:BBIN` subsystem contains the commands for setting the external digital baseband signals.

[:SOURce<hw>]:BBIN:ALEVel:EXECute

This command starts measuring the input signal. The measurement estimates the crest factor and the peak power.

Example: `BBIN:ALEV:EXEC`
starts measuring the input signal.

Usage: Event

Manual operation: See "Auto Level Set" on page 240

[:SOURce<hw>]:BBIN:CDEVice?

Digital Input only.

Indicates the ID of an externally connected R&S Instrument or R&S Device.

Return values:
<CDevice> string

Example: `BBIN:CDEV`
queries the connected device ID.

Usage: Query only

Manual operation: See "Connected Device" on page 238

[:SOURce<hw>]:BBIN:CFACtor <CFactor>

This command 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: `BBIN:CFAC 10`
enters a crest factor of 10 dB for the external baseband signal.

Manual operation: See "Crest Factor" on page 241

[:SOURce<hw>]:BBIN:DIGital:ASETting:STATe <State>

Activates automatic adjustment of the baseband input signal.

The R&S SGT receives peak level, level and crest factor values directly from the connected transmitter and recognizes changes automatically.

Parameters:
<State> 0 | 1 | OFF | ON

*RST: 0

Example: `BBIN:DIG:ASET:STAT ON`
switches on automatic adjustment of the baseband input signal.

Manual operation: See "DIG IQ Auto Setting" on page 240

[:SOURce<hw>]:BBIN:FOFFset <FOffset>

Enters the frequency offset for the external baseband signal.

The complex I/Q bandwidth of the shifted useful signal must not exceed the total available baseband bandwidth (see data sheet).

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 242

[:SOURce<hw>]:BBIN:GIMBalance <GImbalance>

This command enters a gain to the Q component of the external baseband signal.

Parameters:
<GImbalance> float

Range: -3 to 3
Increment: 0.001
*RST: 0
Default unit: dB

Example: `BBIN:GIMB -1.0dB`
amplifies the Q component of the external input signal with -1.0 dB.

[:SOURce<hw>]:BBIN:IQSWap[:STATe] <State>

This command swaps the I and Q channel if set to ON.

Parameters:
<State> 0 | 1 | OFF | ON

*RST: 0

Example: `BBIN:IQSW ON`
swaps the I and Q channel of the external baseband signal.

Manual operation: See "I/Q-Swap" on page 238

[:SOURce<hw>]:BBIN:MODE <Mode>

This command selects the external input signal mode for the "Baseband In" block.

Parameters:

<Mode> ANALog | DIGital

ANALog
The external analog baseband signal is supplied via the inputs **I** and **Q**.

DIGItal
The external digital baseband signal is fed into the signal path via the "Digital Input" connector. The internal signal processing is based on a sample rate of 100 MHz. Input signals with a sample rate less than 100 MHz are upsampled. The sample rate can be estimated or defined by the user in the appropriate entry fields.

*RST: ANALog

Example: `BBIN:SOUR ANAL`
selects an external analog signal as the input signal. The signal must be applied at the inputs I and Q.

[:SOURce<hw>]:BBIN:MPERiod <MPeriod>

Sets the recording duration for measuring the baseband input signal by Auto Level Set.

Parameters:

<MPeriod> integer

Range: 1 to 32
*RST: 2
Default unit: s

Example: `BBIN:MPER 4s`
sets the recording duration for Auto Level Set to 4 seconds.

Manual operation: See "Measurement Period" on page 240

[:SOURce<hw>]:BBIN:OFFSet:I <I>
[:SOURce<hw>]:BBIN:OFFSet:Q <Q>

This command enters a DC offset to the Q component of the external baseband signal.

Parameters:

<Q> float

Range: -10 to 10
Increment: 0.001
*RST: 0
Default unit: %FS

Example: `BBIN:OFFS:Q -0.1PCT`
sets -0.1 %FS DC offset to the Q component of the external input signal.

[:SOURce<hw>]:BBIN:OLOad:HOLD:RESet

This command executes a reset of the Overload Hold State and LED.

Example: `BBIN:MODE DIG`
selects the digital baseband input mode.
`BBIN:OLO:HOLD:RES`
resets the overload hold state.

Usage: Event

[:SOURce<hw>]:BBIN:OLOad:HOLD:STATe?

This command queries an overload since the last reset for evaluating the measurement. The Overload Hold state can be reset via the "Reset" command, or is reset automatically by starting a new measurement ("Auto Level Set") or by setting new values (Crest Factor, Peak Level, Level).

Return values:
<State> 0 | 1 | OFF | ON
*RST: 0

Example: `BBIN:MODE DIG`
selects the digital baseband input mode.
`BBIN:OLO:HOLD:STAT?`
queries the overload state.
`Response: 0`
the AC/DC converter has not been overloaded.

Usage: Query only

Manual operation: See "Overflow Hold" on page 241

[:SOURce<hw>]:BBIN:OLOad:STATe?

This command queries the current overload state of the A/D converter.

Return values:
<State> 0 | 1 | OFF | ON
*RST: 0

Example: `BBIN:MODE DIG`
selects the digital baseband input mode.
`BBIN:OLO:STAT?`
queries the overload state.
`Response: 0`
The AC/DC converter is not overloaded.

Usage: Query only

Manual operation: See "Overflow" on page 241

[:SOURce<hw>]:BBIN:ODELay <Delay>

Seds the output delay of the external baseband signal.

Parameters:

<Delay> float

Range: 0 to 1
Increment: 1E-9
*RST: 0

[:SOURce<hw>]:BBIN:PGAin <PGain>

This command enters the relative gain for the external baseband signal compared with the signals of the other baseband sources. The actual gain of the different baseband signals depends not only on the path gain setting but also on the signal characteristics such as the crest factor and on the number of used sources. used and on the total RF output power. The gain affects the signal on the "Baseband" In block output.

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.

[:SOURce<hw>]:BBIN:POWer:PEAK <Peak>

This command enters the 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: `BBIN:POW:PEAK -2`
enters the peak level of -2 dBfs.

Manual operation: See "Peak Level" on page 241

[:SOURce<hw>]:BBIN:POWer:RMS?

This command queries the rms level of the external digital baseband signal.

Return values:

<Rms> float

Range: -100 to 10
Increment: 0.01
*RST: 0

Example: `BBIN:POW:RMS`
queries the estimated rms level.

Usage: Query only

Manual operation: See "Level" on page 241

[:SOURce<hw>]:BBIN:SKEW <Skew>

This command determines the delay between Q and I channel. Positive values represent a delay for Q versus I.

Parameters:

<Skew> float

Range: -1E-9 to 1E-9
Increment: 1E-12
*RST: 0
Default unit: s

Example: `BBIN:SKEW -23PS`
enters a delay between Q and I channel of 23 picoseconds.

[:SOURce<hw>]:BBIN:SRATe[:ACTual] <Actual>

Sets the sample rate of the external digital baseband signal.

Parameters:

<Actual> float

Range: 400 to 200E6
Increment: 0.001
*RST: 100E6

Example: `:SOURce:BBIN:SRATe:ACTual 50E6`

Manual operation: See "Sample Rate Value" on page 239

[:SOURce<hw>]:BBIN:SRATe:SOURce <Source>

This command queries the source for estimating the sample rate of the digital input signal or defining it by the user.

Note: With a connected **R&S EX-IQ-Box** either the internal clock source (User defined) or an external clock (Digital I/Q In) can be selected in the settings dialog of the R&S EX-IQ-Box. Therefore, the sample rate source is only indicated in this field.

Parameters:

<Source> USER | DIN

*RST: USER

Example: `BBIN:SRAT:SOUR`

queries the sample rate mode of the external digital baseband signal.

Manual operation: See "Sample Rate Source" on page 239

[:SOURce<hw>]:BBIN:STATe <State>

This command switches the feeding of an external analog signal into the signal path on/off.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `BBIN:SOUR ANAL`

selects an external analog signal as the input signal. The signal must be applied at the inputs I and Q.

`BBIN:STAT ON`

switches on the Baseband In block. The external analog signal is A/D-converted and fed into the digital signal.

Manual operation: See "State" on page 238

11.14.6 SOURce:BB:IMPairment Subsystem

This subsystem contains the commands for the digital I/Q impairments.

[:SOURce<hw>]:BB:IMPairment:DELay <Delay>

Sets the time delay of both I and Q vectors relative to the selected trigger and marker or relative to the other instrument(s) working in the master-slave synchronous mode.section .

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: -500E-9 to 500E-9
Increment: 1E-12
*RST: 0

Example: `BB:IMP:DEL 32.0E-9`
sets the I/Q delay

Manual operation: See "IQ Delay" on page 141

[:SOURce<hw>]:BB:IMPairment:IQRatio[:MAGNitude] <IqRatio>

This command sets the ratio of I modulation to Q modulation (amplification “imbalance”). 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:IQR 3 PCT`
sets the imbalance to 3 percent.
`BB:IMP:IQR?`
queries the imbalance.
`Response: 0.259000`
the value is returned in dB

Manual operation: See "Gain Imbalance" on page 140

[:SOURce<hw>]:BB:IMPairment:LEAKage:I <I>

This command sets the carrier leakage amplitude for the I-signal component.

Parameters:

<I> float

Range: -10 to 10
Increment: 0.01
*RST: 0
Default unit: PCT

Example: `BB:IMP:LEAK:I 3 PCT`
sets the leakage for the I-component to 3 percent.

Manual operation: See "I/Q Offset" on page 140

[:SOURce<hw>]:BB:IMPairment:LEAKage:Q <Q>

This command sets the carrier leakage amplitude for the Q-signal component.

Parameters:

<Q> float

Range: -10 to 10
Increment: 0.01
*RST: 0
Default unit: PCT

Example: `BB:IMP:LEAK:Q 3 PCT`
sets the leakage for the Q-component to 3 percent.

Manual operation: See "I/Q Offset" on page 140

[:SOURce<hw>]:BB:IMPairment:QUADrature[:ANGLe] <Angle>

This command sets the quadrature offset for the digital I/Q signal.

Parameters:

<Angle> float

Range: -10 to 10
Increment: 0.01
*RST: 0
Default unit: DEG

Example: `BB:IMP:QUAD:ANGL -5DEG`
sets the quadrature offset to -5 degrees.

Manual operation: See "Quadrature Offset" on page 141

[:SOURce<hw>]:BB:IMPairment:SKEW <Skew>

Sets the time offset between the I and Q vectors.

In an I/Q modulator without I/Q skew, the I and Q vectors are aligned to the marker. With an I/Q skew, both vectors are shifted relative to the marker so that the offset of each of the vectors to the marker will be the half of the I/Q skew value.

A positive I/Q skew means that the Q vector delays relative to the I vector and vice versa.

Parameters:

<Skew> float

Range: -500E-9 to 500E-9
Increment: 1E-12
*RST: 0

Example: `BB:IMP:SKEW 410.0E-9`
sets the I/Q skew.

Manual operation: See "Skew " on page 141

[:SOURce<hw>]:BB:IMPairment:STATe <State>

The command activates (ON) and deactivates (OFF) the three impairment or correction values LEAKage, QUADrature and IQRatio for the digital baseband signal prior to input into the I/Q modulator.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: `BB:IMP:STAT OFF`
deactivates digital impairment.

Manual operation: See "State" on page 139

[:SOURce<hw>]:BB:IMPairment:OPTimization:MODE <Mode>

This command sets the optimization mode.

Parameters:

<Mode> FAST | QHIGh

FAST
Optimization is reached by compensation for I/Q skew.

QHIGh
Optimization is reached by compensation for I/Q skew and frequency response correction.

*RST: FAST

Example: `BB:IMP:OPT:MODE FAST`
sets the optimization mode Fast.

Manual operation: See "Optimization Mode" on page 137

[:SOURce<hw>]:BB:IMPairment:OPTimization:STATe <State>

Activates and deactivates internal compensation of signal distortions by the I/Q modulator.

Parameters:

<State> 0 | 1 | OFF | ON

Example: `BB:IMP:OPT:STAT ON`
activates internal compensation of signal distortions.

Manual operation: See "Optimize internal IQ-Impairments for RF Output" on page 141

[:SOURce]:BB:IMPairment:IQOutput<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

Manual operation: See "State" on page 140

[:SOURce]:BB:IMPairment:IQOutput<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: -500E-9 to 500E-9
Increment: 1E-12
*RST: 0

Manual operation: See "IQ Delay" on page 141

[:SOURce]:BB:IMPairment:IQOutput<ch>:QUADrature[:ANGLe] <Angle>

Sets the quadrature offset. 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

Manual operation: See "Quadrature Offset" on page 141

[:SOURce]:BB:IMPairment:IQOutput<ch>:IQRatio[:MAGNitude] <IqRatio>

Sets the ratio of I modulation to Q modulation (amplification imbalance) of the corresponding digital I/Q 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

Manual operation: See "Gain Imbalance" on page 140

[:SOURce]:BB:IMPairment:IQOutput<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 141

[:SOURce]:BB:IMPairment:IQOutput<ch>:LEAKage:I <I>
[:SOURce]:BB:IMPairment:IQOutput<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

Manual operation: See "I/Q Offset" on page 140

11.14.7 SOURce:BB:PROGress Subsystem General Commands

In the R&S SGT, 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.

[: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 413

Usage: Query only

11.14.8 SOURce:BB:POWer Subsystem

This subsystem contains the commands for retrieving the level values of the digital baseband signal.

[:SOURce<hw>]:BB:CFACtor?

This command 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: `BB:CFAC`
queries the crest factor of the baseband signal.

Usage: Query only

[:SOURce<hw>]:BB:POWer:PEAK?

This command queries the peak power 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 power of the baseband signal.

Usage: Query only

[:SOURce<hw>]:BB:POWer:RMS?

This command queries the power 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 power of the baseband signal.

Usage: Query only

11.14.9 SOURce:CORRection Subsystem

The output level is corrected in the `CORRection` subsystem. Correction is performed by user-defined table values being added to the output level for the respective RF frequency. In the R&S SGT, this subsystem is used to select, transfer and activate user correction tables.

Each list is stored as a file. The name of the user correction file can be freely selected. The file extension `*.uco` is assigned automatically and cannot be changed.

The files can be stored in a freely selectable directory and opened from there. The default directory is set using command `:MMEMory:CDIRectory` on page 322. In the case of files which are stored in the default directory, only the file name has to be specified in commands. Otherwise, the complete absolute path has to be specified with every command. The extension can be omitted in any case.

In the following command examples, the files are stored in the default directory.

[:SOURce]:CORRection:CSET:CATalog?

Requests a list of user correction tables. The individual lists are separated by commas.

The lists are stored with the fixed file extensions `*.uco` in a directory of the user's choice. The directory applicable to the commands is defined with the command `MMEMory:CDIR`.

Return values:

<Catalog>	string

Example:	`MMEM:CDIR '/var/user/ucor'`
	selects the directory for the user correction files.
	`CORR:CSET:CAT?`
	queries which correction tables are available.
	Response:`UCOR1,UCOR2,UCOR3`
	the correction tables `UCOR1, UCOR2 and UCOR3` are available.

Usage:	Query only

[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency <Frequency>

Transfers the frequency data to the table selected with `:CORRection:CSET:SELect`.

The numerical suffix at SOURce must not be used for this command.

Parameters:

<Frequency>	Frequency#1[, Frequency#2, ...]
	Range: 300 kHz to RFmax (depending on model)

Example: `CORR:CSET '/var/user/ucor1'`
selects the table `ucor1`.
`CORR:CSET:DATA:FREQ 100MHz,102MHz,103MHz,...`
enters the frequency value in the table `ucor1`.

Manual operation: See " Edit User Cor. Data " on page 213

[:SOURce<hw>]:CORRection:CSET:DATA:FREQuency:POINts?

The command queries the number of frequency values in the selected table.

The numerical suffix at SOURce must not be used for this command.

Return values:

<Points>	integer
	Range: 0 to 10000
	*RST: 0

Example: `CORR:CSET '/var/user/'`
selects the table ucor1.
`CORR:CSET:DATA:FREQ:POIN?`
queries the number of frequency values in the table ucor1.
Response: `440`
the table ucor1 contains 440 frequency values.

Usage: Query only

[:SOURce<hw>]:CORRection:CSET:DATA:POWer <Power>

Transfers the level data to the table selected with `[:SOURce<hw>]:CORRection:CSET[:SELect]`.

`*RST` does not affect data lists. The numerical suffix at `SOURce` must not be used for this command.

Parameters:

<Power>	Power#1[, Power#2, ...]

Example: `CORR:CSET '/var/user/ucor1'`
selects the table `ucor1`.
`CORR:CSET:DATA:POW 1dB, 0.8dB, 0.75dB,...`
enters the level values in the table `ucor1`.

Manual operation: See " Edit User Cor. Data " on page 213

[:SOURce<hw>]:CORRection:CSET:DATA:POWer:POINts?

Queries the number of level values in the selected table.

The numerical suffix at `SOURce` must not be used for this command.

Return values:

<Points> integer

Range: 0 to 10000
*RST: 0

Example: `CORR:CSET '/var/user/ucor1'`
selects the table ucor1.
`CORR:CSET:DATA:POW:POIN?`
queries the number of level values in the table ucor1.
Response: `440`
the table ucor1 contains 440 level values.

Usage: Query only

[:SOURce<hw>]:CORRection:CSET:DATA[:SENSor<ch>][:POWer]:SONCe

The command fills the selected user correction list 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: `CORR:CSET:DATA:SENS:POW:SONC`
fills the user correction list with level values acquired by the power sensor connector to the SENSOR connector.

Usage: Event

Manual operation: See " Fill User Correction Data with Sensor" on page 219

[:SOURce]:CORRection:CSET:DELete <Filename>

Deletes the specified table.

The lists are stored with the fixed file extensions `*.uco` in a directory of the user's choice. The directory applicable to the commands is defined with the command `MMEMory:CDIR`. A path can also be specified in command `SOUR:CORR:CSET:CAT?`, in which case the file in the specified directory is deleted.

Setting parameters:

<Filename> <table name>

Example: `MMEM:CDIR '/var/user/ucor'`
selects the directory for the user correction files.
`CORR:CSET:DEL 'UCOR1'`
deletes the table `ucor1`.

Usage: Setting only

Manual operation: See " User Cor. Data - User Correction " on page 213

[:SOURce<hw>]:CORRection:DEXChange:AFILe:CATalog?

Requests a list of available ASCII files for export/import of user correction data. The individual files are separated by commas.

The ASCII files are stored with the fixed file extensions `*.txt` or `*.csv` in a directory of the user's choice. The directory applicable to the commands is defined with the command `MMEMory:CDIR`.

Return values:

<Catalog>	string

Example:	`MMEM:CDIR '/var/user/import'`
	selects the directory for the ASCII files with frequency and level value pairs.
	`CORR:DEXC:AFIL:EXT TXT`
	selects that ASCII files with extension `*.txt` are listed.
	`CORR:DEXC:AFIL:CAT?`
	queries the available files with extension `*.txt`.
	Response: `'ucor1,ucor2'`
	the ASCII files `ucor1.txt` and `ucor2.txt` are available.

Usage:	Query only

[:SOURce<hw>]:CORRection:DEXChange:AFILe:EXTension <Extension>

Selects the file extension of the ASCII file to be imported or exported. Selection TXT (text file) or CSV (Excel file) is available.

Parameters:

<Extension>	TXT | CSV *RST: TXT

Example:	`MMEM:CDIR '/var/user/import'`
	selects the directory for the ASCII files with frequency and level value pairs.
	`CORR:DEXC:AFIL:EXT TXT`
	selects that ASCII files with extension *.txt are listed.
	`CORR:DEXC:AFIL:CAT?`
	queries the available files with extension *.txt.
	Response: `'list1,list2'`
	the ASCII files `ucor1.txt` and `ucor2.txt` are available.

Manual operation:	See " Extension" on page 216

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SELect <Filename>

Selects the ASCII file to be imported or exported.

The ASCII files are stored with the fixed file extensions `*.txt` or `*.csv` in a directory of the user's choice. The directory applicable to the commands is defined with the command `MMEMory:CDIR`. A path can also be specified in command `SOUR:CORR:DEXC:AFIL:SEL`, in which case the files are stored or loaded in the specified directory.

Parameters:

<Filename> <ascii file name>

Example: `CORR:DEXC:MODE IMP`
selects that ASCII files with frequency and level value pairs are imported and transferred into user correction lists.
`CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`
selects that ASCII file `ucor.csv` is imported.
`CORR:DEXC:SEL '/var/user/import_ucor_imp'`
selects that the ASCII file `ucor.csv` is imported into user correction list `ucor_imp`.

Manual operation: See " Select ASCII Source/Destination " on page 216

[: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: `CORR:DEXC:MODE EXP`
selects that the user correction list is exported into an ASCII file.
`CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`
selects ASCII file ucor.csv as destination for the user correction list data.
`CORR:DEXC:AFIL:SEP:COL TAB`
the pairs of frequency and level values are separated by a tabulator.
`CORR:DEXC:AFIL:SEP:DEC DOT`
selects the decimal separator dot.
`CORR:DEXC:SEL '/var/user/import_ucor_imp'`
selects that the user correction list ucor_imp is imported into ASCII file ucor.csv.

Manual operation: See " Column Separator" on page 216

[:SOURce<hw>]:CORRection:DEXChange:AFILe:SEParator:DECimal <Decimal>

Selects the decimal separator used in the ASCII data between '.' (decimal point) and ',' (comma) with floating-point numerals.

Parameters:

<Decimal> DOT | COMMa

*RST: DOT

Example: `CORR:DEXC:MODE EXP`
selects that the user correction list is exported into an ASCII file.
`CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`
selects ASCII file ucor.csv as destination for the user correction list data.
`CORR:DEXC:AFIL:SEP:COL TAB`
the pairs of frequency and level values are separated by a tabulator.
`CORR:DEXC:AFIL:SEP:DEC DOT`
selects the decimal separator dot.
`CORR:DEXC:SEL '/var/user/import_ucor_imp'`
selects that the user correction list `ucor_imp` is imported into ASCII file `ucor.csv`.

Manual operation: See " Decimal Point" on page 216

[:SOURce<hw>]:CORRection:DEXChange:EXECute

Starts the export or import of the selected file. When import is selected, the ASCII file is imported as user correction list. When export is selected, the user correction list is exported into the selected ASCII file.

Example: `CORR:DEXC:MODE IMP`
selects that ASCII files with frequency and level value pairs are imported and transferred into user correction lists.
`CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`
selects that ASCII file ucor.csv is imported.
`CORR:DEXC:SEL '/var/user/import_ucor_imp'`
selects that the ASCII file `ucor.csv` is imported into user correction list `ucor_imp`.
`CORR:DEXC:EXEC`
starts the import of the ASCII file data into the user correction file.

Usage: Event

Manual operation: See " Import/Export " on page 216

[:SOURce<hw>]:CORRection:DEXChange:MODE <Mode>

Selects if user correction lists should be imported or exported. Depending on the selection her, the file select command define either the source or the destination for user correction lists and ASCII files.

Parameters:

<Mode> IMPort | EXPort

*RST: IMPort

Example: `CORR:DEXC:MODE IMP`
selects that ASCII files with frequency and level value pairs are imported and transferred into user correction lists.
`CORR:DEXC:AFIL:SEL '/var/user/ucor.csv'`
selects that ASCII file ucor.csv is imported.
`CORR:DEXC:SEL '/var/user/ucor_imp'`
selects that the ASCII file `ucor.csv` is imported into user correction list `ucor_imp`.

Manual operation: See " Mode - User Correction" on page 215

[:SOURce<hw>]:CORRection:DEXChange:SELect <Filename>

Selects the user correction list to be imported or exported.

The user correction files are stored with the fixed file extensions `*.uco` in a directory of the user's choice. The directory applicable to the commands is defined with the command `MMEMory:CDIR`. A path can also be specified in command `SOUR:CORR:DEXC:SEL`, in which case the files are stored or loaded in the specified directory.

Parameters:
<Filename> string

Example: `CORR:DEXC:MODE IMP`
selects that ASCII files with frequency and level value pairs are imported and transferred into user correction lists.
`CORR:DEXC:AFIL:SEL '/var/user/import_ucor.csv'`
selects that ASCII file ucor.csv is imported.
`CORR:DEXC:SEL '/var/user/import_ucor_imp'`
selects that the ASCII file `ucor.csv` is imported into user correction list `ucor_imp`.

Manual operation: See " Select Destination/Source " on page 216

[: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 11.9.2, "Extensions for User Files", on page 320.

To determine the file location (directory/path) you can either enter it with the command directly, or use the command `MMEMory:CDIR`.

To activate level correction use the command `[:SOURce<hw>]:CORRection[:STATe]`.

Parameters:
<Filename> <table name>

Example: `CORR:CSET '/var/user/ucor1'`
selects the table `ucor1`.
`CORR ON`
activates level correction. Correction is performed using the table `ucor1`.

Manual operation: See " User Cor. Data - User Correction " on page 213

[:SOURce<hw>]:CORRection[:STATe] <State>

Activates/deactivates level correction. Level correction is performed using the table which has been selected with the command `[:SOURce<hw>]:CORRection:CSET[:SELect]`.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Example: `SOUR:CORR:CSET '/var/user/ucor1'`
selects the table `ucor1`.
`SOUR:CORR ON`
activates user correction.

Manual operation: See " State " on page 213

[: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: `CORR:VAL?`
queries the value currently used for level correction.
Response: `-3`
the correction value is - 3 dB.

Usage: Query only

Manual operation: See " User Correction " on page 213

[: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

Manual operation: See " Fill User Correction Data with Sensor" on page 219

11.14.10 SOURce:IQ Subsystem

This subsystem contains the commands for checking the I/Q modulation.

[:SOURce]:IQ:CREStfactor <CrestFactor>

Sets the crest factor of the IQ modulation signal.

Parameters:

<CrestFactor> float

Range: 0 to 35
Increment: 0.01
*RST: 0

Manual operation: See "Crest Factor" on page 138

[:SOURce]:IQ:IMPairment:IQRatio[:MAGNitude] <IqRatio>

Sets the ratio of I modulation to Q modulation (amplification “imbalance”). 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-3
*RST: 0

Manual operation: See "Gain Imbalance" on page 139

[:SOURce]:IQ:IMPairment:LEAKage:I <I>
[:SOURce]:IQ:IMPairment:LEAKage:Q <Q>

Sets the carrier leakage amplitude for the Q-signal component.

Parameters:

<Q>	float	
	Range:	-10 to 10
	Increment:	0.01
	*RST:	0

Manual operation: See "I/Q Offset" on page 139

[:SOURce]:IQ:IMPairment:QUADrature[:ANGLe] <Angle>

Sets the quadrature offset for the digital I/Q signal.

Parameters:

<Angle>	float	
	Range:	-10 to 10
	Increment:	0.01
	*RST:	0

Manual operation: See "Quadrature Offset" on page 139

[:SOURce]:IQ:IMPairment[:STATe] <State>

Activates/ deactivates the three impairment or correction values LEAKage, QUADrature and IQRatio for the baseband signal prior to input into the I/Q modulator.

Parameters:

<State>	0 | 1 | OFF | ON	
	*RST:	0

[:SOURce]:IQ:IMPairment:SWAP[:STATe] <State>

When set to ON, this command swaps the I and Q channel for an external modulation signal.

Parameters:

<State>	0 | 1 | OFF | ON	
	*RST:	0

Manual operation: See "I/Q Swap" on page 136

[:SOURce]:IQ:STATe <State>

Switches the I/Q modulation on and off.

Parameters:

<State>	0 | 1 | OFF | ON	
	*RST:	0

Manual operation: See "I/Q Mod State" on page 60

[:SOURce]:IQ:SOURce <Source>

Sets the input signal for the I/Q modulator.

Parameters:

<Source> ANALog | BASeband

*RST: 0

Manual operation: See "IQ Source" on page 136

[:SOURce<hw>]:IQ:SWAP[:STATe] <State>

When set to ON, this command 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 136

[:SOURce]:IQ:WBSTate <State>

Selects optimized settings for wideband modulation signals.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Manual operation: See "I/Q Wideband" on page 137

11.14.11 SOURce:IQ:OUTPut Subsystem

[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe <State>

Activates the specified analog I/Q output.

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 142

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:PRESet

Sets the default settings (`*RST` values specified for the commands).

Not affected are:

- The state set with the command `[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe`.
- If `SCONfiguration:EXTernal:PBEHaviour 1`, the I/Q ouptput type set with the command `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE`.

Usage:	Event
Manual operation:	See "Set to Default" on page 142

[: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 143

[: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>	"<filename>" Filename or complete file path
Usage:	Setting only
Manual operation:	See "Save/Recall" on page 143

[: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> "<filename>"

Filename or complete file path

Usage: Setting only

Manual operation: See "Save/Recall" on page 143

[: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> "<filename>"

Filename or complete file path

Usage: Setting only

Manual operation: See "Save/Recall" on page 143

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE <Type>

Sets 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 143

[: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 144

[: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 7-4.

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 144

[: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 7-4.

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 144

[: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 144

[: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 145

11.14.12 Analog I/Q Output

This section describes the commands of the output of an analog I/Q signal.

[:SOURce<hw>]:IQ:OUTPut:ANALog:STATe <State>

Activates the specified analog I/Q output.

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 142

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:TYPE <Type>

Sets 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 143

[: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 144

[: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 7-4.

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 144

[: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 7-4.

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 144

[: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 144

[: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 145

11.14.13 SOURce:IQ:OUTPut:ENVelope Commands

The following remote control commands require software option R&S SGT-K540.

Example: Generating an RF envelope signal and defining the shaping function

```
// define the RF level and frequency
SOURce1:FREQuency:CW 2143000000
SOURce1:POWer:LEVel:IMMediate:AMPLitude -15
SOURce1:POWer:LEVel:IMMediate:OFFSet 0.5
SOURce1:CORRection:VALue?
// Response: 1

// enable RF envelope generation and define the settings
SOURce1:IQ:OUTPut:ANALog:ENVelope:STATe 1
SOURce1:IQ:OUTPut:ANALog:ENVelope:ADAPtion AUTO
SOURce1:IQ:OUTPut:ANALog:TYPE DIFF
SOURce1:IQ:OUTPut:ANALog:ENVelope:ETRak USER
SOURce1:IQ:OUTPut:ANALog:ENVelope:VREF VCC
SOURce1:IQ:OUTPut:ANALog:ENVelope:POWer:OFFSet?
// Response: 1.5

SOURce1:IQ:OUTPut:ANALog:ENVelope:VPP:MAX 4
SOURce1:IQ:OUTPut:ANALog:ENVelope:GAIN 0
SOURce1:IQ:OUTPut:ANALog:ENVelope:EMF:STATe 1
SOURce1:IQ:OUTPut:ANALog:ENVelope:RIN 50
SOURce1:IQ:OUTPut:ANALog:ENVelope:TERMination GROund
SOURce1:IQ:OUTPut:ANALog:ENVelope:BINPut 1
SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:OFFSet 2

SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:MIN 0.5
SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:MAX 2.5

SOURce1:IQ:OUTPut:ANALog:ENVelope:BIAS 0
SOURce1:IQ:OUTPut:ANALog:ENVelope:OFFSet -2
SOURce1:IQ:OUTPut:ANALog:ENVelope:VOUT:MAX?
// Response: 0.5
SOURce1:IQ:OUTPut:ANALog:ENVelope:VOUT:MIN?
// Response: -1.5

SOURce1:IQ:OUTPut:ANALog:ENVelope:PIN:MIN -30
SOURce1:IQ:OUTPut:ANALog:ENVelope:PIN:MAX 0

SOURce1:IQ:OUTPut:ANALog:ENVelope:DELay 0.00000000001
SOURce1:IQ:OUTPut:ANALog:ENVelope:FDPD OFF

// enable envelope shaping
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:MODE DETR
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:DETRoughing:FUNCtion F3
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:DETRoughing:COUPling OFF
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:DETRoughing:FACtor 0.225
// SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:DETRoughing:PEXPonent 1

// quering the oprating point level, current PEP and levels
// SOURce1:IQ:OUTPut:ANALog:ENVelope:ADAPtion?
// Response: Auto
```

```
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue:LEVel?
// Response: 0.927
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue:PEP?
// Response: 1.922
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue? 1,NORM,VOLT
// Response: 2.5
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue? 0,NORM,VOLT
// Response: 0.563
// SOURce1:IQ:OUTPut:ANALog:ENVelope:PIN:MAX?
// Response: 0
// SOURce1:IQ:OUTPut:ANALog:ENVelope:PIN:MIN?
// response: -30
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue? 0,DBM,POW
// Response: 2.5
// SOURce1:IQ:OUTPut:ANALog:ENVelope:VCC:VALue? -30,DBM,POW
// Response: 0.563

SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:MODE TABL
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:PV:FILE:CATalog?
// Response: myLUT_pv
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:PV:FILE:SELect "/var/user/myLUT_pv.iq_lutpv"
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:INTerp LIN
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:SCALe POWer

// change the envelope shaping mode
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:MODE POLY
// query files with polynomial functions in the default user directory
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients:CATalog?
// Response: env_poly_evm,myPoly
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients:LOAD "myPoly"
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients?
// Response: 0.135,0.82
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients 0.135,0.83
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:COEFficients:STORe "/var/user/myPoly.iq_poly"

// enable the outputs
SOURce1:IQ:OUTPut:ANALog:STATe 1
OUTPut1:STATe 1

// store the settings
MMEMory:CDIRectory "/var/user/setups"
SOURce1:IQ:OUTPut:ANALog:SETTings:CATalog?
// Response: etrak_v1-2
SOURce1:IQ:OUTPut:ANALog:SETTings:STORe "my_ET"

SOURce1:IQ:OUTPut:ANALog:PREset
// change the envelope voltage adaptation mode
SOURce1:IQ:OUTPut:ANALog:ENVelope:ADAPtion MAN

SOURce1:IQ:OUTPut:LEVel 4
```

```
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:GAIN:PRE -3
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:GAIN:POST 2.5

// change the envelope shaping mode
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:MODE TABL
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:FILE:CATalog?
// Response: myLUT_vv
SOURce1:IQ:OUTPut:ANALog:ENVelope:SHAPing:FILE:SELect "/var/user/myLUT_vv.iq_lut"

// set the shaping values in raw format
// SOURce1:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:DATA  0,0, 0.1,0.2, 1,1
// SOURce1:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:CATalog?
// Response: myLUT_vv
// set the shaping values and store them into a file
// SOURce1:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:NEW "LUT_vv_raw", 0,0, 0.1,0.2, 1,1.5
// SOURce1:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:CATalog?
// Response: myLUT_vv, LUT_vv_raw
```

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:STATe <State>

Enables the output of a control signal that follows the RF envelope.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "RF Envelope" on page 159

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:ADAPtion <AdaptionMode>

Defines the envelope voltage adaption mode.

Parameters:

<AdaptionMode> AUTO | MANual | POWer
`AUTO` = Auto Normalized, `POWer` = Auto Power, `MANual` = Manual
*RST: AUTO

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Envelope Voltage Adaptation" on page 159

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:ETRak <ETrakIfcType>

Selects one of the predefined interface types or allows user-defined settings.

See Table 7-5.

Parameters:

<ETrakIfcType> USER | ET1V2 | ET1V5 | ET2V0

*RST: USER

Example: `SOURce1:IQ:OUTPut:ANALog:ENVelope:ETRak ET2V0`

Manual operation: See "eTrak® Interface Type" on page 160

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VREF <VoltageReferenc>

Defines whether the envelope voltage V_{out} is set directly or it is estimated from the selected supply voltage V_{cc}.

Parameters:

<VoltageReferenc> VCC | VOUT

*RST: VCC

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Envelope Voltage Reference" on page 160

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:DELay <Delay>

Enables a time delay of the generated envelope signal relative to the corresponding RF signal.

Parameters:

<Delay> float

Range: -500E-9 to 500E-9
Increment: 1E-12
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Envelope to RF Delay" on page 166

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:FDPD <CalcFromDpdStat>

Enables calculation of the envelope from predistorted signal.

Parameters:

<CalcFromDpdStat> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Options: R&S SGT-K540/K541

Manual operation: See "Calculate Envelope form Predistorted Signal" on page 167

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VOUT:MIN <VoutMin>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VOUT:MAX <VoutMax>

Queries the minimum and maximum values of the estimated envelope output voltage V_{out}.

Parameters:

<VoutMax> float

Range: 0.04 to 8
Increment: 1E-3
*RST: 1

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "V_{out}Min/Max" on page 160

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:BIAS <Bias>

Sets a bias.

Parameters:

<Bias> float

Range: -4 to 4
Increment: 1E-4
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Bias" on page 161

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:OFFSet <Offset>

Sets an offset between the envelope and the inverted envelope signal.

Parameters:

<Offset> float

Range: -4 to 4
Increment: 1E-4
*RST: 0
Default unit: mV

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Offset" on page 161

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VPP[:MAX] <VppMax>

Set the maximum value of the driving voltage V_{pp} of the used external DC modulator.

Parameters:

<VppMax> float

Range: 0.04 to 8
Increment: 1E-3
*RST: 1

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "V_{pp}Max" on page 163

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:EMF[:STATe] <EmfState>

Defines whether the EMF or the voltage value is used.

Parameters:

<EmfState> 0 | 1 | OFF | ON

*RST: 1

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "EMF" on page 162

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:RIN <InputResistance>

Sets the input impedance R_{in} of the used external DC modulator.

Parameters:

<InputResistance> float

Range: 50|100 to 1E6
Increment: 0.1
*RST: 50

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "R_{in}" on page 162

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:TERMination <Termination>

Sets how the inputs of the DC modulator are terminated.

Parameters:

<Termination> GROund | WIRE

*RST: GROund

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Termination" on page 162

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:BINPut <BipolarInput>

Enables the generation of a bipolar signal.

Parameters:

<BipolarInput> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Bipolar Input" on page 163

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:GAIN <Gain>

Sets the gain of the used external DC modulator.

Parameters:

<Gain> float

Range: -50 to 50
Increment: 0.01
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Gain" on page 163

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:OFFSet <VccOffset>

Applies a voltage offset on the supply voltage V_{cc}.

Parameters:

<VccOffset> float

Range: 0 to 10
Increment: 1E-3
*RST: 0
Default unit: mV

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "V_{cc}Offset" on page 164

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:MIN <VccMin>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:MAX <VccMax>

Sets the maximum value of the supply voltage V_{cc}.

Parameters:

<VccMax> float

Range: 0.04 to 8
Increment: 0.001
*RST: 1

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "V_{cc}Min/Max" on page 164

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue:PEP?

Queries the Vcc value of the current PEP of the generated RF signal.

Return values:

<VccForCrtPep> float

Range: 0 to 38
Increment: 1E-3
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Usage: Query only

Manual operation: See "Diagram" on page 175

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue:LEVel?

Queries the Vcc value of the current RMS power level (operating point).

Return values:

<VccForRfLevel> float

Range: 0 to 38
Increment: 1E-3
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Usage: Query only

Manual operation: See "Diagram" on page 175

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:VCC:VALue? <xValue>, <xUnit>, <xScale>

Queries the V_{CC} value for the selected `<xValue>`.

Query parameters:

<xValue> float

Value on the x-axis
Value range depends on the selected "Envelope Voltage Adaptation" and PEP_{in}Min and PEP_{in}Max values.

<xUnit> NORMalized | DBM | V

*RST: NORMalized

<xScale> VOLTage | POWer

*RST: VOLTage

Return values:

<VccValue> float

Range: 0 to 38
Increment: 1E-3
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Usage: Query only

Manual operation: See "Diagram" on page 175

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:PIN:MIN <PinMin>

Sets the minimum value of the input power P_{in}.

Parameters:

<PinMin> float

Range: -145 to 20
Increment: 0.01
*RST: -30

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "PEP_{in}Min/Max" on page 165

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:PIN:MAX <PinMax>

Sets the maximum value of the input power P_{in}.

Parameters:

<PinMax> float

Range: -145 to 20
Increment: 0.01
*RST: -20

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "PEP$_{in}$Min/Max" on page 165

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:POWer:OFFSet?

Queries the current power offset, that is the sum of enabled "RF Level > Offset" and "User Correction".

Return values:

<PowerOffset> float

Range: -200 to 200
Increment: 0.01
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Usage: Query only

Manual operation: See "Power Offset" on page 165

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:MODE <ShapingMode>

Enables envelope shaping and selects the method to define the shaping function.

Parameters:

<ShapingMode> OFF | LINear | TABLe | POLYnomial | DETRoughing | POWer

`LINear` = Linear (Voltage)
`POWer` = Linear (Power)

*RST: OFF

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Shaping" on page 169

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:SCALe <Scale>

Determines the units used on the x and y axis.

Parameters:

<Scale> POWer | VOLTage

*RST: VOLTage

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Scale" on page 175

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:GAIN:PRE <PreGain>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:GAIN:POST <PostGain>

Sets a post-gain.

Parameters:

<PostGain> float

Range: -3 to 20
Increment: 1E-2
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Post-Gain" on page 173

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:CATalog?
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:CATalog?

Queries the available table shaping files in the default directory. Only files with the file extension `*.iq_lut` or `*.iq_lutpv` are listed.

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Usage: Query only

Manual operation: See "Shaping Table" on page 173

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE[:SELect] <Filename>
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE[:SELect] <Filename>

Selects an envelope shaping file (extension `*.iq_lut` or `*.iq_lutpv`).

Parameters:

<Filename> string

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Shaping Table" on page 173

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:DATA <Vin/Vmax>,<Vcc/Vmax>[,<Vin/Vmax>,<Vcc/Vmax>...]
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:DATA

Defines the shaping function in a raw data format.

See also `[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:NEW` on page 444.

Parameters:

<P>,<Vcc>	Sequence of up to 4000 comma-separated value pairs.
Example:	See Example "Generating an RF envelope signal and defining the shaping function" on page 432

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:FILE:NEW
[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:PV:FILE:NEW <Filename>,<P>,<Vcc>

Stores the shaping values into a file with the selected file name and loads it.

The file is stored in the default directory or in the directory specified with the absolute file path. If the file does not yet exist, a new file is created. The file extension is assigned automatically.

Setting parameters:

<Filename>	string
<P>,<Vcc>	value pairs
Example:	See Example "Generating an RF envelope signal and defining the shaping function" on page 432
Usage:	Setting only

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:INTerp <Interpolation>

For envelope shaping with shaping tables, enables linear interpolation.

Parameters:

<Interpolation>	OFF | LINear | POWer `LINear` = Linear (Voltage) `POWer` = Linear (Power) *RST: OFF
Example:	See Example "Generating an RF envelope signal and defining the shaping function" on page 432
Manual operation:	See "Interpolation" on page 174

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients

Sets the polynomial coefficients.

Example:	See Example "Generating an RF envelope signal and defining the shaping function" on page 432
Manual operation:	See "Polynomial Order" on page 178

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:CATalog?

Queries the available polynomial files in the default directory. Only files with the file extension `*.iq_poly` are listed.

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Usage: Query only

Manual operation: See "Save/Recall Polynomial" on page 178

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:STORe <Filename>

Saves the polynomial function as polynomial file.

Setting parameters:

<Filename> string

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Usage: Setting only

Manual operation: See "Save/Recall Polynomial" on page 178

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:COEFficients:LOAD <Filename>

Loads the selected polynomial file.

Setting parameters:

<Filename> string

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Usage: Setting only

Manual operation: See "Save/Recall Polynomial" on page 178

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:CLIPping:FROM <ClippingFrom>

Enables clipping and defines its limits.

Parameters:

<ClippingFrom> integer

Range: 0 to 100
*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:CLIPping:TO <ClippingTo>

Enables clipping and defines its limits.

Parameters:

<ClippingTo> integer

Range: 0 to 100
*RST: 100

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:FUNCtion <DetrFunction>

Sets the detroughing function.

Parameters:

<DetrFunction> F1 | F2 | F3

*RST: F1

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Detroughing Function" on page 172

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:COUPling <CouplingState>

Enables/disables deriving the detroughing factor (d) from the selected V_{cc} value.

Parameters:

<CouplingState> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Couple Detroughing Factor with Vcc" on page 172

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing:FACTor <DetrFactor>

Sets the detroughing factor.

Parameters:

<DetrFactor> float

Range: 0 to 2
Increment: 1E-3
*RST: 0.2

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Detroughing Factor (d)" on page 173

[:SOURce<hw>]:IQ:OUTPut[:ANALog]:ENVelope:SHAPing:DETRoughing: PEXPonent <PowerExponent>

Sets the exponent (a) for the detroughing function `F3`.

Parameters:

<PowerExponent> float

Range: 1 to 10
Increment: 1E-3
*RST: 2

Example: See Example "Generating an RF envelope signal and defining the shaping function" on page 432

Manual operation: See "Exponent (a)" on page 173

11.14.14 SOURce:IQ:DPD Subsystem

The `SOURce:IQ:DPD` subsystem contains the commands for enabling and configuring of digital predistortion.

Example: Defining correction coefficients and enabling digital predistortion

```
*RST



SOURce1:IQ:DPD:PIN:MIN -35
SOURce1:IQ:DPD:PIN:MAX -2.5

// select look-up table files with correction values
SOURce1:IQ:DPD:SHAPing:MODE TABLe
SOURce1:IQ:DPD:SHAPing:TABLe:AMAM:FILE:CATalog?
// Response: My_DPD_AM-AM,MyDPD_AM-AM
SOURce1:IQ:DPD:SHAPing:TABLe:AMAM:FILE:SELect "My_DPD_AM-AM"
SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?
// Response: My_DPD_AM-PM,MyDPD_AM-PM
SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:SELect "My_DPD_AM-PM"
SOURce1:IQ:DPD:SHAPing:TABLe:INTerp LINer
SOURce1:IQ:DPD:SHAPing:TABLe:INVert?
// Response: 0

// enable digital predistortion
SOURce1:IQ:DPD:AMPM:AMFirst 1
SOURce1:IQ:DPD:AMAM:STATe 1
SOURce1:IQ:DPD:AMPM:STATe 1
```

```
SOURce1:IQ:DPD:LREFerence BDPD
SOURce1:IQ:DPD:STATe 1

// enable the output
SOURce1:IQ:STATe 1
OUTPut1:STATe 1

// query the PEP, level and crest factor values before and after the DPD
SOURce1:IQ:DPD:INPut:PEP?
// Response: -3.43
SOURce1:IQ:DPD:INPut:LEVel?
// Response: -15
SOURce1:IQ:DPD:INPut:CFACtor?
// Response: 11.57

SOURce1:IQ:DPD:OUTPut:PEP?
SOURce1:IQ:DPD:OUTPut:LEVel?
SOURce1:IQ:DPD:OUTPut:CFACtor?

// change level reference and
// query the PEP, level and crest factor values before and after the DPD
SOURce1:IQ:DPD:LREFerence ADPD
SOURce1:IQ:DPD:OUTPut:ERRor:MAX 0.1
SOURce1:IQ:DPD:OUTPut:ITERations:MAX 3
SOURce1:IQ:DPD:MEASurement:STATe?
// Response: 1
SOURce1:IQ:DPD:OUTPut:ERRor?
// Response: 0
SOURce1:IQ:DPD:OUTPut:PEP?
// Response: -3.57
SOURce1:IQ:DPD:OUTPut:LEVel?
// Response: -15
SOURce1:IQ:DPD:OUTPut:CFACtor?
// Response: 11.43

// enable static DPD and set the pre-gain
// SOURce1:IQ:DPD:LREFerence SDPD
// SOURce1:IQ:DPD:GAIN:PRE -18
// set the predistorion values in raw format
// SOURce1:IQ:DPD:SHAPing:TABLe:AMAM:FILE:DATA -30.4,-5.2, -25.1,-4.5, -18.5,-2.5, -10.5,-1
// SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:DATA -30.4, -5, -25.1, 5, -10, 0
// SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?
// Response: My_DPD_AM-PM,MyDPD_AM-PM
// set the predistorion values and store them into a file
// SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:NEW "DPD_AM-PM_raw", -30.4, -5, -25.1, 5, -10, 0
// SOURce1:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?
// Response: My_DPD_AM-PM,MyDPD_AM-PM,DPD_AM-PM_raw
// SOURce1:IQ:DPD:AMPM:VALue:PEP?
// Response: 4.255
// SOURce1:IQ:DPD:AMPM:VALue:VALue? -30,DBM
```

```
// Response:-4.439

// change the shaping mode
SOURce1:IQ:DPD:SHAPing:MODE POLYnomial
// query files with polynomial functions in the default user directory
SOURce1:IQ:DPD:SHAPing:POLYnomial:COEFficients:CATalog?
// Response: MyDTD_Poly,myDTD_Poly4th
SOURce1:IQ:DPD:SHAPing:POLYnomial:COEFficients:LOAD "MyDTD_Poly4th"
SOURce1:IQ:DPD:SHAPing:POLYnomial:COEFficients?
// Response: 0,0,-0.25,0.2,0.6,-0.3,0.3,0.3,0.5,-0.4
SOURce1:IQ:DPD:SHAPing:POLYnomial:COEFficients:STORe "/var/user/myPoly.dpd_poly"
```

[:SOURce<hw>]:IQ:DPD:STATe <State>

Enabels/disables the generation of digitally pre-distorted signals.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Manual operation: See "State" on page 185

[:SOURce<hw>]:IQ:DPD:PRESet

Sets the default DPD settings (`*RST` values specified for the commands).

Not affected is the state set with the command `[:SOURce<hw>]:IQ:DPD:STATe`.

Usage: Event

Manual operation: See "Set to Default" on page 185

[:SOURce<hw>]:IQ:DPD:SETTing:CATalog?

Queries the files with digital predistortion setting in the default directory. Listed are files with the file extension `*.dpd`.

Return values:

<Catalog> "<filename1>,<filename2>,..."

Returns a string of file names separated by commas.

Usage: Query only

Manual operation: See "Save/Recall" on page 186

[:SOURce<hw>]:IQ:DPD:SETTing:DELete <Filename>

Deletes the selected file from the default or specified directory. Deleted are files with the file extension `*.dpd`.

Setting parameters:

<Filename> "<filename>"

Filename or complete file path

Usage: Setting only

Manual operation: See "Save/Recall" on page 186

[:SOURce<hw>]:IQ:DPD:SETTing:LOAD <Filename>

Loads the selected file from the default or the specified directory. Loaded are files with extension `*.dpd`.

Setting parameters:

<Filename> "<filename>"

Filename or complete file path

Usage: Setting only

Manual operation: See "Save/Recall" on page 186

[:SOURce<hw>]:IQ:DPD:SETTing:STORe <Filename>

Stores the current settings into the selected file; the file extension (`*.dpd`) is assigned automatically.

Setting parameters:

<Filename> "<filename>"

Filename or complete file path

Usage: Setting only

Manual operation: See "Save/Recall" on page 186

[:SOURce<hw>]:IQ:DPD:AMAM:STATe <State>
[:SOURce<hw>]:IQ:DPD:AMPM:STATe <State>

Enabels/disables the AM/AM and AM/PM digital predistortion.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Manual operation: See "AM/AM and AM/PM State" on page 187

[:SOURce<hw>]:IQ:DPD:AMFirst <AmAmFirstState>

Sets that the AM/AM predistortion is applied before the AM/PM.

Parameters:

<AmAmFirstState>	0 | 1 | OFF | ON *RST: 0
Example:	See Example "Defining correction coefficients and enabling digital predistortion" on page 447
Manual operation:	See "AM/AM First" on page 186

[:SOURce<hw>]:IQ:DPD:LREFerence <LevelReference>

Sets whether a dynamic (`BDPD|ADPD`) or a static (`SDPS`) adaptation of the range the selected DPD is applied on.

Parameters:

<LevelReference>	BDPD | ADPD | SDPD *RST: BDPD
Example:	See Example "Defining correction coefficients and enabling digital predistortion" on page 447
Manual operation:	See "Level Reference" on page 186

[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor?

Queries the resulting level error.

Return values:

<AchievedError>	float
Example:	see Example "Defining correction coefficients and enabling digital predistortion" on page 447
Usage:	Query only
Manual operation:	See "Achieved Output Level Error" on page 187

[:SOURce<hw>]:IQ:DPD:OUTPut:ERRor:MAX <MaximumError>

Sets the allowed maximum error.

Parameters:

<MaximumError>	float Range: 0.01 to 1 Increment: 0.01 *RST: 0.1
Example:	see Example "Defining correction coefficients and enabling digital predistortion" on page 447
Manual operation:	See "Maximum Output Level Error" on page 186

[:SOURce<hw>]:IQ:DPD:OUTPut:ITERations:MAX <MaxIterations>

Sets the maximum number of performed iterations to achieving the required error set with [:SOURce<hw>]:IQ:DPD:OUTPut:ERRor:MAX.

Parameters:

<MaxIterations>	integer	
	Range:	1 to 10
	*RST:	3

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

[:SOURce<hw>]:IQ:DPD:MEASurement:STATe?

Queries whether the interactions are competed.

Return values:

<MeasureValidity>	0 | 1 | OFF | ON	
	*RST:	1

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Query only

[:SOURce<hw>]:IQ:DPD:INPut:CFACtor?
[:SOURce<hw>]:IQ:DPD:OUTPut:CFACtor?
[:SOURce<hw>]:IQ:DPD:INPut:LEVel?
[:SOURce<hw>]:IQ:DPD:OUTPut:LEVel?
[:SOURce<hw>]:IQ:DPD:INPut:PEP?
[:SOURce<hw>]:IQ:DPD:OUTPut:PEP?

Queries the measured values the before and after the enabled digital predistortion.

Return values:

<PEP> float

The query returns `-1000` if the calculation is impossible or there are no measurements results available.

Example: see Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Query only

Manual operation: See "Input/Output PEP, Level and Crest Factor" on page 187

[:SOURce<hw>]:IQ:DPD:PIN:MIN <PepInMin>
[:SOURce<hw>]:IQ:DPD:PIN:MAX <PepInMax>

Sets the value range of the input power.

Parameters:

<PepInMax> float

Range: -145 to 20
Increment: 0.01
*RST: 10

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Manual operation: See "Input Range (PEP_{in})" on page 190

[:SOURce<hw>]:IQ:DPD:GAIN:PRE <PreGain>

Sets a pre-gain (i.e. an attenuation) to define the range the static DPD is applied in.

Parameters:

<PreGain> float

Range: -50 to 20
Increment: 1E-2
*RST: 0

Example: see Example "Defining correction coefficients and enabling digital predistortion" on page 447

Manual operation: See "Pre-Gain" on page 190

[:SOURce<hw>]:IQ:DPD:SHAPing:MODE <Shaping>

Selects the method to define the correction coefficients.

Parameters:

<Shaping> TABLe | POLYnomial | NORMalized

*RST: TABLe

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Manual operation: See "Shaping" on page 188

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:CATalog?
[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:CATalog?

Queries the available table files in the default directory. Only files with the extension `*.dpd_magn`(AM/AM) or `*.dpd_phase`(AM/PM) are listed.

Return values:

<Catalog> "<filename1>,<filename2>,..."

Returns a string of file names separated by commas.

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Query only

Manual operation: See "Shaping Table" on page 191

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE[:SELect] <Filename>
[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE[:SELect] <Filename>

Selects a file with correction values (extension `*.dpd_magn` (AM/AM) or `*.dpd_phase`(AM/FM)).

Parameters:

<Filename> string

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Manual operation: See "Shaping Table" on page 191

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:NEW
[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:NEW

Stores the correction values into a file with the selected file name and loads it.

The file is stored in the default directory or in the directory specified with the absolute file path. If the file does not yet exist, a new file is created. The file extension is assigned automatically.

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Setting only

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMAM:FILE:DATA
[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:DATA

Defines the predistortion function in a raw data format.

See also `[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:AMPM:FILE:NEW` on page 455.

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

[:SOURce<hw>]:IQ:DPD:SHAPing:TABLe:INTerp <Interpolation>

Enables a linear (voltage or power) interpolation between the defined correction values.

Parameters:

<Interpolation> OFF | POWer | LINear

POWer
Linear power interpolation

LINear
Linear voltage interpolation

*RST: OFF

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Manual operation: See "Interpolation" on page 189

[:SOURce<hw>]:IQ:DPD:SHAPing[:TABLe]:INVert <InvertValues>

Inverts the defined correction values.

Parameters:

<InvertValues> 0 | 1 | OFF | ON

*RST: 0

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Manual operation: See "Invert correction values" on page 189

[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients

Sets the polynomial coefficients.

Example: see Example "Defining correction coefficients and enabling digital predistortion" on page 447

Manual operation: See "Polynomial Order" on page 195

[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:CATalog?

Queries the available polynomial files in the default directory. Only files with the file extension `*.dpd_poly` are listed.

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Query only

Manual operation: See "Save/Recall Polynomial" on page 195

[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:LOAD <Filename>

Loads the selected polynomial file.

Setting parameters:
<Filename> string

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Setting only

Manual operation: See "Save/Recall Polynomial" on page 195

[:SOURce<hw>]:IQ:DPD:SHAPing:POLYnomial:COEFficients:STORe <Filename>

Saves the polynomial function as polynomial file.

Setting parameters:
<Filename> string

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Setting only

Manual operation: See "Save/Recall Polynomial" on page 195

[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA

Defines the normalized predistortion function in a raw data format (binary data).

Parameters:
<#> The binary data must start with the sign #

<LengthOfNrOfBytes> ASCII format
Sets the length of `<NrOfBytes>`, i.e. the number of digits used to write `<NrOfBytes>`

<NrOfBytes> An ASCII integer value that specifies the number of bytes that follow in the `<NormData>` part
Each of the `<NormData>` parameters is coded with 8 bytes.
Then the number of bytes `<NrOfBytes>` is calculated as:
`<NrOfBytes>` = 8 + 8 + n(8+8+8), where n is the number of points `<NoOfPoints>`.

Setting parameters:
<NormData> <PinMax><NoOfPoints>{<VinVmax><DeltaV><DeltaPhase>}
Values in **binary format**, describing the maximum absolute input power Pin_{max}, the number of subsequent points *n* and the normalized values Vin/Vmax, ΔV/V, ΔPhase [deg].

Example:

```
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA #240<values>
// the binary <values> are not printable
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA:CATalog?
// norm
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA:STORe "My_DPD_Normalized"
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA:CATalog?
// norm,My_DPD_Normalized
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA:LOAD "norm"
SOURce1:IQ:DPD:SHAPing:NORMalized:DATA?
// #3112
// the binary data <NormData> is 112 bytes long, i.e. 3 points are define
// binary data is machine readable but not printable
```

Manual operation: See "Pin$_{max}$" on page 197

[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:CATalog?

Queries the available files with normalized data in the default directory. Only files with the file extension `*.dpd_norm` are listed.

Example: see `[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA` on page 457

Usage: Query only

Manual operation: See "Save/Recall Normalized Data" on page 197

[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:LOAD <Filename>

Loads the selected file.

Setting parameters:
<Filename> string

Example: See `[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA` on page 457

Usage: Setting only

Manual operation: See "Save/Recall Normalized Data" on page 197

[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA:STORe <Filename>

Saves the normalized data in a file.

Setting parameters:
<Filename> string

Example: See `[:SOURce<hw>]:IQ:DPD:SHAPing:NORMalized:DATA` on page 457

Usage: Setting only

Manual operation: See "Save/Recall Normalized Data" on page 197

[:SOURce<hw>]:IQ:DPD:AMAM:VALue:LEVel?
[:SOURce<hw>]:IQ:DPD:AMPM:VALue:LEVel?

Queries the delta phase and delta power values of the current RF RMS power level.

Return values:

<DeltaPhase> float

Range: -180 to 180
Increment: 0.01
*RST: 0

Example: see Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Query only

[:SOURce<hw>]:IQ:DPD:AMAM:VALue:PEP?
[:SOURce<hw>]:IQ:DPD:AMPM:VALue:PEP?

Queries the delta phase and delta power values for the current PEP of the generated RF signal.

Return values:

<DeltaPhase> float

Range: -180 to 180
Increment: 0.01
*RST: 0

Example: see Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Query only

[:SOURce<hw>]:IQ:DPD:AMAM:VALue?
[:SOURce<hw>]:IQ:DPD:AMPM:VALue?

Queries the delta phase and delta power values for the selected `<xValue>`.

Query parameters:

<xValue> float

Value on the x-axis
Value range depends on the selected PEP_{in}Min and PEP_{in}Max values.

<xUnit> DBM | V

*RST: DBM

Return values:

<DeltaPhase> float

Range: -180 to 180
Increment: 0.01
*RST: 0

<DeltaPower> float

Range: -20 to 20
Increment: 0.01
*RST: 0

Example: See Example "Defining correction coefficients and enabling digital predistortion" on page 447

Usage: Query only

11.14.15 SOURce:PHASe Subsystem

[:SOURce]:PHASe <Phase>

Specifies the phase variation relative to the current phase.

Parameters:

<Phase> float

Range: -360 to 360
Increment: 0.1
*RST: 0
Default unit: DEG

Manual operation: See "Delta Phase" on page 200

[:SOURce]:PHASe:REFerence

Adopts the phase set with command `[:SOURce]:PHASe` as the current phase.

Usage: Event

Manual operation: See "Reset Delta Phase Display" on page 200

11.14.16 SOURce:PULM Subsystem

This subsystem contains the commands for setting the pulse modulation.

Programming Examples

Example: Performing pulse modulation

This 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
SOURce:PULM:SOURce INT
// Set trigger mode
SOURce:PULM:TRIGger:MODE AUTO
// Select pulse mode
SOURce:PULM:MODE DOUB

// ******************************************************************
// Alternatively configure the pulse modulation settings for
// external modulation source
// ******************************************************************
// Select the external modulation source
SOURce:PULM:SOURce EXT
// Set the polarity of the externally applied modulation signal.
SOURce:PULM:POLarity NORMal
// Select the impedance for the external pulse modulation trigger input
SOURce:PULM:TRIGger:EXTernal:IMPedance G10K

// ******************************************************************
// Configure the pulse generator settings
// ******************************************************************
// Set pulse period
SOURce:PULM:PERiod 10 us
// Set pulse width
SOURce:PULM:WIDth 8 us
// Set double pulse width
SOURce:PULM:DOUBle:WIDTh 0.0000012
// Set double pulse delay
SOURce:PULM:DOUBle:DELay 0.0000045

// ******************************************************************
// Activate the signal output
// ******************************************************************
SOURce:PGENerator:OUTPut:STATe 1
SOURce:PULM:STATe 1
OUTPut1:STATe 1
```

[:SOURce<hw>]:PULM:DELay <Delay>

Sets the pulse delay.

Parameters:

<Delay> float

Range: 0 to 100 s
Increment: 10 ns
*RST: 10 ns

Example: `PULM:DEL 13 us`
13 us elapse after a trigger before the first pulse is generated.

[: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

Range: 40 ns to 100 s
Increment: 10 ns
*RST: 1 ns

Example: `PULM:DOUB:DEL 22 us`
22 us elapse between the beginning of the first pulse and the beginning of the second pulse in double-pulse mode.

Manual operation: See "Double Pulse Delay" on page 232

[:SOURce<hw>]:PULM:DOUBle:WIDTh <Width>

Sets the width of the second pulse in case of double pulse generation.

Example: `PULM:DOUB:WIDT 33 us`
sets a width of 33 us for the second pulse.

Manual operation: See "Double Pulse Width" on page 232

[:SOURce<hw>]:PULM:MODE <Mode>

Sets the mode of the pulse generator.

Parameters:

<Mode> SINGle | DOUBle

SINGle
Enables single pulse generation.

DOUBle
Enables double pulse generation. The two pulses are generated in one pulse period.

*RST: SINGle

Example: `PULM:MODE DOUB`
enables double pulse generation.

Manual operation: See "Pulse Mode" on page 231

[:SOURce<hw>]:PULM:PERiod <Period>

Sets the period of the generated pulse. The period determines the repetition frequency of the internal signal.

Example: `PULM:PER 220 us`
the pulse period is 220 us.

Manual operation: See "Pulse Period" on page 231

[:SOURce<hw>]:PULM:POLarity <Polarity>

Parameters:

<Polarity> NORMal | INVerted

NORMal
The RF signal is suppressed during the pulse pause.

INVerted
The RF signal is suppressed during the pulse.

*RST: NORMal

Example: `PULM:POL INV`
selects inverted polarity.

Manual operation: See "Polarity" on page 231

[:SOURce<hw>]:PULM:SOURce <Source>

Selects the source for pulse modulation.

Parameters:
<Source> INTernal | EXTernal

INTernal
The internal pulse generator is used for the pulse modulation.

EXTernal
The signal applied externally via the trigger connector is used for the pulse modulation.

*RST: INTernal

Manual operation: See "Source" on page 231

[:SOURce<hw>]:PULM:STATe <State>

Activates the pulse modulation.

Parameters:
<State> 0 | 1 | OFF | ON

*RST: 0

Example: `PULM:STAT ON`
activates pulse modulation.

Manual operation: See "State" on page 230

[:SOURce<hw>]:PULM:TRIGger:EXTernal:GATE:POLarity <Polarity>

Selects the polarity of the Gate signal.

Parameters:
<Polarity> NORMal | INVerted

*RST: NORMal

Example: `PULM:TRIG:EXT:GATE:POL NORM`
The pulse signal is generated while the gate signal is high.

Manual operation: See "Gate Input Polarity" on page 233

[:SOURce<hw>]:PULM:TRIGger:EXTernal:IMPedance <Impedance>

Selects the impedance for external pulse trigger.

Parameters:
<Impedance> G50 | G10K

*RST: G50

Example: `SOUR:PULM:TRIG:EXT:IMP G50`
selects 50 Ohm as the trigger impedance for the external pulse trigger.

Manual operation: See "External Impedance" on page 231

[:SOURce<hw>]:PULM:TRIGger:EXTernal:SLOPe <Slope>

Parameters:

<Slope> NEGative | POSitive

*RST: POSitive

Example: `PULM:TRIG:EXT:SLOP NEG`

The pulse generator is triggered on the negative slope of the external trigger signal.

Manual operation: See "Ext. Trigger Input Slope" on page 233

[:SOURce<hw>]:PULM:TRIGger:MODE <Mode>

Selects the trigger mode for pulse modulation.

Parameters:

<Mode> AUTO | EXTernal | EGATe

AUTO

The pulse modulation is generated continuously.

EXTernal

The pulse modulation is triggered by an external trigger event. The trigger signal is supplied via the trigger connector.

EGATe

The pulse modulation is gated by an external gate signal. The trigger signal is supplied via the trigger connector.

*RST: AUTO

Example: `PULM:TRIG:MODE EXT`

selects triggering by an external trigger event.

Manual operation: See "Trigger Mode" on page 233

[:SOURce<hw>]:PULM:WIDTh <Width>

Sets the width of the generated pulse. The width determines the pulse length. The pulse width must be at least 20ns less than the set pulse period.

Example: `PULM:WIDT 33 us`

sets a width of 33 us for the pulse.

Manual operation: See "Pulse Width" on page 232

11.14.17 SOURce:POWer Subsystem

[:SOURce]:POWer:ALC:DSENsitivity <Sensitivity>

Sets the power detector sensitivity. Used for compatibility reasons only.

Parameters:

<Sensitivity> OFF | LOW | MED | HIGH

*RST: OFF

Manual operation: See "Detector Sensitivity" on page 211

[:SOURce]:POWer:ALC:SONCe

Briefly activates level control for correction purposes.

Usage: Event

Manual operation: See "Readjust" on page 208

[:SOURce]:POWer:ALC[:STATe] <State>

Activates/deactivates automatic level control.

Parameters:

<State> 1 | OFFTable | OFF | ONTable | AUTO | ON

*RST: ONTable

Manual operation: See "State" on page 211

[:SOURce]:POWer:ATTenuation:DIGital <AttDigital>

Sets a relative attentuation value for the baseband signal.

Parameters:

<AttDigital> float

Range: 0 to 80
Increment: 1E-3
*RST: 0
Default unit: dB

Manual operation: See "Digital Attenuation" on page 206

[:SOURce]:POWer:ATTenuation:RFOFf:MODE <Mode>

Determines the attenuator's state after the instrument is switched on.

Parameters:

<Mode>	MAX | FATTenuated | FIXed | UNCHanged

Manual operation: See "RF-Off-Mode" on page 210

[:SOURce]:POWer:ATTenuation:SOVer[:OFFSet] <Offset>

Sets the switch-over offset value of the attenuator.

Parameters:

<Offset> float

Range: -10 to 10
Increment: 0.1
*RST: 0

Manual operation: See "SATT Switch-Over Offset" on page 209

[:SOURce]:POWer:LIMit[:AMPLitude] <Amplitude>

Sets the upper limit of the RF signal power.

The value is not affected by an instrument preset and `*RST` function. This parameter is influenced only by the factory preset (`SYST:FPR`) and its factory value is equal to the upper limit.

Parameters:

<Amplitude> float

Range: -120 to 25
Increment: 0.01

Manual operation: See "Limit" on page 208

[:SOURce]:POWer:LMODe <LevMode>

Selects the level mode.

Parameters:

<LevMode> NORMal | LOWNoise | LOWDistortion | USER

NORM
automatic selection of the best settings

LNOISe
settings for lowest noise

LDIStortion
settings for lowest distortions

Manual operation: See "Mode" on page 207

[:SOURce]:POWer:POWer <Amplitude>

Sets the level at the RF output connector.

This value does not consider a specified offset. The command `[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude]` sets the level of the "Level" display, that means the level containing offset.

Parameters:

<Amplitude> float

Range: -20 to 25
Increment: 0.01
*RST: -10

Example: `POW:POW 15`
sets the RF level at output to 15 dBm.

Manual operation: See "Level/Level Offset" on page 60

[:SOURce]:POWer:PEP?

Queries the RF signal peak envelope power.

Return values:

<PEP> float

Usage: Query only

[:SOURce]:POWer:SCHaracteristic <Characteristic>

Selects the characteristic for the level setting.

Parameters:

<Characteristic> AUTO | UNINterrupted | CVSWr | USER | MONotone

UNINterrupted
uninterrupted level setting

CVSWr
constant-VSWR

MONotone
strictly monotone

*RST: AUTO

Manual operation: See "Setting Characteristic" on page 207

[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] <Amplitude>

Sets the RF level at the RF output connector of the instrument.

Parameters:

<Amplitude>	float	
	Range:	-120 to 25
	Increment:	0.01
	*RST:	-10
	Default unit:	dBm

Manual operation: See "Level/Level Offset" on page 60

[:SOURce]:POWer[:LEVel][:IMMediate]:OFFSet <Offset>

Specifies the constant level offset of a downstream attenuator/amplifier. If a level offset is entered, the level entered with `:POWer` no longer corresponds to the RF output level.

The following correlation applies:

`:POWer` = RF output level + `POWer:OFFSet`.

Entering a level offset does not change the RF output level, but rather the query value of `:POWer`.

Only dB is permitted as the unit here. The linear units (V, W, etc.) are not permitted.

Parameters:

<Offset>	float	
	Range:	-100 to 100
	Increment:	0.1
	*RST:	0

Manual operation: See "Offset" on page 207

[:SOURce]:POWer:RANGe:LOWer?
[:SOURce]:POWer:RANGe:UPPer?

Queries the minimum/maximum level range in the current level mode

Return values:

<Upper> float

Usage: Query only

Manual operation: See "Level Range" on page 208

[:SOURce]:POWer:WIGNore <State>

Ignores level range warnings.

Parameters:

<State>	0 | 1 | OFF | ON	
	*RST:	0

Example: `POW:WIGN ON`

suppresses the level range warnings.

11.14.18 SOURce:ROSCillator Subsystem

[:SOURce]:ROSCillator:SOURce <Source>

Select the reference oscillator signal source.

Parameters:

<Source>	INTernal | EXTernal

Manual operation: See "Ref. Oscillator Source/Ext Ref On/Off" on page 60

[:SOURce]:ROSCillator:EXTernal:FREQuency <ExtFreq>

Selects the frequency of the external reference.

Parameters:

<ExtFreq>	10MHZ | 100MHZ | 1000MHZ | 13MHZ 13MHZ requires RF board with part number 1419.5308.02. To find out the RF board installed in the instrument: Select "SGMA-GUI > instrument name > Setup > Hardware Config" > "RF Assembly" Observe the part number of the assembly "RfBoard".

Manual operation: See "Ext. Ref. Input Frequency" on page 203

[:SOURce]:ROSCillator:OUTPut:FREQuency <OutputFreq>

Selects the output for the reference oscillator signal.

Parameters:

<OutputFreq>	10MHZ | 100MHZ | 1000MHZ | 13MHZ 13MHZ requires RF board with part number 1419.5308.02.

Manual operation: See "Output Frequency" on page 204

[:SOURce]:ROSCillator:EXTernal:SBANdwidth <SBandwidth>

Sets the synchronization bandwidth for an external reference signal.

Parameters:

<SBandwidth>	WIDE | NARRow **NARRow** The synchronization bandwidth is. **WIDE** Synchronization bandwidth is.

Example: `ROSC:SOUR EXT`
Selects the external source.
`ROSC:EXT:FREQ 10 MHz`
Informs the instrument that the external reference has a frequency of 10 MHz.
`ROSC:EXT:SBAN WID`
Selects wideband setting for synchronization bandwidth.

Manual operation: See "Synchronization Bandwidth" on page 203

[: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 user-defined values are used, the instrument is no longer in the calibrated state. However, the calibration value is not changed and the instrument resumes the calibrated state after sending the command `:SOURce:ROSCillator:INTernal:ADJust:STATe OFF`.

Parameters:

<State>	0 | 1 | OFF | ON *RST: -

Example: `ROSC:SOUR INT`
Selects the internal source.
`ROSC:ADJ ON`
Activates use of a user-defined adjustment value.
`ROSC:ADJ:VAL 1400`
Sets the adjustment value to 1400.

Manual operation: See "Adjustment Active" on page 204

[:SOURce]:ROSCillator[:INTernal]:ADJust:VALue <Value>

Allows an application to shift the reference oscillator frequency by a small amount.

The setting range depends on the reference oscillator type and its factory calibration value. Allowed are the following ranges:

- For TCXO oscillator: Max - Min = 1023
- For OCXO oscillator: Max - Min = 65535 (option R&S SGT-B1 required.)

Parameters:

<Value>	integer	
	Range:	Min to Max
	*RST:	32767

Manual operation: See "DAC Value" on page 205

11.15 STATus Subsystem

This system contains the commands for the status reporting system. See also Chapter 15.1.5, "Status Reporting System", on page 537 for detailed information.

*RST on page 307 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 SGT cause the status registers to be changed.
  Setting values: A decimal value in the range 0 to 32767 (=2^{15}-1)

: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:EVEN?`
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 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:

<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 478.

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

11.16 SYSTem Subsystem

The `SYSTem` subsystem contains a series of commands for general functions which do not directly affect signal generation.

: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

: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

: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:
<Serror> string

Example: `SYST:SERR`
queries all errors existing in the error queue.

Example: `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: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:COMMunicate:GPIB:LTERminator <LTerminator>

Sets the terminator recognition for remote control via GPIB bus.

Parameters:

<LTerminator> STANdard | EOI

EOI
The terminator must be sent together with the line message EOI (End of Line). This setting is recommended for binary block transmissions where a character could coincidentally have the value LF (Line Feed) but is not intended as the terminator. This setting must be selected for block data with undefined length.

STANdard
An LF (Line Feed) is recognized as the terminator regardless of whether it is sent with or without EOI.

*RST: STANdard

Example: `SYSTem:COMMunicate:GPIB:LTERminator 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: `SYSTem:COMMunicate:GPIB:RESource?`
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: 1 to 30
*RST: 28

Example: `SYSTem:COMMunicate:GPIB:SELF:ADDRess 28`
sets GPIB address.

:SYSTem:COMMunicate:NETWork:IPADdress <IpAddress>

Sets the IP address.

Parameters:
<IpAddress> string

Range: 0.0.0.0. to ff.ff.ff.ff

Example: `SYSTem:COMMunicate:NETWork:IPADdress '7.8.9.10'`
sets the IP address of the instrument.

Manual operation: See "IP Address" on page 258

:SYSTem:COMMunicate:NETWork:IPADdress:MODE <Mode>

Selects manual or automatic setting of the IP address.

Parameters:
<Mode> AUTO | STATic

*RST: AUTO

Example: `SYSTem:COMMunicate:NETWork:IPADdress:MODE AUTO`
the IP address is assigned automatically (DHCP)

Manual operation: See "Address Mode" on page 257

:SYSTem:COMMunicate:NETWork:MACaddress <MacAddress>

Queries the MAC address of the network adapter.

Parameters:
<MacAddress> string

Example: `SYST:COMM:NETW:MAC`
queries the MAC address.

:SYSTem:COMMunicate:NETWork:STATus?

Queries the network configuration state.

Return values:
<State> 0 | 1 | OFF | ON

Usage: Query only

:SYSTem:COMMunicate:NETWork:RESTart

Restarts the network connection to the instrument, terminates the connection and sets it up again.

Example: `SYSTem:COMMunicate:NETWork:RESTart`

Usage: Event

:SYSTem:COMMunicate:NETWork[:COMMon]:HOSTname <Hostname>

Sets the individual host name of the R&S SGT.

Note: it is recommended that you do not change the host name in order to avoid problems with the networdk connection. However, if you change the host name be sure to use an unique name.

The host name is a protected parameter, To change it, first disable protection level 1 with command `:SYSTem:PROTect<ch>[:STATe]` on page 485.

Parameters:
<Hostname> string

Example: `SYSTem:PROTect1:STATe OFF,123456`
`SYSTem:COMMunicate:NETWork:HOSTname 'SIGGEN'`
sets the individual computer name of the R&S SGT.

Manual operation: See "Hostname" on page 257

:SYSTem:COMMunicate:NETWork[:IPADdress]:DNS <DNS>

Determines or queries the network DNS server to resolve the name.

Parameters:
<DNS> string

Example: `SYST:COMM:NETW:IPAD:DNS?`
Response: `"10.0.1.11"`

: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: `SYSTem:COMMunicate:NETWork:IPADdress:GATeway '1.2.3.4'`
sets the IP address of the default gateway.

Manual operation: See "Default Gateway" on page 258

:SYSTem:COMMunicate:NETWork[:IPADdress]:SUBNet:MASK <Mask>

Sets the subnet mask.

Parameters:

<Mask> string

Example: `SYSTem:COMMunicate:NETWork:IPADdress:SUBNet:MASK '255.255.0.0'`
determines the subnet mask.

Manual operation: See "Subnet Mask" on page 258

:SYSTem:COMMunicate:NETWork:RESource?

Queries the VISA resource string, used for remote control of the instrument with VXI-11 protocol.

Return values:

<Resource> string

Example: `SYSTem:COMMunicate:NETWork:RESource?`
Response: `"TCPIP::192.1.2.3::INSTR"`

Usage: Query only

Manual operation: See "Visa Resource Strings" on page 259

:SYSTem:COMMunicate:SERial:BAUD <Baud>

Sets the baudrate for the serial remote control interface.

Parameters:

<Baud> 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200

*RST: 115200

Example: `SYSTem:COMMunicate:SERial:BAUD 115200`
determines 115200 baudrate.

:SYSTem:COMMunicate:SERial:PARity <Parity>

Sets the parity for the serial remote control interface.

Parameters:

<Parity> NONE | ODD | EVEN

*RST: NONE

Example: `SYST:COMM:SER:PAR NONE`
selects parity NONE.

: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: `SYSTem:COMMunicate:SERial:RESource?`
queries the VISA resource string.
Response: `"ASRL1::INSTR"`

Usage: Query only

:SYSTem:COMMunicate:SERial:SBITs <SBits>

Sets 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.

:SYSTem:COMMunicate:HISLip:RESource?

Queries the VISA resource string, used for remote control of the instrument with HiSLIP protocol.

Return values:

<Resource> string

Example: `SYSTem:COMMunicate:HISLip:RESource?`
Response: `"TCPIP::192.1.2.3::hislip0::INSTR"`

Usage: Query only

Manual operation: See "Visa Resource Strings" on page 259

:SYSTem:COMMunicate:PCIexpress:RESource?

Queries the visa resource string for remote control via the PCIe interface.

Return values:

<Resource> string

Usage: Query only

Manual operation: See "Visa Resource Strings" on page 259

: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: `SYSTem:COMMunicate:SOCKet:RESource?`
Response: "`TCPIP::10.113.1.150::5025::SOCKET`"

Usage: Query only

Manual operation: See "Visa Resource Strings" on page 259

:SYSTem:COMMunicate:USB:RESource?

Queries the visa resource string for remote control via the USB interface.

Return values:

<Resource> string

Example: `SYSTem:COMMunicate:USB:RESource?`
queries the VISA resource string for remote control via the USB interface.
Response: "`USB::72::000000::INSTR`"

Usage: Query only

Manual operation: See "Visa Resource Strings" on page 259

:SYSTem:IDENtification <Identification>

Selects the mode the instrument identification is performed.

Parameters:

<Identification> AUTO | USER

AUTO
The "IDN String" and the "OPT String" are set automatically.

USER
Enables the selection of user definable "IDN String" and "OPT String".

*RST: AUTO

Example: `SYST:IDEN USER`
selects the user defined identification string.

Manual operation: See "Identification Mode" on page 260

:SYSTem:KLOCk <State>

Keyboard **LOC**k disables the front panel keys of the instrument.

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`.

:SYSTem:LANGuage <Language>

Sets the command set to be used.

The instrument can also be remote controlled via the command set of several other generators.

Note: While working in a emulation mode, the instrument's specific command set is disabled, i.e. the SCPI command `SYSTem:LANGuage` will be discarded.

The return to the SCPI command set of the R&S SGT can only be performed by using the appropriate command of the selected command set.

Parameters:

<Language> string

Example: `SYSTem:LANGuage "SCPI"`

sets the SCPI command set.

Manual operation: See "Language" on page 260

: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?
// 1
// the startup of the instrument is completed
```

Usage: Query only

:SYSTem:PROTect<ch>[:STATe] <State>[, <Key>]

Activates/deactivates the specified protection level.

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. 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 lock-out internal adjustments.

Example: `SYSTem:PROTect1:STATe ON`
activates protection level 1. Internal adjustments are only possible after deactivating the lock-out.
`SYSTem:PROTect1:STATe OFF,123456`
deactivates protection level 1. Internal adjustments are enabled again.

: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 485.

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 261

: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 485.

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 261

:SYSTem:TIME:ZONE <TimeZone>

Sets the time zone. You can query the list of the available time zones with `:SYSTem:TIME:ZONE:CATalog?`.

Parameters:
<TimeZone> string

Manual operation: See "Time Zone" on page 262

:SYSTem:TIME:ZONE:CATalog?

Querys the list of available time zones.

Return values:
<Catalog>

Usage: Query only

Manual operation: See "Time Zone" on page 262

:SYSTem:OSYStem?

Queries the operating system of the instrument.

Return values:
<OperSystem> string

Example: `SYSTem:OSYStem?`
Response: "`Linux`"

Usage: Query only

: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:MMEMory:PATH:USER?

Queries the user directory, that means the directory the instrument stores user files on.

Return values:
<PathUser> string

Example: `SYSTem:MMEMory:PATH:USER?`
Response: "/var/user/"'

Usage: Query only

11.17 TEST Subsystem

The TEST system contains the commands for performing the routines as well as for direct manipulation of the hardware assemblies (`:TEST:DIRect`).

The self tests return a "0" if the test is performed successfully, otherwise a value other than "0" is returned. None of the commands of this system have an `*RST` value.

NOTICE

Improper use can destroy the assembly

The respective hardware assembly responds directly to the `:TEST:DIRect` command; any safety mechanisms are bypassed. The command is intended for servicing purposes and should be used only by the Rohde & Schwarz service personnel.

:TEST:ALL:STARt

Starts the selftest. Use the command `:TEST:ALL:RESult?` to query the result.

Usage: Event

:TEST:ALL:RESult?

Queries the result of the performed selftest. Start the selftest with `:TEST:ALL:STARt`.

Return values:

<Result> 0 | 1 | RUNning | STOPped

*RST: STOPped

Usage: Query only

:TEST:KEYBoard[:STATe] <State>

Enable/disable keyboard and LED test state.

Parameters:

<State> 0 | 1 | OFF | ON

:TEST:BBIN?

This command performs a selftest on the baseband input hardware options. Several analog diagnostics points are checked to verify the correct function of the module.

Return values:

<Bbin> 0 | 1 | OFF | ON

Example: `TEST:BBIN?`

Response: "0" on success, "1" on fail

Usage: Query only

:TEST:BB:CONNection?

Queries the state of the connection between connectors USER1 and USER2.

A `0=PASS` response indicates that the connection is established, whereas a response `1=FAIL` stands for a faulty connection.

Return values:

<Connection> 0 | 1 | PASS | FAIL

Usage: Query only

Manual operation: See "Execute Connection Test" on page 264

:TEST:EIQMode <EiqMode>

Triggers a connection test for testing the active external IQ devices.

Parameters:

<EiqMode> IQIN | IQOut

*RST: IQOut

11.18 UNIT Subsystem

The `UNIT` subsystem contains the commands specifying which units are valid if no unit is indicated in a command. These settings are valid for the entire instrument.

:UNIT:ANGLe <Angle>

Sets the default angle unit for remote control. Does not influence the manual control parameter units and the display.

Parameters:

<Angle>	DEGRee | RADian
	*RST: RADian

Example: `UNIT:ANGL DEG`
sets DEG as a default unit for all commands which determine angle values.

:UNIT:POWer <Power>

Defines the default unit for 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

Example: `UNIT:POW V`
sets V as a default unit for all commands which determine power values.

11.19 List of R&S SGT Commands

12 Waveform and List Format

The R&S SGT uses a tag-oriented format for externally or internally generated waveforms.

A waveform version number is not necessary due to the flexible, tag-based form.

Tags are self-contained information units. 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 in most cases it is in ASCII plain text.

The **`Length`** specifies the number of bytes in a `WAVEFORM` tag, a `DATA LIST` tag or a `EMPTYTAG` (from `:` to `}`, ASCII integer).

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 SGT. On the other hand they are left unchanged, are saved without an error message and can be read back again.

R&S AMIQ waveforms can also be loaded on the instrument, where they are converted internally into an R&S SGT waveform.

12.1 Tag Description

This section first describes the mandatory `TYPE` tag which identifies the file and is always located at the start of the file. The rest of the tags used in the R&S SGT are then described in 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}

(mandatory, must be the first tag in the file)

Identifies the file as a valid R&S SGT file. It must be present and must be the first in the waveform. If a file of the same name already exists on the target medium, it is overwritten.

Setting parameters:

magic
Designates the file type and has the following values:

SMU-WV
A valid R&S SGT waveform.

SMU-MWV
A valid R&S SGT multi segment waveform.

xxxxxxxx
Is an ASCII-coded checksum of the data part of the `WAVEFORM` tag in the file.
The checksum for waveforms is used for detecting transmission errors. If the `TYPE` 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 `WAVEFORM` 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):

```
UINT32 checksum(void *start, UINT32 length)
{
UINT32 i, result = 0xA50F74FF;
for(i=0; i < length/4; i++)
result = result ^ ((UINT32 *)start)[i];
return(result);
}
```

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 SGT. 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 waveform 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 SGT. 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

{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:8666666.666666666}
{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

{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: 4333}`
`BB:ARB:WAV:TAG? 'SAMPLES'`
Queries the content of the `SAMPLES` tag of the selected waveform file.
`Response: '4333'`
The waveform contains 4333 I/Q samples.

Usage: Setting only

{[TRACE] LIST [#]: Pos0:Val0;Pos1:Val1;...Posx:Valx;...PosN-1:ValN-1}

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. To select which of these signals is defined, `[TRACE]` and the associated number are used. For ARB waveforms, it is only meaningful to define marker signals (on ARB multi segment waveforms these tags will be ignored).

Setting parameters:

[TRACE]
Specifies the name of the marker or control signal.
You can choose from the following names:
`MARKER; BURST; LEVATT; CW MODE; HOP, MAP`

[#]
Specifies the number in the case of control signals and marker signals with the same name. There is a choice between 4 markers and 3 LEVATT signals. Lines LEVATT 1 and 2 are needed for internal purposes and should not be used.

Pos
Specifies in ASCII format the number of the position in the sequence, with effect from which the binary state of the marker or of the control signal changes from 0 to 1 or from 1 to 0.

Val
Specifies the binary state of the marker or of the control signal {0; 1} 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

{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).

Setting parameters:

Length
Specifies the number of bytes in a `WAVEFORM` 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 — `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 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 MWV_SEGMENT_COUNT, MWV_SEGMENT_START, and MWV_SEGMENT_LENGTH.
Further `MWV_SEGMENT_...` tags are also available, for example for level and clock information.

Example: **One segment waveform**
{WAVEFORM-401:#$I_0,Q_0,I_1,Q_1,I_2,Q_2,\ldots I_{99},Q_{99}$}
100 I/Q pairs with 4 bytes each are transmitted - none multi-segment

Example: **Multi-segment waveform**
{WAVEFORM-1201:
#$I_{0,Seg0},Q_{0,Seg0},I_{1,Seg0},Q_{1,Seg0},\ldots I_{99,Seg0},Q_{99,Seg0},I_{0,Seg1},Q_{0,Seg1},I_{1,Seg1},$
$Q_{1,Seg1},\ldots I_{199,Seg1},Q_{199,Seg1}$}
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

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.

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.
During the multi segment calculation, the clock rates of all individual original waveforms were taken over unchanged in the segments of the multi segment output waveform (no software resampling is done).
If the segments have different clock rates, there are some restrictions on signal output, i.e. switching per external trigger and seamless switching between segments is not possible.
If all segments have already an identical clock rate, this mode is usually set to `HIGHEST`.

HIGHEST
All segments have an identical clock rate, which is the highest clock rate of all original waveforms.
If an individual original waveform has a lower clock rate, an upsampling to the highest clock rate will performed on calculation of the multi segment output waveform.

USER
All segments have an identical clock rate, which is given by the user.
Note: Only upsampling is allowed, no downsampling!
If an individual original waveform has a lower clock rate, an upsampling to the user clock rate will performed on calculation of the multi segment output waveform.

Example:

```
{MWV_SEGMENT_CLOCK_MODE: UNCHANGED}
{MWV_SEGMENT_CLOCK_MODE: HIGHEST}
{MWV_SEGMENT_CLOCK_MODE: USER}
```

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 3dB 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: "/var/user/sine.wv", "/var/user/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…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 will be given out synchronously to the I/Q sample sequence. One marker element mx consists of 4 bit, which are assigned to the 4 possible marker lines of the instrument (one bit per marker line). One 4 bit marker element is needed for every I/Q sample in the `WAVEFORM` tag - so 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.

<table>
<tr><td>MSB 7</td><td colspan="6">Byte</td><td>LSB 1</td></tr>
<tr><td colspan="4">Marker element m_x
(synchronous to I/Q Sample x)</td><td colspan="4">Marker element m_{x+1}
(synchronous to I/Q Sample x+1)</td></tr>
<tr><td>Marker 4</td><td>Marker 3</td><td>Marker 2</td><td>Marker 1</td><td>Marker 4</td><td>Marker 3</td><td>Marker 2</td><td>Marker 1</td></tr>
</table>

Figure 12-1: 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 `CONTROL LIST WIDTH4` 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.
Example:	{CONTROL LIST WIDTH4-51: #$m_0m_1...m_x...m_{99}$} 100 marker elements, each marker element with 4 bits
Usage:	Setting only

12.2 How to Manually Create a Waveform Using Tag File Format

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 516). 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 12-2 illustrates this general workflow.

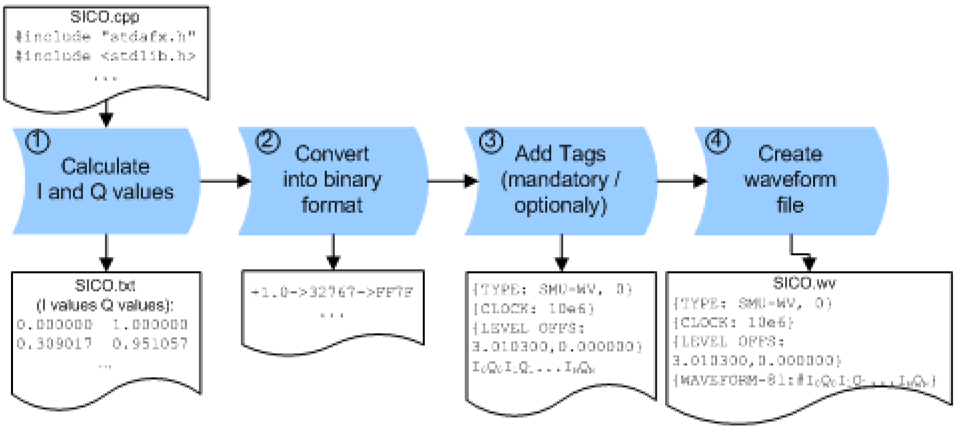


Figure 12-2: Principle of creating a waveform manually

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 12-3: 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 12-4 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)	$I_{quant,dec}$ = I * FS = I * (2^{15}-1)	$I_{quant,hex}$	$I_{quant,hex}$ (Little endian waveform file representation)	Q = cos(deg)	$Q_{quant,dec}$ = I * FS = I * (2^{15}-1)	$Q_{quant,hex}$	$Q_{quant,hex}$ (Little endian waveform file representation)
0	0	0.000000	0	0000	0000 I_0	1.000000	32767	7FFF	FF7F Q_0
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 12-4: I and Q values calculation and conversion

3. 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:
   - 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.

4. Pack the binary data into a WAVEFORM tag with the described structure.

   ```
   {WAVEFORM-Length: #I0Q0I1Q1I2Q2 ... InQn}
   ```

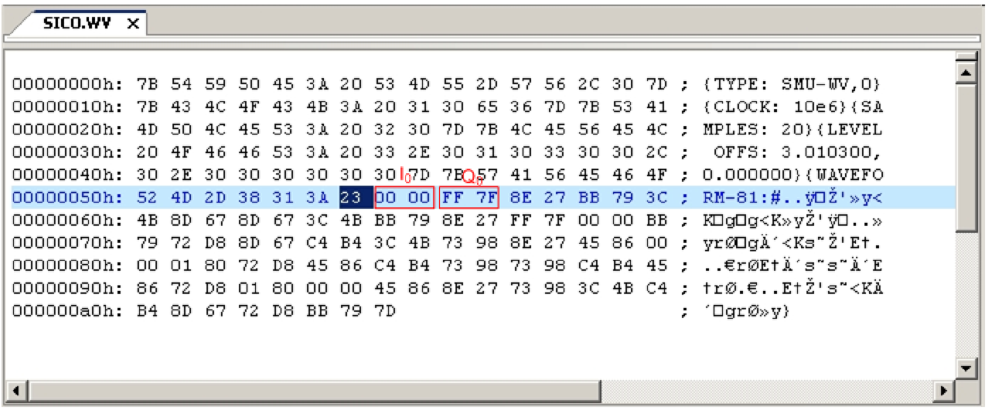
   - Calculate the `Length`
     Length = Number of I/Q pairs * 4 + 1 = 20*4 + 1 = 81 bytes
   - Place the string `{WAVEFORM-81:#` at the beginning of the data set
   - Place the symbol `}` at the end of the data set

   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;
}
```

12.3 Editing Waveform Files

You can edit the internally and externally crated waveform files. The waveform contains 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, you have to change the `{EMPTYTAG-Length}` value.
  For example, if you add a new tag or add bytes to an existing tag, reduce the length information by the number of newly introduced bytes.

13 Maintenance

The instrument does not need periodic maintenance. Only cleaning the instrument is essential.

Follow the instructions in the service manual and the safety instructions when exchanging modules or ordering spare parts. The order number for spare parts is included in the service manual. The service manual includes further information particularly on troubleshooting, repair, exchange of modules (including battery exchange, adjustment of the OCXO oscillator) 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.

13.1 Cleaning

The outside of the instrument can be cleaned sufficiently using a soft, lint-free dust cloth. Make sure that the fan openings 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.

NOTICE

Risk of instrument damage due to obstructed fans

If the instrument is operated in dusty areas, the fans may become obstructed by dust or other particles in the process of time. Make sure to check and, if necessary, clean the fans regularly to ensure they operate properly at all times. If the instrument is run with obstructed fans for a longer period, it may become overheated which may cause damage.

13.2 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 electro-static charging.

14 Error Messages and Troubleshooting

This chapter describes the error messages of the R&S SGT. The error messages are output in the "Info" line on the screen and entered in the error/event queue of the status reporting system.

A great variety of different messages such as status messages, error messages, warnings or information are displayed in the header field of the screen. Some error messages require that the error must be eliminated before correct instrument operation can be ensured. The "Info" window with a list of current messages and a detailed description of each message can be opened with the "Info" button (see also Chapter 6.2.1, "Info Dialog", on page 56).

14.1 Status Information

The status messages are displayed in the Info line of the R&S SGMA-GUI main panel. The status information gives the user an overview of the main operating states and settings of the instrument. The states are indicated for information only and do not necessitate any action by the user.

Status Information displayed in the Info line

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 with the parameter "SGMA-GUI > Instrument Name > Level > Attenuator Fixed Range".

14.2 Error Messages

Messages indicate errors in the instrument. They are displayed in the info line 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).

See also Chapter 6.2.1, "Info Dialog", on page 56 and Chapter 6.2.2, "Understanding the Messages in the Info Bar", on page 58.

14.2.1 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?` and `:SYSTem:ERRor[:NEXT]?`.

14.2.2 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 ensured.

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?`

14.3 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.

14.4 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 of 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
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.
182	Adjustment data missing	Adjustment data are missing.	The adjustment data have to be generated first by an internal or external adjustment or to be loaded into the instrument.
183	Adjustment data invalid	Adjustment data are invalid and must be restored.	The adjustment data have 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	A error occurs when writing or reading a EEPROM.	The EEPROM might be defect and has to be replaced.
203	Invalid EEPROM data		
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 dialog. 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 mapping files is `*.map`. It is not possible to enter another file extension when selecting a list.	Check the selected list type.
460	Cannot open file	The selected file can not be opened.	Check the path and file name.
461	Cannot write file	The file can not be written.	Check if the file is read-only.
462	Cannot read file	The file can not be read.	Check if the file contents are compatible with the file type.
463	Filename missing	The required operation cannot be executed because the file name is not specified.	A file name has to be entered when creating a new 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 the mapping files is `*.map`. It is not possible to enter another file extension when storing a list.

Error Code	Error	Description	Remedy
465	File contains invalid data	The selected file contains data that is not valid for the file type.	Check the file extension. 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 are therefore inva-lid.
468	Cannot find directory	Required folder cannot be found.	Check drive and path.
469	No files found	Folder is empty	

15 Annex

15.1 Remote Control Basics

This chapter provides basic information on operating an instrument via remote control.

15.1.1 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 15.1.3, "SCPI Command Structure", on page 526. 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.

15.1.2 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.

15.1.3 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.

15.1.3.1 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.

15.1.3.2 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 15.1.3.3, "SCPI Parameters", on page 530.

Example:

Definition:`HCOPy:DEVice:CMAP:COLor:RGB <red>,<green>,<blue>`

Command:`HCOP:DEV:CMAP:COL:RGB 3,32,44`

Special characters

<table>
<tr><td>|</td><td>Parameters
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.
Example:
Definition:HCOPy:PAGE:ORIentation LANDscape | PORTrait
Command HCOP:PAGE:ORI LAND specifies landscape orientation
Command HCOP:PAGE:ORI PORT specifies portrait orientation
Mnemonics
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.
Example:
DefinitionSENSE:BANDwidth|BWIDth[:RESolution] <numeric_value>
The two following commands with identical meaning can be created:
SENS:BAND:RES 1
SENS:BWID:RES 1</td></tr>
<tr><td>[ ]</td><td>Mnemonics in square brackets are optional and may be inserted into the header or omitted.
Example: HCOPy[:IMMediate]
HCOP:IMM is equivalent to HCOP</td></tr>
<tr><td>{ }</td><td>Parameters in curly brackets are optional and can be inserted once or several times, or omitted.
Example: SENSe:LIST:FREQuency <numeric_value>{,<numeric_value>}
The following are valid commands:
SENS:LIST:FREQ 10
SENS:LIST:FREQ 10,20
SENS:LIST:FREQ 10,20,30,40</td></tr>
</table>

15.1.3.3 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.

15.1.3.4 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. ● Binary: #B10110 ● Octal: #O7612 ● Hexa: #HF3A7 ● Block: #21312
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates the header from the parameters.

15.1.3.5 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`

15.1.3.6 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: `HCOP:PAGE:ORI?`
  Response: `LAND`

15.1.4 Command Sequence and Synchronization

IEEE 488.2 defines a distinction between overlapped and sequential commands:

- A sequential command is one which finishes executing before the next command starts executing. Commands that are processed quickly are usually implemented as sequential commands. Sequential commands are not implemented in the instrument, however the execution time of most commands is so short that they act as sequential commands when sent in different command lines.
- An overlapping command is one which does not automatically finish executing before the next command starts executing. Usually, overlapping commands take longer to process and allow the program to do other tasks while being executed. If overlapping commands do have to be executed in a defined order, e.g. in order to avoid wrong measurement results, they must be serviced sequentially. This is called synchronization between the controller and the instrument.

Setting commands within one command line, even though they may be implemented as sequential commands, are not necessarily serviced in the order in which they have been received. In order to make sure that commands are actually carried out in a certain order, each command must be sent in a separate command line.

As a general rule, send commands and queries in different program messages.

15.1.4.1 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. The controller can be forced to wait for the corresponding action to occur.

*Table 15-1: 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.	• Setting bit 0 in the ESE • Setting bit 5 in the SRE • Waiting for service request (SRQ)
*OPC?	Stops command processing until 1 is returned. This occurs when all pending operations are completed.	Send *OPC? directly after the command whose processing must be terminated before other commands can be executed.
*WAI	Stops further command processing until all commands sent before *WAI have been executed.	Send *WAI directly after the command whose processing must be terminated before other commands are executed.

Command synchronization using `*WAI` or `*OPC?` is a good choice if the overlapped command takes only little time to process. The two synchronization commands simply block overlapped execution of the command. Append the synchronization command to the overlapping command, for example:

`SINGle; *OPC?`

For time consuming overlapped commands, you can 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 (with a timer) using the sequence: `*OPC; *ESR?`

   A return value (LSB) of 1 indicates that the overlapped command has finished.

15.1.5 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.

15.1.5.1 Hierarchy of the Status Registers

The Figure 15-1 shows the hierarchical structure of information in the status registers (ascending from left to right).

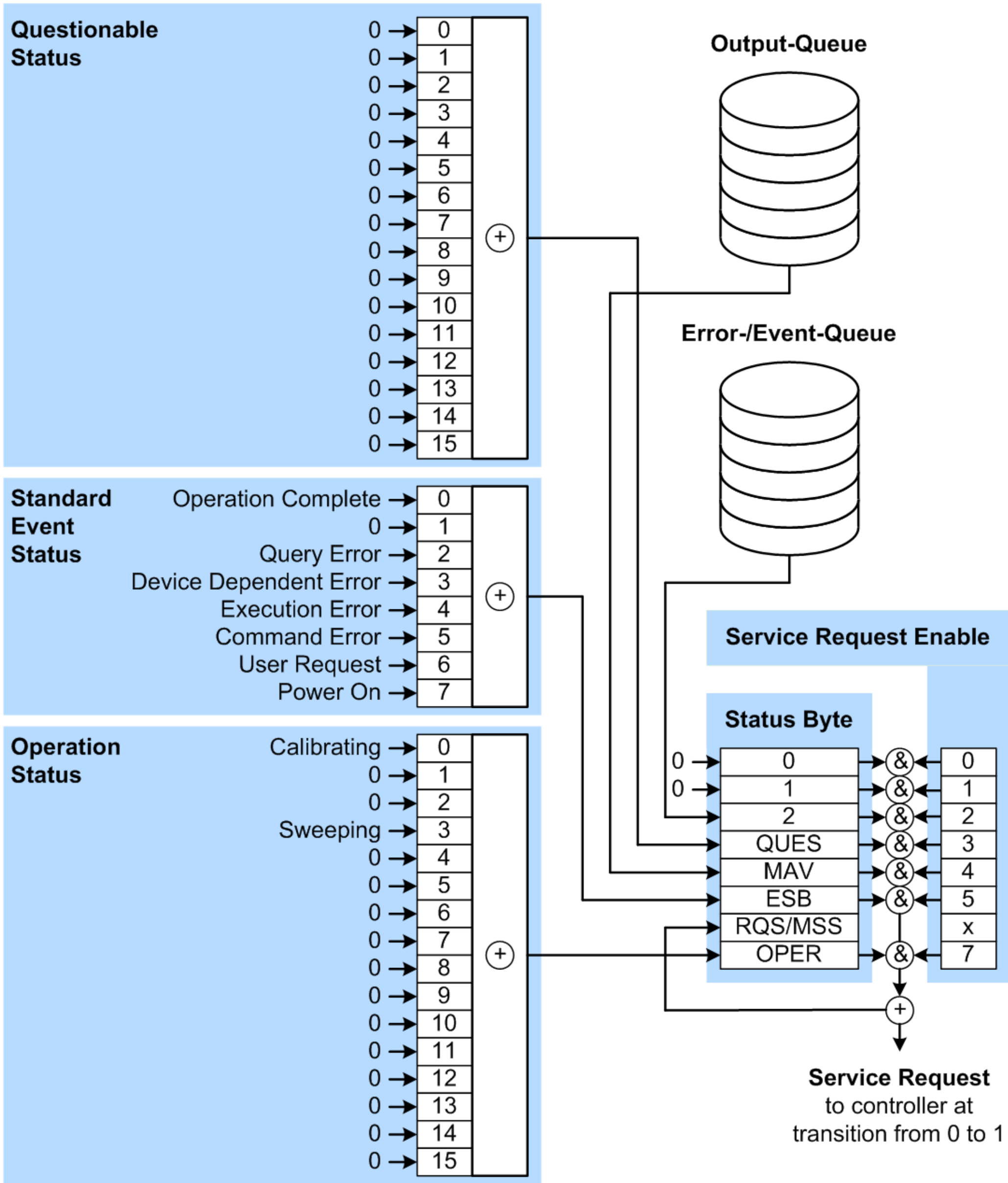


Figure 15-1: Graphical overview of the status registers hierarchy

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 SGT uses the following status registers:

- **Status Byte** (STB) and **Service Request Enable** (SRE), see Chapter 15.1.5.3, "Status Byte (STB) and Service Request Enable Register (SRE)", on page 541.

- **Standard Event Status**, i.e. the Event status Register (ESR) and the Event Status Enable (ESE), see Chapter 15.1.5.4, "Event Status Register (ESR) and Event Status Enable Register (ESE)", on page 542.
- **Questionable Status** and **Operation Status**, the (SCPI status registers, see Chapter 15.1.5.2, "Structure of a SCPI Status Register", on page 539, Chapter 15.1.5.5, "Questionable Status Register (STATus:QUEStionable)", on page 543 and Chapter 15.1.5.6, "Operation Status Register (STATus:OPERation)", on page 543.
- **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`.

15.1.5.2 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.

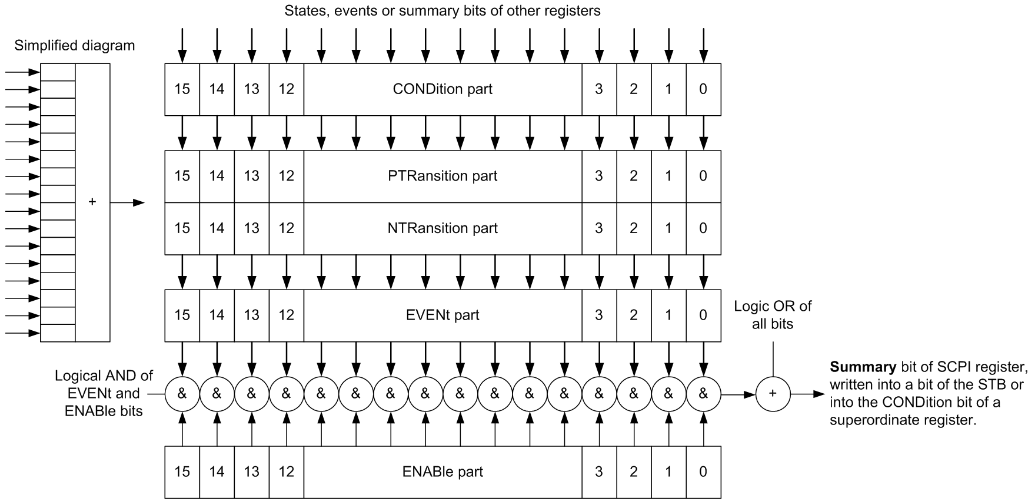


Figure 15-2: The status-register model

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.

15.1.5.3 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 15-2: 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 EVENt bit is set in the QUEStionable status register and the associated ENABle bit is set to 1. A set bit indicates a questionable instrument status, which can be specified in greater detail by querying the STATus:QUEStionable status register.

Bit No.	Meaning
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	`STATus:OPERation` status register summary bit The bit is set if an `EVENt` bit is set in the `OPERation` status register and the associated `ENABle` 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 `STATus:OPERation` status register.

15.1.5.4 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 15-3: Meaning of the bits used in the event status register

Bit No.	Meaning
0	Operation Complete This bit is set on receipt of the command *OPC 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.

Bit No.	Meaning
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.

15.1.5.5 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 15-4: Meaning of the bits used in the questionable status register

Bit No.	Meaning
0–15	Not used

15.1.5.6 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 15-5: Meaning of the bits used in the operation status register

Bit No.	Meaning
0	Calibrating The bit is set during the calibration phase.
1–2	Not used
3	Sweeping This bit is set during a sweep in automatic or single mode.
4–15	Not used

15.1.5.7 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]?`. 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.

15.1.5.8 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 15-6: Resetting the status reporting system

<table>
<tr><th>Event</th><th colspan="2">Switching on supply voltage
Power-On-Status-Clear</th><th rowspan="2">DCL, SDC
(Device Clear, Selected Device Clear)</th><th rowspan="2">*RST or SYSTem:PRESet</th><th rowspan="2">STATus:PRESet</th><th rowspan="2">*CLS</th></tr>
<tr><th>Effect</th><th>0</th><th>1</th></tr>
<tr><td>Clear STB, ESR</td><td>-</td><td>Yes</td><td>-</td><td>-</td><td>-</td><td>Yes</td></tr>
<tr><td>Clear SRE, ESE</td><td>-</td><td>Yes</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Clear PPE</td><td>-</td><td>Yes</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Clear error queue</td><td>Yes</td><td>Yes</td><td>-</td><td>-</td><td>-</td><td>Yes</td></tr>
<tr><td>Clear output buffer</td><td>Yes</td><td>Yes</td><td>Yes</td><td>1)</td><td>1)</td><td>1)</td></tr>
<tr><td>Clear command processing and input buffer</td><td>Yes</td><td>Yes</td><td>Yes</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="7">1) The first command in a command line that immediately follows a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.</td></tr>
</table>

15.1.6 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.

15.2 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 SGT 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;
}
```

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