



ROHDE & SCHWARZ

Test and Measurement
Division

Operating Manual

Option SMIQB60

Arbitrary Waveform Generator

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



Safety Instructions

Rohde & Schwarz makes every effort to keep the safety standard of its products up to date and to offer its customers the highest possible degree of safety. Our products and the auxiliary equipment required for them are designed and tested in accordance with the relevant safety standards. Compliance with these standards is continuously monitored by our quality assurance system. This product has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards. To maintain this condition and to ensure safe operation, observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, Rohde & Schwarz will be happy to answer them.

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

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

Symbols and safety labels

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

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

Safety Instructions

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

Tags and their meaning

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

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

Basic safety instructions

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

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

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



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



Informaciones de seguridad

Es el principio de Rohde & Schwarz de tener a sus productos siempre al día con los standards de seguridad y de ofrecer a sus clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas de seguridad vigentes. Nuestra sección de gestión de la seguridad de calidad controla constantemente que sean cumplidas estas normas. Este producto ha sido fabricado y examinado según el comprobante de conformidad adjunto según las normas de la CE y ha salido de nuestra planta en estado impecable según los standards técnicos de seguridad. Para poder preservar este estado y garantizar un funcionamiento libre de peligros, deberá el usuario atenerse a todas las informaciones, informaciones de seguridad y notas de alerta. Rohde&Schwarz está siempre a su disposición en caso de que tengan preguntas referentes a estas informaciones de seguridad.

Además queda en la responsabilidad del usuario utilizar el producto en la forma debida. Este producto solamente fue elaborado para ser utilizado en la industria y el laboratorio o para fines de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa pueda ser dañada. El uso del producto fuera de sus fines definidos o despreciando las informaciones de seguridad del fabricante queda en la responsabilidad del usuario. El fabricante no se hace en ninguna forma responsable de consecuencias a causa del maluso del producto.

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

Símbolos y definiciones de seguridad

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

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

Informaciones de seguridad

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

Palabras de señal y su significado

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

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

Informaciones de seguridad elementales

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

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

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

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

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Technical Information

Option SMIQB60

Arbitrary Waveform Generator

Technical Data

Waveform Memory, Interpolation

Output memory
Waveform length 1 to 524216 in steps of one sample value

Note: This waveform length cannot be compared directly to the corresponding values of conventional ARB generators. The SMIQB69 performs the oversampling required to suppress the aliasing effects by means of the analog filter automatically at realtime conditions by means of hardware interpolation, i.e., the wave to be stored does not lengthen by the oversampling factor. E.g., an oversampling of 1.62 is sufficient for a WCDMA signal. Compared to a conventional ARB providing an oversampling of 4, the output memory of the SMIQB60 corresponds to a 1.25 Msample memory.

Resolution	12 bits
Load time 512k I/Q-samples	4 s
Non-volatile memory	
Number of blocks	22 (one waveform occupies at least one block)
Block size	65527
Interpolation	
Interpolation bandwidth (-0.1dB)	0,375 * clock rate
Attenuation of the analog aliasing filter	> 70 dB

Clock generation

Clock rate	1 kHz to 40 MHz
Resolution	0.1 Hz
Mode	Internal or external

Signal output

Channels	2 (I and Q)
Output resistance	50 Ω
Output level (EMF, Peak)	
Normal mode	$\sqrt{I^2 + Q^2} = 1 \text{ V}$
Manual mode	-6 to 0 dB referred to 1 V, setting range up to 3 dB
Level difference of channels	< 0.2% with 1 kHz ¹⁾
Offset	< -54 dB in normal mode ¹⁾
Frequency response	
absolute	
up to 12 MHz	< 1 dB
up to 10 MHz	typ. 0.1 dB
group delay	
up to 10 MHz	typ. 1 ns
I/Q synchronism	
absolute	
up to 10 MHz	typ. 0.05 dB
group delay	
up to 10 MHz	typ. 0.5 ns
SFDR (sinewave 1 MHz, clock 4 MHz, up to 12 MHz)	> 60 dB

Triggering

Trigger modes	Auto, Retrig, Armed Auto, Armed Retrig
Trigger source	Internal or external
External trigger input	Threshold -2.5 to 2.5 V, impedance $1\text{ k}\Omega / 50\ \Omega$
External trigger frequency	< 10 MHz
External trigger delay	0 to 2^{16} sampling values
External trigger inhibit	0 to 2^{26} sampling values
Pulse width	> 50 ns

Trigger outputs

Number	2
Delay	0 to 524216 sampling values
On Time	1 to 524215 sampling values
Off Time	1 to 524215 sampling values
Level	TTL

Graphic Displays

CCDF	Determination and graphic display of the CCDF in the output memory of the loaded wave. Determination of crest factor. The CCDF functions of up to 3 of the latest loaded waves can be displayed simultaneously.
------	---

Use of WinIQSIM

WinIQSIM is a Windows software which allows for the calculation of various I and Q baseband signals on a personal computer (see Data Sheet AMIQ/WinIQSIM PD 757.3970.22). Moreover, it supports loading of the waves into the SMIQ and operation of the SMIQB60 option via the PC.




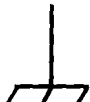




¹⁾ following a 1-hour warm-up time and calibration for 4 hours operating time and temperature variations $< 5^\circ\text{C}$

Safety Instructions

This unit has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:

							
Observe operating instructions	Weight indication for units >18 kg	PE terminal	Ground terminal	Danger! Shock hazard	Warning! Hot surfaces	Ground	Attention! Electrostatic sensitive devices require special care

1. The unit may be used only in the operating conditions and positions specified by the manufacturer. Unless otherwise agreed, the following applies to R&S products:
IP degree of protection 2X, Pollution severity 2, overvoltage category 2, altitude max. 2000 m.
The unit may be operated only from supply networks fused with max. 16 A.
2. For measurements in circuits with voltages $V_{rms} > 30 V$, suitable measures should be taken to avoid any hazards.
(using, for example, appropriate measuring equipment, fusing, current limiting, electrical separation, insulation).
3. If the unit is to be permanently wired, the PE terminal of the unit must first be connected to the PE conductor on site before any other connections are made. Installation and cabling of the unit to be performed only by qualified technical personnel.
4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.
5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.
If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.
6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.
7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.
Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.
8. If the unit has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.
If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.
9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.
Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.
Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.
Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.
(visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

continued overleaf

Safety Instructions

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.
11. Lithium batteries must not be exposed to high temperatures or fire.
Keep batteries away from children.
If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).
Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.
Do not short-circuit the battery.
12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.
13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.
14. Any additional safety instructions given in this manual are also to be observed.



Certificate No.: 99015

This is to certify that:

Equipment type	Order No.	Designation
SMIQ02B	1125.5555.02	Vector Signal Generator
SMIQ03B	1125.5555.03	
SMIQ04B	1125.5555.04	
SMIQ06B	1125.5555.06	
SMIQB10	1085.5009.02	Modulation Coder
SMIQB11	1085.4502.02/.04	Data Generator
SMIQB12	1085.2800.02/.04	Memory Extension
SMIQB14	1085.4002.02	Fading Simulator
SMIQB15	1085.4402.02	Second Fading Simulator
SMIQB17	1104.9000.02	Noise Generator
SMIQB20	1125.5190.02	Modulation Coder
SMIQB21	1125.5490.02	BER Measurement
SMIQB46	1105.0006.02	Low ACP
SMIQB47	1125.5090.02	Low ACP
SMIQB60	1136.4390.02	Arbitrary Waveform Generator

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

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

Conformity is proven by compliance with the following standards:

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

Affixing the EC conformity mark as from 1999

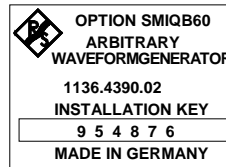
ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 2000-04-06

Central Quality Management FS-QZ / Becker

1 Installing Option SMIQB60

Option SMIQB60 has to be enabled by entering a key upon installation. An option label containing the installation key is supplied and has to be affixed to the rear of SMIQ for service and repair purposes. As a prerequisite, SMIQ must be fitted with hardware option SMIQB20 (modulation coder).



<== Example!

Fig. 1-1 Option label with example of installation key

Enabling the option
(see Fig. 1-2)

- Switch on SMIQ.
- Call UTILITIES menu (select with rotary knob, confirm with [SELECT] key).
- Call INSTALL menu ==> [SELECT].
- Call OPTION TO INSTALL menu ==> [SELECT].
- Select option SMIQB60 ARB MOD ==> [SELECT].
- Enter the 5- or 6-digit installation key shown on the option label into the INSTALLATION KEY line. Then press the [ENTER] key.
- You will receive a message confirming that the installation key has been verified and the option is installed.
- To make the option available, the unit has to be switched off and on again.
- Once the installation has been successfully completed, Option SMIQB60 can be selected from the main menu.

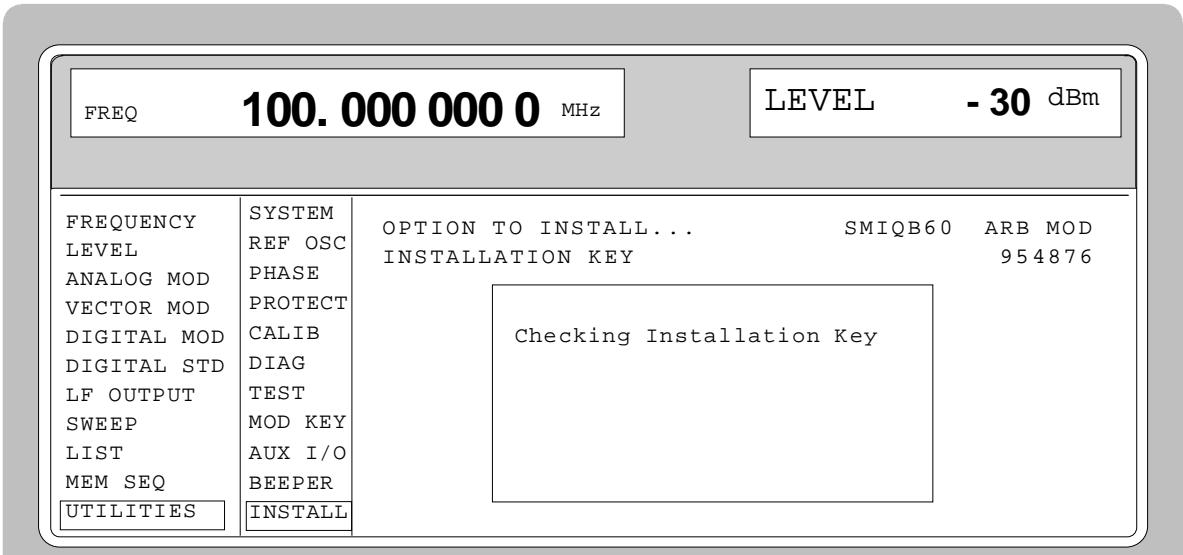


Fig. 1-2 Enabling Option SMIQB60

Once the installation has been completed, the availability of the new option can be checked in the module list in the UTILITIES DIAG CONFIG menu.

2 Manual Operation

The option SMIQB60, a two-channel ARB generator, is an integrated I/Q modulation source of the SMIQ. Thus, arbitrary modulation signals such as COFDM, multicarrier or noise can be generated. The software WinIQSIM enables the calculation of modulation signals and the loading of these signals into the instrument. Furthermore, signals which were calculated by a mathematical program such as Matlab may be transferred.

2.1 Function

Conventional ARB generators substantially consist of an output memory with series-connected D/A converter and analog filter. Due to the limited number of filters and their steepness the sampling rate often has to be set considerably higher than required by Nyquist's theorem, in order for the aliasing effects to be sufficiently suppressed by the analog filter. Fig. 2-1 shows these ratios for a 1-MHz sinewave signal. If a filter provides a cutoff-frequency of 11 MHz, a sampling rate of at least 12 MHz must be selected to make sure that the aliasing effects are suppressed sufficiently.

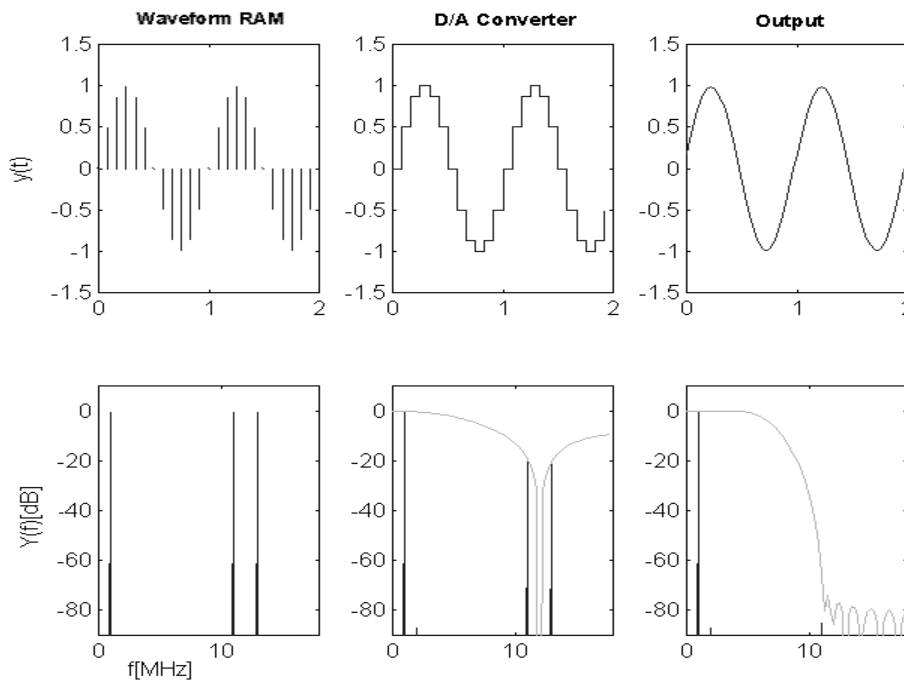


Fig. 2-1 Signal flow of ARB generator

This conception has been considerably improved in the option SMIQB60. The modulation signal is interpolated to a higher sampling rate by means of a very steep-edged, digital interpolation filter and is then output. The interpolation rate is set by the SMIQB60 automatically such that aliasing of the interpolated sampling rate is suppressed by the analog filter. This procedure offers the following advantages to the user:

1. Oversampling has to be selected such that the bandwidth of the interpolation filter exceeds that of the modulation signal. The following equation applies:

$$ov * int_bw \geq mod_bw,$$

ov == Oversampling,

int_bw == 0.375, standardized bandwidth of the interpolation filter,

mod_bw == bandwidth of the modulation signal standardized to symbol rate

The following value is thus obtained for the digital standard W-CDMA with the baseband filter $\sqrt{\cos}$, $\alpha = 0.22$:

$$mod_bw = \frac{(1 + \alpha)}{2} = 0.61, \Rightarrow ov \geq \frac{0.61}{0.375} = 1.63.$$

2. Due to the reduced oversampling, the duration of the signal increases with constant number of sampling values. Accordingly, the number of sampling values decreases with constant signal duration. Usually, with conventional ARB generators, the minimum oversampling is limited to 4. Thus, provided that the above parameters of the W-CDMA system apply, the 512 ksamples of the SMIQB60 correspond to $4/1.63 * 512 = 1256$ kSamples memory in a conventional ARB generator.

The block diagram in Fig. 2-2 roughly illustrates the structure of the ARB generator.

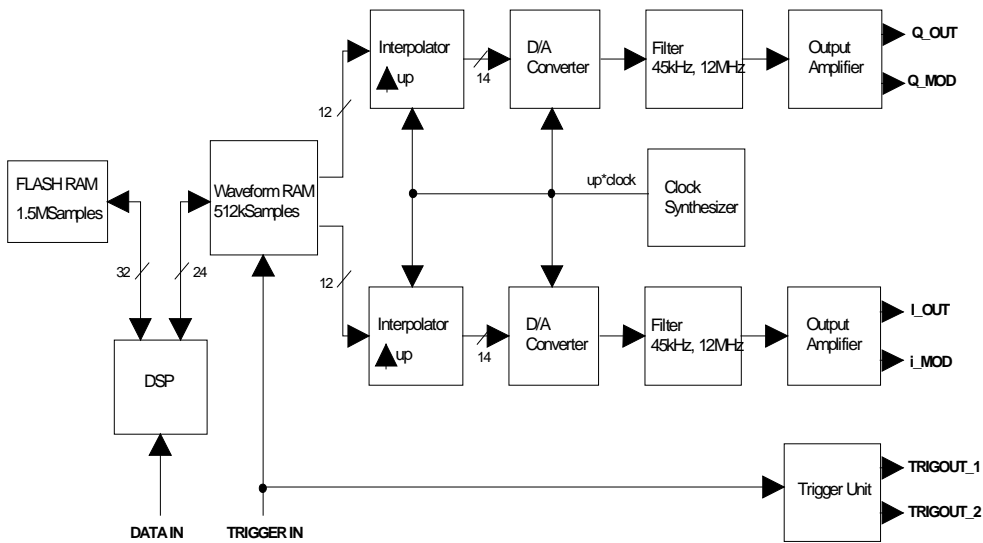


Fig. 2-2 Block diagram SMIQB60

The I/Q data are loaded by the host computer via the DATA IN interface to the DSP which passes them into a non-volatile FLASH RAM. The latter is organized in 22 blocks of 64ksamples, each. At least one block is occupied by each waveform. The I/Q data are subject to a convolution filter which limits the signal bandwidth. This is required for further processing.

If a waveform is selected, the I/Q data are loaded into the output memory. They are convoluted by a correction filter, which compensates all errors in the path to the I/Q modulator. In particular, the Si frequency response of the D/A converter as well as the frequency responses of the analog filter on the SMIQB60 and of the I/Q filter of the option SMIQB47 are corrected. Fig. 2-3 illustrates the further signal flow in the frequency and time domains.

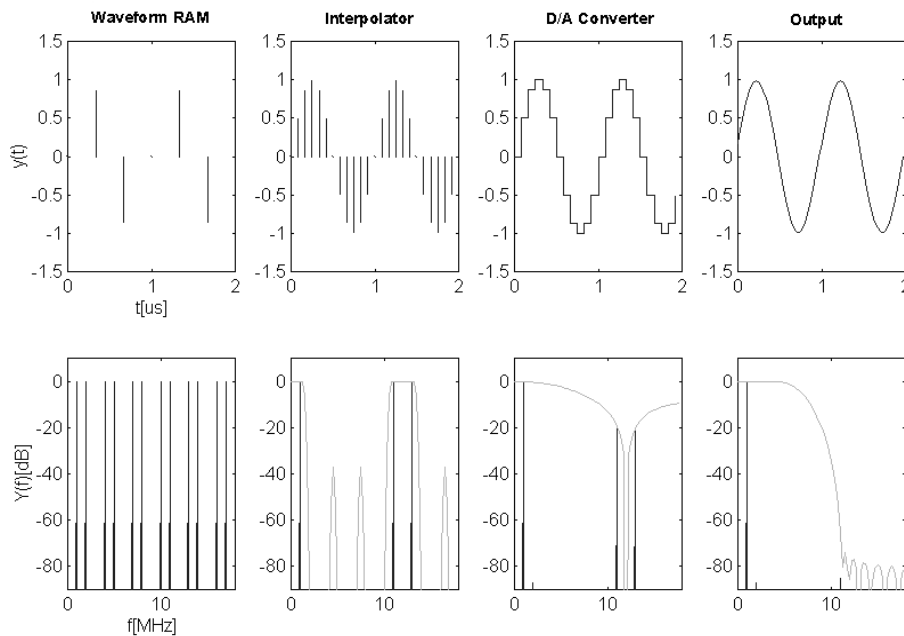


Fig. 2-3 Signal flow SMIQB60

A 1-MHz sinewave signal with $f_a = 3$ MHz is sampled by way of example. The sampling procedure causes aliasing to occur in the frequency range $(n \cdot 3 \pm 1)$ MHz. The following interpolation filter increases the sampling rate by the factor 4. This corresponds to a correct reconstruction of the additional sampling values in the time domain. Due to the sample-and-hold process at the output of the subsequent D/A converter, a stair-step signal is generated in the time domain which corresponds to a SI-weighting in the frequency domain. The analog filter compensates for the aliasing of the interpolated sampling rate, the output signal is a sinewave signal in the time domain. SMIQB60 automatically sets the interpolation rate such that aliasing is suppressed by the analog filter.

The sampling rate is increased internally by the factor 4, in order to avoid errors with CCDF determination of the waveform with low sampling rate.

The absolute value of the I/Q output signal is 0.5 Vs at 50Ω (= 0 dB) in Normal mode. This is the nominal output of the I/Q modulator. The output level may be varied in Manual mode between -6 dB and 3 dB in order to optimize the ACP in various channel offsets, e.g. The range above 0 dB is not specified, signal frequencies above 10 MHz may lead to a limitation.

The internal calibration of the SMIQB20, which is performed automatically with calibration of the vector modulation, corrects offset and gain errors to a minimum.

The trigger facilities of the SMIQB60 are similar to those of the data generator SMIQB11 (see Digital Modulation). The trigger generator consists of programmable counters which generate a periodic sequence with a pulse duty ratio of On Time/Off Time with settable start delay. E.g., to generate a slot trigger for a W-CDMA signal with a chip rate of 3.84 MHz, the following values are set:

$t_{\text{Slot}} = \text{Slot time}$

$t_{\text{Chip}} = \text{Chip time}$

$t_a = \text{Sampling time}$

$$t_{\text{Slot}} = 625\mu\text{s} = 2400 t_{\text{Chip}}, t_{\text{Chip}} = \text{ov} * t_a, \text{ov} = 2, \Rightarrow t_{\text{Chip}} = 4800 * t_a$$

On Time = 100 (for example) \Rightarrow Off Time = 4700.

The trigger signals are time-synchronous with the I/Q output signals. WinIQSIM supports the generation of predefined trigger signals (see Use of WinIQSIM Software).

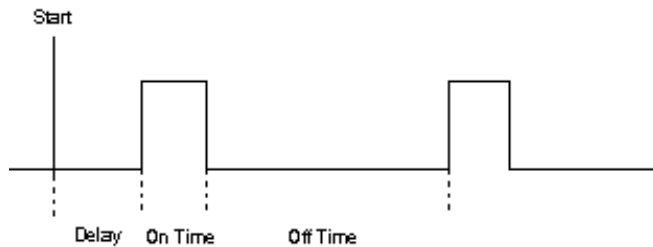


Fig. 2-4 Trigger signals SMIQB60

2.1.1 Use of WinIQSIM

The SMIQB60 is supported by WinIQSIM starting with version 3.30. Waveforms can be loaded via the IEC/IEEE bus into the FLASH memory, an individual operating menu allows for setting numerous SMIQ parameters. It must be noted that settings of WinIQSIM cannot be read from the waveform. WinIQSIM provides predefined settings for bit and symbol clock for the generation of trigger signals, slot and frame trigger and the restart signal for the BERT (SMIQB21). Si and filter compensation is not supported by WinIQSIM since these functions are carried out directly on the SMIQB60. Waveforms which contain these corrections may also be loaded in the SMIQB60. This is recognized and the internal correction filters are modified accordingly.

2.2 ARB MOD Menu

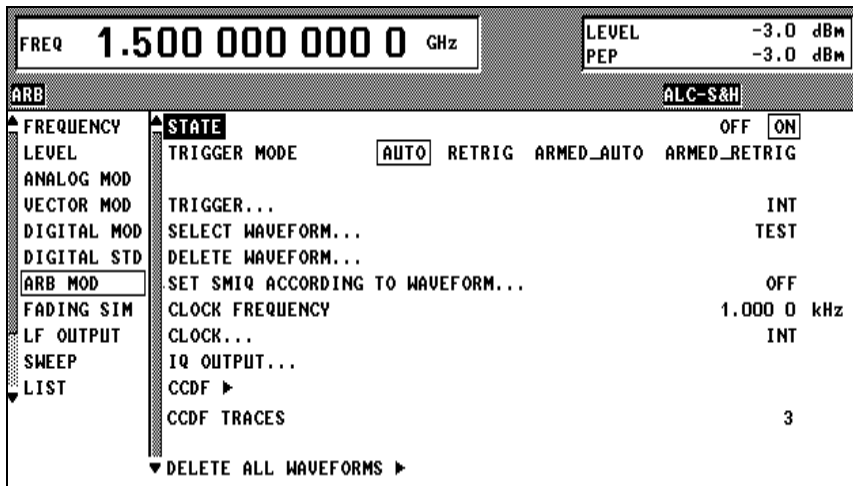


Fig. 2-5 ARB MOD menu

STATE

Switching on/off ARB function. The state is indicated in the status line.

ON

Loads the selected waveform in the output RAM and sets the module according to the current settings. This may last a few seconds depending on the length of the selected waveform. If vector modulation, digital modulation or digital standard were switched on, they are switched off automatically.

IEC/IEEE bus command :ARB:STAT ON

OFF

Modulation is switched off, output of ARB waveform stops.

IEC/IEEE bus command :ARB:STAT OFF

TRIGGER MODE

Configuration of run control of ARB mode.

AUTO

The calculated waveform (sequence) is output immediately and repeated in cycles. Trigger events are ignored.

IEC/IEEE bus command :ARB:SEQ AUTO

RETRIG

Cyclic repetition of output. A trigger event initiates a restart.

IEC/IEEE bus command :ARB:SEQ RETR

ARMED_AUTO

Only a trigger event initiates a start. Subsequent trigger events are ignored.

IEC/IEEE bus command :ARB:SEQ AAUT

ARMED_RETRIG

like ARMED_AUTO. Each following trigger event initiates a new start.

IEC/IEEE bus command :ARB:SEQ ARET

EXECUTE TRIGGER ➤

Initiates a trigger to start the ARB sequence (not displayed with TRIGGER MODE = AUTO).

IEC/IEEE bus command :TRIG:DM:IMM

TRIGGER...

Opens a window for setting the trigger facilities and the trigger outputs.

SELECT WAVEFORM...	Opens a window for selection of an ARB waveform and for display of its parameters.
DELETE WAVEFORM...	Opens a window for selection of an ARB waveform to be deleted.
SET SMIQ ACCORDING TO WAVEFORM...	Opens a window for configuration of the automatic setting of SMIQ parameters.
CLOCK FREQUENCY	Input value for the sample clock. If the clock is supplied by an external source, the applied frequency must be entered here. IEC/IEEE bus command :ARB:CLOC 4.096MHz
CLOCK...	Opens a window for selection of the clock source and delay of the clock signal.
IQ OUTPUT...	Opens a window for entry of the IQ level and mode.
CCDF >	Display of the Complementary Cumulative Distribution Function of the waveform loaded.
CCDF TRACES	Entry of the number of CCDFs. 1 to 3 may be selected.
DELETE ALL WAVEFORMS >	All waveforms are deleted (after being confirmed by the user).

2.2.1 ARB MOD - TRIGGER Menu

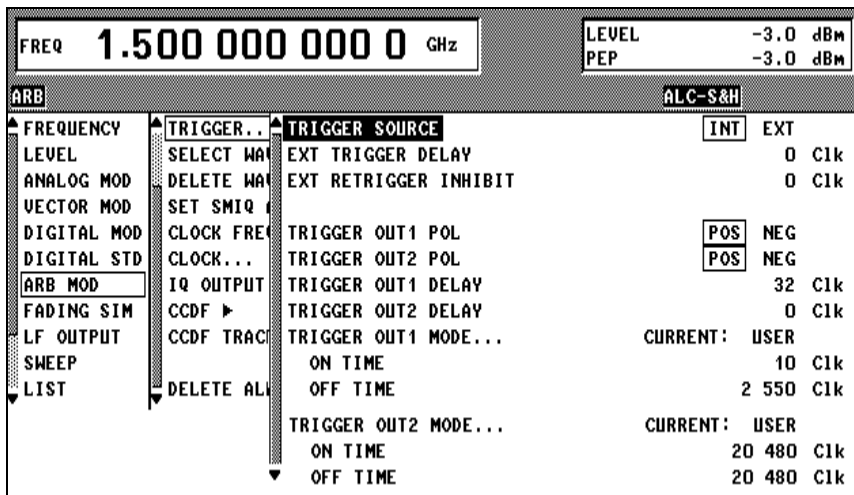


Fig. 2-6 ARB MOD - TRIGGER... menu

TRIGGER... Opens a window for setting the trigger facilities and the trigger outputs.

TRIGGER SOURCE

Configuration of trigger source.

INT Manually via EXECUTE TRIGGER or via software.

IEC/IEEE bus command :ARB:TRIG:SOUR INT

EXT Triggering with active edge at input socket.

IEC/IEEE bus command :ARB:TRIG:SOUR EXT

EXT TRIGGER DELAY

Delays the start of sequence by the indicated samples after occurrence of an external trigger event. The resolution is 2 samples with clock rates (CLOCK) above 20 MHz (otherwise, 1 sample).

IEC/IEEE bus command :ARB:TRIG:DEL 234

EXT RETRIGGER INHIBIT

Retriggering is inhibited until the sequence has reached the indicated sample.

IEC/IEEE bus command :ARB:TRIG:INH 345

TRIGGER OUT1(2) POL

Signal polarity at the trigger outputs.

POS active state: positive voltage

IEC/IEEE bus command
:ARB:TRIG:OUTP1:POL POS

NEG active state: 0 or lower voltage

IEC/IEEE bus command
:ARB:TRIG:OUTP2:POL NEG

TRIGGER OUT1(2) DELAY

Delay of the supplied trigger signals by the set number of samples.

IEC/IEEE bus command :ARB:TRIG:OUTP:DEL 765

(TRIGGER...) TRIGGER OUT1(2) MODE

The user may select one of the displayed modes for generation of the trigger output signals.

Depending on the system, WinIQSIM can calculate clock signals for BIT, SYMBOL, SLOT, FRAME and the restart signal (sequence) and transmit them together with the waveform. These modes set the counters for ON TIME and OFF TIME (see below). The names are defined as modes by WinIQSIM, stored in the waveform where they can be selected. The maximum number of defined counters is 4. It may occur that only the SEQUENZ and USER modes can be provided since the entirety of modes is not always available for all systems.

BIT_CLK edge at beginning of each bit
SYMB_CLK edge at beginning of each modulation symbol
SLOT_CLK edge at beginning of each slot
FRAM_CLK edge at beginning of each frame
SEQUENZ edge at beginning of each sequence (may, e.g., be used as restart signal for BERT)
PULSE pulse defined by WinIQSIM user
USER The user defines a pulse by means of the parameters for ON and OFF TIME.

IEC/IEEE bus command :ARB:TRIG:OUTP:MODE USER

....ON TIME

Length of the active state of the output trigger signals indicated as number of samples. Can be modified only, if MODE = USER.

This time is repeated after OFF TIME has run off.

IEC/IEEE bus command :ARB:TRIG:OUTP:ONT 3789

....OFF TIME

Length of the non-active state of the output trigger signals indicated as number of samples. Can be modified only, if MODE = USER.

IEC/IEEE bus command :ARB:TRIG:OUTP2:OFFT 639

2.2.2 ARB MOD - SELECT WAVEFORM Menu

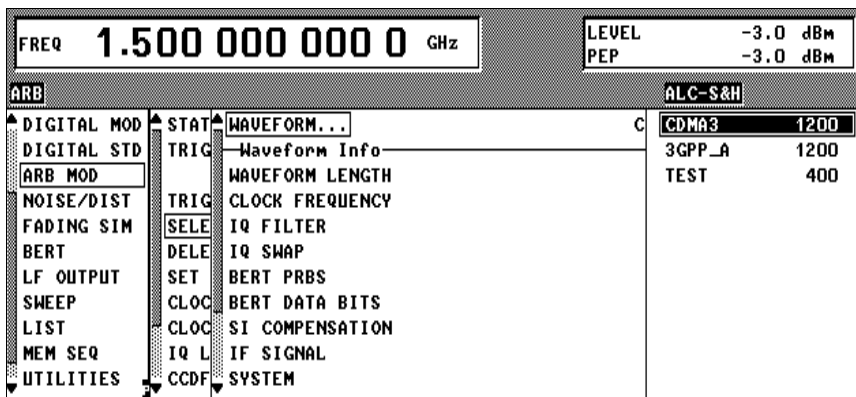


Fig. 2-7 ARB MOD - SELECT WAVEFORM... menu

SELECT WAVEFORM... Opens a window for selection of an ARB waveform and for display of its parameters.

WAVEFORM A list of ARB waveforms is offered to the right. The length of the waveforms is indicated in samples. The user selects a waveform from this list, which then becomes the active waveform. Further information on this waveform is then provided.

IEC/IEEE bus command : ARB:WAV:SEL `TEST`

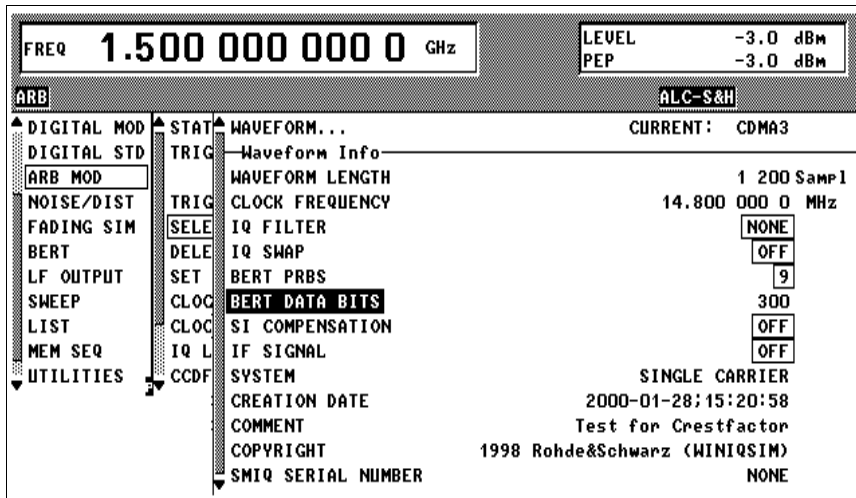


Fig. 2-8 ARB MOD - WAVEFORM INFO menu

SELECT WAVEFORM... ----Waveform Info -----

These lines are for display purposes only, they cannot be modified. They are filled with values from the active waveform when opening the menu. After being confirmed by the user they are updated via (SELECT). Setting parameters are not set until this confirmation and errors are signaled with conflicts, when the menu is left via RETURN (see SET SMIQ ACCORDING TO WAVEFORM menu). IEC/IEEE bus commands have the form of queries.

SELECT WAVEFORM...	WAVEFORM LENGTH	<p>Displays the number of samples contained in the waveform.</p> <p>IEC/IEEE bus command :ARB:WAV:POIN?</p>
	CLOCK FREQUENCY	<p>Provides the sample rate which the waveform has been generated for. This value is always entered as CLOCK FREQUENCY parameter of the ARB MOD menu with loading a waveform (independent of SET SMIQ ACCORDING TO WAVEFORM).</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'CLOCK'</p>
	IQ FILTER	<p>Displays the setting used for calculation of the waveform in WinIQSIM. WinIQSIM sets this value to 0 (OFF), if the waveform is calculated for the SMIQ in particular. If, however, a compensation for an IQ filter is taken into account (for example when calculating the waveform for AMIQ), the compensation is automatically counted back by the SMIQ. Independently from this setting, however, a suitable IQ filter can be selected in the SMIQ. Compensation of the IQ filter is executed automatically by the SMIQ.</p> <p>The value of the waveform is used in the VECTOR MOD menu for the IQ filter if this is enabled in the SET SMIQ ACCORDING TO WAVEFORM menu.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'LACP FILTER'</p>
	IQ SWAP	<p>Indicates the setting used with the waveform calculation in WinIQSIM. The value is used in the VECTOR MOD menu for the IQ SWAP setting after enabling in the SET SMIQ ACCORDING TO WAVEFORM menu.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'IQ SWAP'</p>
	BERT PRBS	<p>Displays the type of PRBS used for the data in WinIQSIM, if the data have been prepared for a BER measurement.</p> <p>The setting is used in the BERT menu for setting the type of PRBS after clearing in the SET SMIQ ACCORDING TO WAVEFORM menu. A waveform cannot be used always for a BER measurement. If not, the display reads NONE.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'PRBS LENGTH'</p>
	BERT DATA BITS	<p>Indicates the number of data bits in a waveform, if the data have been prepared for a BER measurement by WinIQSIM. If the waveform cannot be used for a BER measurement, zero is displayed, here.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'BERT DATABITS'</p>

(SELECT WAVEFORM...) SI COMPENSATION	<p>ON indicates that the SI compensation of WinIQSIM was taken into account with calculation of the waveform. Since the SMIQ, independent of that calculation, also takes into account the SI compensation, it is disabled in WinIQSIM, if the waveform is calculated particularly for the SMIQ. It is however counted back by the SMIQ, if it was taken into account e.g., with calculation of a waveform for the AMIQ.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'SI COMPENSATED'</p>
IF SIGNAL	<p>ON indicates that the waveform was converted into an IF signal by WinIQSIM. This signal is not intended to be used as IQ vector. However, the user may derive it from the I-channel output and apply as IF signal.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'IF_SIGNAL'</p>
SYSTEM	<p>Indicates the standard used to calculate the waveform in WinIQSIM. The following standards have been defined: Single Carrier, Multi Carrier, Multi Carrier Mixed Signal, 3GPP W-CDMA, IS-95, CDMA2000 and Import.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'SYSTEM'</p>
CREATION DATE	<p>Displays the creation date of the waveform. Provides the user with information and is added automatically with calculation in WinIQSIM.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'DATE'</p>
COMMENT	<p>Is provided for information purposes and may be entered as comment text in WinIQSIM.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'COMMENT'</p>
COPYRIGHT	<p>Indicates whether the waveform was generated using the protected software WinIQSIM.</p> <p>IEC/IEEE bus command :ARB:WAV:TAG? 'COPYRIGHT'</p>
SMIQ SERIAL NUMBER	<p>Is important, if the wave was generated in WinIQSIM with IQ FILTER = ON. In this case, filter coefficients have been used for compensation, which are best only for SMIQs with this serial number. Otherwise a warning is displayed.</p>

2.2.3 ARB MOD - DELETE WAVEFORM Menu

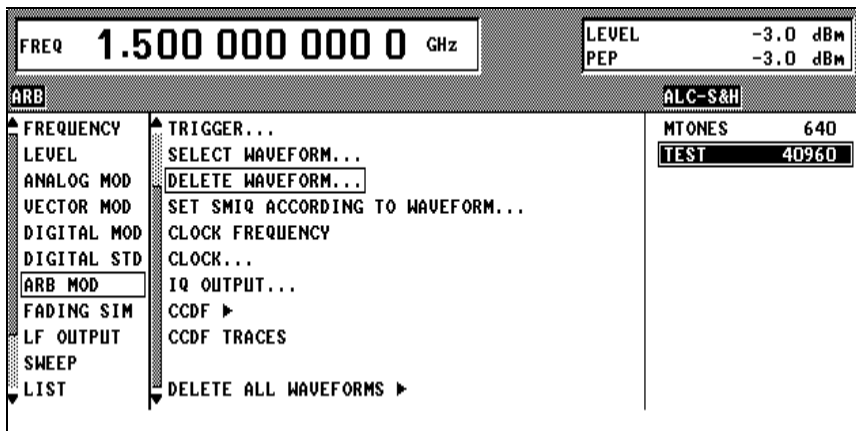


Fig. 2-9 ARB MOD - DELETE WAVEFORM... menu

DELETE WAVEFORM... Opens a window for selection of an ARB waveform to be deleted. A list of ARB waveforms including information on their lengths is offered to the right, where the user may select a waveform.

IEC/IEEE bus command :ARB:WAV:DEL `TEST`

2.2.4 ARB MOD - SET SMIQ ACCORDING TO WAVEFORM Menu

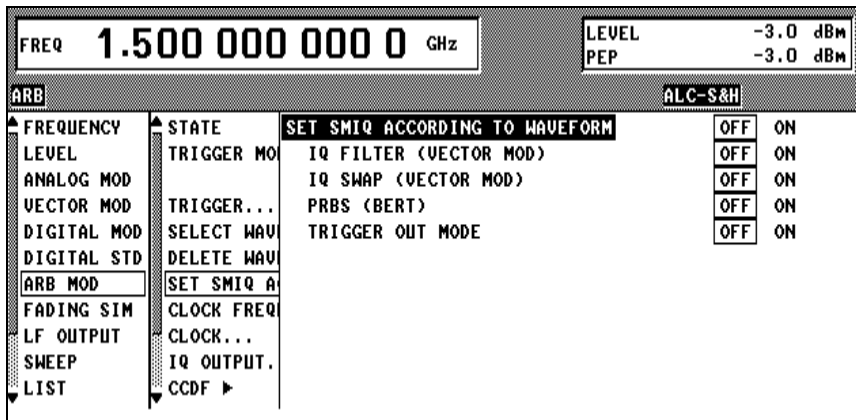


Fig. 2-10 ARB MOD - SET SMIQ ACCORDING TO WAVEFORM menu

SET SMIQ ACCORDING TO WAVEFORM... Opens a window for configuration of the automatic setting of SMIQ parameters.

SET SMIQ ACCORDING TO WAVEFORM ON In any case, settings on the SMIQ are made based on the information from the waveform to be loaded.

IEC/IEEE bus command :ARB:ASET:STAT ON

OFF No settings are made, even if the following configurations are set ON. CLOCK FREQUENCY in the ARB MOD menu is always set.

IEC/IEEE bus command :ARB:ASET:STAT OFF

(SET SMIQ ACCORDING TO WAVEFORM...) ...IQ FILTER (VECTOR MOD)

The parameter IQ FILTER (filter of LACP Option SMIQB47) is set in the VECTOR MOD menu. If a waveform in WinIQSIM was compensated with the frequency responses of this filter, it should be switched on. A warning is output, if the waveform is compensated, however, this compensation does not apply for an SMIQ of this serial number or if the option is not fitted to the SMIQ.

ON Parameter is set
IEC/IEEE bus command
:ARB:ASET:DM:IQF ON

OFF Parameter is not set
IEC/IEEE bus command
:ARB:ASET:DM:IQF OFF

...IQ SWAP (VECTOR MOD)

The IQ SWAP parameter in the VECTOR MOD menu is set. If a waveform has been generated in WinIQSIM for this mode, it should be switched on. A warning is output, if the parameter is not set as indicated in the waveform.

ON Parameter is set
IEC/IEEE bus command
:ARB:ASET:DM:IQSW ON

OFF Parameter is not set
IEC/IEEE bus command
:ARB:ASET:DM:IQSW OFF

...PRBS (BERT)

The type of PRBS in the BERT menu is set. If a waveform has been generated in WinIQSIM with this PRBS, the latter should be selected with BER measurement. A warning is output, if the parameter is not set as indicated in the waveform.

ON Parameter is set
IEC/IEEE bus command
:ARB:ASET:BERT:TYPE ON

OFF Parameter is not set
IEC/IEEE bus command
:ARB:ASET:BERT:TYPE OFF

...TRIGGER OUT MODE

The parameters TRIGGER OUT1 MODE and TRIGGER OUT2 MODE in the ARB MOD TRIGGER... menu are set. Thus, the user can select the function of the SMIQ trigger outputs in WinIQSIM (see TRIGGER menu).

ON Parameter is set
IEC/IEEE bus command
:ARB:ASET:TRIG:MODE ON

OFF Parameter is not set
IEC/IEEE bus command
:ARB:ASET:TRIG:MODE OFF

2.2.5 ARB MOD - CLOCK... Menu

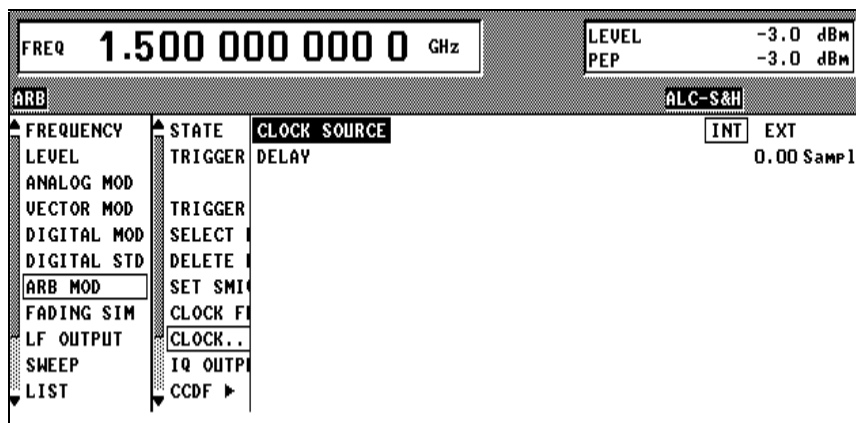


Fig. 2-11 ARB MOD - CLOCK... menu

CLOCK... Opens a window for selection of the clock source and delay of the clock signal.

CLOCK SOURCE Defines the source for the sample clock.

INT Clock is generated internally.

IEC/IEEE bus command :ARB:CLOC:SOUR INT

EXT Clock must be applied at the socket.

IEC/IEEE bus command :ARB:CLOC:SOUR EXT

DELAY

Delay of the modulation signal against the clock signal. This may be used, e.g., for synchronization with a second instrument, to obtain time-synchronous modulation signals of both instruments.

IEC/IEEE bus command :ARB:CLOC:DEL 0.55

2.2.6 ARB MOD - IQ OUTPUT... Menu

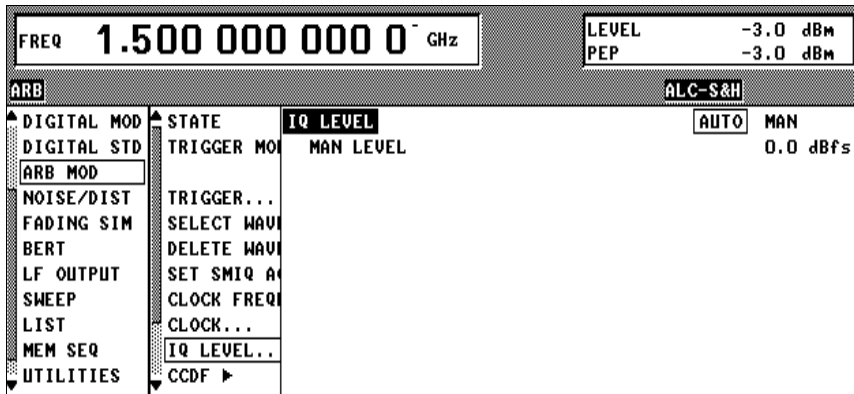


Fig. 2-12 ARB MOD - IQ OUTPUT... menu

IQ OUTPUT...

Opens a window for entry of the IQ level and automatic level setting.

IQ LEVEL

Defines the operating mode for setting the IQ level.

AUTO The level is set automatically to a maximum sum vector of 0.5 V for maximum input level of the IQ modulator. The subsequent level entry is not effective.

IEC/IEEE bus command

:ARB:IQ:LEV:MODE AUTO

MAN

The level is set using the level entry below. The instrument data can not be guaranteed for entry values above 0 dB, since the output level is limited. However, the signal-to-noise ratio, e.g., may thus be increased.

IEC/IEEE bus command

:ARB:IQ:LEV:MODE MAN

MAN LEVEL

Indicates the IQ level referred to maximum voltage.

Range: -6 ... 3 dBfs

IEC/IEEE bus command :ARB:IQ:LEV -2.5DB

IQ SKEW

Determines the delay between I and Q channel. Positive values delay I against Q.

IEC/IEEE bus command :ARB:IQ:SKEW -250ps

3 Remote Control - Arbitrary Waveform Generator

3.1 ARB System - Description of IEC/IEEE Bus Commands

Refer to chapter "ARB Waveform Format" following the information on the IEC/IEEE bus commands where explanation of waveform formats and tags is provided.

Command	Parameter	Default unit	Remarks
:ARB			
:STATe	ON OFF		
:SEQUence	AUTO RETRigger AAUTO ARETrigger		
:WAVEform			
:SElect	'name'		
:DElete	'name'		No query
:DATA	'name', <blockdata>		Not readable
:CATalog?	⇒ name[,name]...		Query only
:LENGth?	⇒ n		Query only
:TAG? '<tagname>'	⇒ <string>		Query only
:FREE?	⇒ n		Query only
:POINts?	⇒ n		Query only
:TRIGger			
:SOURce	INTernal EXTernal		
:DElay	0 to 65 535	(clocks)	
:INHibit	0 to 67.1E6	(clocks)	
:OUTPut<i>	with <i> = [1] 2		
:POLarity	POSitive NEGative		
:DElay	0 to 524 255	(clocks)	
:MODE	USER 'mode_string'		
CATalog?	⇒ name[,name]...		Query only
:ONTime	0 to 524 255	(clocks)	
:OFFTime	0 to 524 255	(clocks)	
:ASET			
:STATe	ON OFF		
:DM			
:IQFilter	ON OFF		
:IQSWap	ON OFF		
:BERT			
:TYPE	ON OFF		
:TRIGger			
:MODE	ON OFF		
:CLOCK	1 kHz to 40.0 MHz	Hz	
:SOURce	INTernal EXTernal		
:DElay	0.0 to 0.99	(clocks)	
:IQ			
:LEVel	-3 to 6	dB	
:MODE	MANuell AUTO		
:SKEW	-1000...1000		

:ARB:STATe ON | OFF

This command switches on (ON) or off (OFF) the arbitrary waveform generator.

Example: :ARB:STAT ON

*RST value is OFF

:ARB:SEQuence AUTO | RETRigger | AAUTo | ARETrigger

This command configures the sequence control of the ARB mode.

AUTO The waveform is repeated in cycles.

RETRigger Cyclic repetition; new start upon trigger.

AAUTo Armed Auto; starts after a trigger event, further triggers are ignored.

ARETrigger Armed Retrigger; starts after a trigger event, each new trigger initiates a new start.

Example: :ARB:SEQ RETR

*RST value is AUTO

:ARB:WAVeform:SElect '<name>'

This command is used to select a waveform to be the active waveform.

Example: :ARB:WAV:SEL 'name'

:ARB:WAVeform:DElete '<name>'

This command is used to select a waveform to be deleted. This command triggers an event and, therefore, has no *RST value.

Example: :ARB:WAV:DEL 'name'

:ARB:WAVeform:DATA '<name>', <binary block data>

This command is used to load waveform data into the SMIQ and store them under a name. Refer to chapter "ARB Waveform Format" for more detailed information on this command.

Example: :ARB:WAV:DATA 'name'

:ARB:WAVeform:CATalog?

This command calls the list of all waveforms.

Example: :ARB:WAV:CAT?

:ARB:WAVeform:CATalog:LENGth?

This command requests for the number of waveforms in the list.

Example: :ARB:WAV:CAT:LENG?

:ARB:WAVeform:TAG? '<tagname>'

This command requests for the content of a tag. Refer to the following chapter "ARB Waveform Format" for more detailed information on tags.

Example: :ARB:WAV:TAG 'tagname'

:ARB:WAVeform:FREE?

This command requests for free memory space for further waveforms.

Example: :ARB:WAV:FREE?

:ARB:WAVeform:POINts?

This command returns the number of samples contained in a waveform.

Example: :ARB:WAV:POIN?

:ARB:TRIGger:SOURce INTernal | EXTernal

This command allows for configuration of the trigger source.

INT Triggering via IEC/IEEE bus or using the Execute comment of manual control.

EXT Triggering via the external trigger input.

Example: :ARB:TRIG:SOUR EXT

*RST value INT

:ARB:TRIGger:DELay 0 to 65 535

This command is used to enter the trigger delay (as number of samples).

Example: :ARB:TRIG:DEL 234

*RST value is 0

:ARB:TRIGger:INHibit 0 to 67.1E6

This command sets the time of trigger inhibition (as number of samples).

Example: :ARB:TRIG:INH 345

*RST value is 0

:ARB:TRIGger:OUTPut[1]2:POLarity POSitive | NEGative

This command is used to define the signal polarity at the trigger output. I

POSitive positive voltage with active state

NEGative voltage 0 or low, positive with active state

Example: :ARB:TRIG:OUTP2:POL POS

*RST value is NEG

:ARB:TRIGger:OUTPut[1]2:DELay 0 to 524 255

This command defines the signal delay at the trigger output indicated as number of samples.

Example: :ARB:TRIG:OUTP2:DEL 765

*RST value is 0

:ARB:TRIGger:OUTPut[1]2:MODE USER | 'mode_string'

This command allows for selection of a mode for generation of the trigger output signals. The counters for ON TIME and OFF TIME are set.

Example: :ARB:TRIG:OUTP2:MODE USER

*RST value is USER

:ARB:TRIGger:OUTPut[1]2:MODE:CATalog?

This command initiates the output of a list of all available modes.

Example: :ARB:TRIG:OUTP2:MODE:CAT?

:ARB:TRIGger:OUTPut[1]|2:ONTime 0 to 524 255

This command sets the length of the active state of output trigger signals (indicated as number of samples). Setting is only possible, if :ARB:TRIG:OUTP:MODE is set to USER.

Example: :ARB:TRIG:OUTP2:ONT 765 *RST value is 0

:ARB:TRIGger:OUTPut[1]|2:OFFTime 0 to 524 255

This command sets the length of the non-active state of output trigger signals (indicated as number of samples). Setting is only possible, if :ARB:TRIG:OUTP:MODE is set to USER.

Example: :ARB:TRIG:OUTP2:OFFT 765 *RST value is 0

:ARB:ASET:STATe ON | OFF

This command is used to switch on (ON) or off (OFF) the automatic setting of SMIQ parameters by the waveform to be loaded.

Example: :ARB:ASET:STAT ON *RST value is OFF

:ARB:ASET:DM:IQFilter ON | OFF

This command is used to set the parameter IQ FILTER in the VECTOR MOD menu (ON) or it remains unaffected (OFF). Commands :DM:IQ:FILT:STAT and :DM:IQ:FILT:FREQ.

Example: :ARB:ASET:DM:IQF ON *RST value is OFF

:ARB:ASET:DM:IQSWap ON | OFF

This command is used to set the parameter IQ SWAP in the VECTOR MOD menu (ON) or it remains unaffected (OFF). Command :DM:IQSW:STAT.

Example: :ARB:ASET:DM:IQSW ON *RST value is OFF

:ARB:ASET:BERT:TYPE ON | OFF

This command is used to set the type of PRBS in the BERT menu (ON) or it remains unaffected (OFF). Command :BERT:SET:TYPE.

Example :ARB:ASET:BERT:TYPE ON *RST value is OFF

:ARB:ASET:TRIGger:MODE ON | OFF

This command is used to set the parameters TRIGGER OUT1 MODE and TRIGGER OUT2 MODE in the ARB MOD TRIGGER...menu. Command :ARB:TRIG:OUTP:MODE.

Example: :ARB:ASET:TRIG:MODE ON *RST value is OFF

:ARB:CLOCK 1kHz to 40.0 MHz

This command specifies the entry value for the sample clock.

Example: :ARB:CLOC 4.096MHz *RST value is 0

:ARB:CLOCK:SOURce INTernal | EXTernal

This command is used to select the source for the sample clock.

INTernal The internal clock generator is used.

EXTernal The clock is applied externally at the socket.

Example: :ARB:CLOC:SOUR EXT

*RST value is INT

:ARB:CLOCK:DELay 0.0 to 0.99

This command is used to set the delay of the modulation signal against the clock signal.

Example: :ARB:CLOC:DEL 0.55

*RST value is 0

:ARB:IQ:LEVel -3 dB to +6 dB

This command sets the IQ level referred to maximum input level.

Example: :ARB:IQ:LEV 1

*RST value is 0

:ARB:IQ:LEVel:MODE MANuell | AUTO

This command is used to select the operating mode for setting the IQ level.

MANual Level setting with subsequent entry.

AUTO Automatic level setting to 0.5 V.

Example: :ARB:IQ:LEV:MODE MAN

*RST value is AUTO

:ARB:IQ:SKEW -1000...1000 ps

The command determines the delay between I and Q channel.

Example: :ARB:IQ:SKEW -250ps

*RST value is 0

3.2 ARB Waveform Format

Waveform format The waveform format is used for transmission via the IEC/IEEE bus and the serial interface, it is packed in a binary block command.

Tags A tag-oriented format is used. Tags are self-contained information units. They have the general format

{Name: Data} or {Name-length: Data}

The colon separates the name and data sections. For the sake of clarity the colon is always followed by a blank.

Name identifies the tag. It is always specified in upper-case characters.

Data are tag-specific but in most cases plain text in ASCII format.

Length indicates the number of bytes of the WAVEFORM tag and consists of:

	number of digits of the Start -value	(1 to 7)
+	length of ",#"	(2 bytes)
+	number of I/Q pairs * 4	(2 bytes for each I- and Q-value).

Several tags in one waveform Tags may be interleaved. Normally the order of the tags within a waveform is irrelevant, but there may be exceptions. All tags can but need not be contained in a waveform. Exceptions are described with the individual tags.

Unknown tags are not evaluated by SMIQ but are stored unchanged and without an error message and can be read again.

The following tags are defined:

{TYPE: magic, xxxxxxxx}

(indispensable)

The TYPE tag identifies this waveform as a valid SMIQ waveform. The tag must be the first tag in the waveform. xxxxxxxx is an ASCII-coded checksum over the data range of the WAVEFORM tag in this waveform. It is calculated by the following algorithm where 'start' is a pointer to the first byte after the double dagger '#' sign in the WAVEFORM tag and 'length' denotes the number of bytes between 'start' and the final brace (excluding the latter; 'length' must be a multiple of 4):

```
UINT32 checksum(void *start, UINT32 length)
{
    UINT32 i, result = 0xA50F74FF;

    for(i=0; i < length/4; i++)
        result = result ^ ((UINT32 *)start)[i];

    return(result);
}
```

The checksum is used for recognizing transmission errors. If the TYPE tag contains 0 or a non-numerical value for the checksum, it is ignored by the SMIQ.

'magic' identifies the type of the waveform and has the following value:

WV The waveform is a complete, self-contained waveform. When already available on the target medium, the previous version is overwritten.

Note: *Because of the flexible, tag-based form of the waveforms, a version number is not required.*

{CLOCK: frequency} (indispensable)

This tag specifies the clock frequency with which the waveform should be output. A query of ARB: CLOcK? after loading the waveform returns the values set by means of the {CLOCK: . . . } tag.

{COMMENT: string} (Important for TYPE = WV_ADD)

The tag contains a plain-text ASCII string of any length. The string is not evaluated in the SMIQ, it serves for the output of keywords on the PC and for describing the waveform. The string may contain all printable ASCII characters except the closing brace.

{COPYRIGHT: string} (optional)

This tag contains the name under which WinIQSIM (or other programs for waveform generation) are registered. The string may contain all printable ASCII characters except the closing brace.

{DATE: yyyy-mm-dd;hh:mm:ss} (optional)

This tag contains date and time at which the waveform was generated. The year should be specified with four digits. SMIQ does not evaluate this tag.

{WAVEFORM-length: 0, #xxxxxxxxxxxx...} (indispensable)

This tag contains the actual waveform data.

The quantity *length* indicates the number of bytes of the WAVEFORM tag and consists of:

- + length of ",#" (2 bytes)
- + number of I/Q pairs * 4 (2 bytes for each I- and Q-value).

Example:

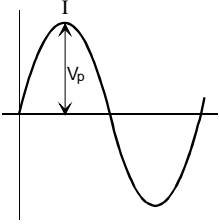
{WAVEFORM-403: 0, # I Q I Q I Q I Q I Q }

403 Bytes

xxxxxxx... are binary(!) data, that alternately contain I and Q samples, the first sample being a I sample. Each sample consists of two bytes, the least-significant one (LSByte) is the first.

The two bytes of a sample cover the value range 0x300 ... 0xFD00 (0x768 ... 64768). This value is transferred to the D/A converter unchanged.

Different output levels are applied to the output connectors of SMIQ:

	<p>Binary value of the sample</p> <p>identical with the value of the waveform D/A converter</p>	<p>Asymmetric outputs</p> <p>amplitude V_p at 50Ω between inner and outer conductor of I and Q output</p>  <p>Valid as Q output also!</p>
OUTP:I Q FIX	<p>0x300 (768) 0x8000 (32768) 0xFD00 (64768)</p>	<p>0 V 0.25 V 0.5 V</p>
OUTP:I Q VAR	<p>0x300 (768)</p>	<p>0 V</p>
<p>OUTP:I Q INV</p> <p>Same level as the waveform for VAR, phase shifted by 180°</p>	<p>0x8000 (32768) 0xFD00 (64768)</p>	<p>0.5 V 1 V</p>

3.2.1 Creating a Waveform „Manually“

We will use to example of a sine function in the I channel and a cosine function in the Q channel, each with 20 points, to explain how a waveform file SICO.WV is generated.

The sine and cosine values are calculated by a short program written in the programming language C (see the following example for creating a C-program). They are stored in the file SICO.TXT as follows:

Contents of SICO.TXT:

Sine (I) Cosine (Q)

0.000000	1.000000
0.309017	0.951057
0.587785	0.809017
0.809017	0.587785
0.951057	0.309017
1.000000	-0.000000
0.951056	-0.309017
0.809017	-0.587785
0.587785	-0.809017
0.309017	-0.951056
-0.000000	-1.000000
-0.309017	-0.951057
-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

The decimal values in SICO.TXT should be normalized such that they are in the between -1.0 and $+1.0$. The waveform file SICO.WV will be based on the contents of this file.

To be read by SMIQ these waveform data must be coded binary and packed into an appropriate WAVEFORM information unit.

SMIQ recognizes a great variety of information units called tags. A tag consists of a name and a data set and is enclosed in curved brackets. The tag is a kind of label carrying the information what SMIQ should do with the data set (see also section „ARB Waveform Format“ and step 3 of the following instructions).

The following steps outline how to create the waveform file SICO.WV:

Step 1

The values from the file SICO.TXT must be converted into binary format consisting of integer numbers without a sign and with 16-bit width. The numeric range between -1.0 and $+1.0$ corresponds to the modulation range of the waveform D/A converter of 64000.

+1.0 →	64768]	
0.0 →	32768	}	64000
-1.0 →	768]	

A further C-program is suitable for creating the binary data set from the ASCII values stored in SICO.TXT file (see following example for creating a C-program). This program stores the binary data set to a file called SICO.WV.

The contents of the file SICO.WV reads as follows:

```
IQIQIQIQIQIQI ... IQ
```

Explanation: *There is no readable representation for binary values in this document. This is why we use the sequence IQIQIQ to characterize the binary code in the present example.*

Step 2

The file SICO.WV contains now the binary data set corresponding to the 20 I/Q pairs. Before this binary data set can be further processed in step 3, the TYPE tag

{TYPE: WV, xxxxxxx} must be placed in front.

The TYPE tag must be the first entry in a WAVEFORM. The TYPE tag identifies the waveform as a valid SMIQ waveform.

WV denotes that the waveform is closed upon itself.

xxxxxxx is the checksum of the waveform. To simplify our example **0** is used, i.e., SMIQ does not evaluate a checksum.

To enter the TYPE tag in the SICO.WV file an ASCII editor which is able to handle binary data as well, e.g. the Microsoft Windows editor **NOTEPAD** or **multi edit** from AMERICAN CYBERNETICS, must be used.

Now the contents of the SICO.WV file read:

```
{TYPE: WV, 0}
IQIQIQIQIQIQIQIQIQIQI ... IQ
```

Step 3

The binary data must now be packed into a WAVEFORM tag with the following structure:

```
{WAVEFORM-Length: □Start, #IQIQIQIQIQIQIQIQIQI ... IQ}
```

The WAVEFORM tag consists of the following characters and data:

- { Opens each tag.
- WAVEFORM Name of the tag for waveform.
- Separates the name from the length indication.
- Length Length of the data set
Length indicates the number of bytes of the data set and consists of:
 - + number of digits of the **Start**-value (1 to 7, in our example 1)
 - + length of ",#" (2 bytes)
 - + number of I/Q pairs * 4 (2 bytes for each I- and Q-value).

In our example containing a sine and a cosine with 20 pairs for each wave and with the start address 0 in the SMIQ's output memory, the resulting length is **83**.
- :□ Separates the name and length from the remainder of the data set. The blank □ can be omitted.
- Start Address in the output memory of SMIQ used to store the following samples. In our example and most applications, this will be '0'.
- ,# Indicates the beginning of the binary data.
- IQIQIQ Binary data set.
 The binary data contain the I and Q values in alternate order, the first value is an I value. Each value consists of 2 Bytes, starting with the least significant bit.
- } Terminates each tag.

The editor mentioned above which can handle binary data is now used to place the string "{WAVEFORM-83:□0, #" in front and '}' at the end of the data set.

The contents of the waveform file SICO.WV for 20 I/Q pairs and start address 0 in the SMIQ's RAM is now ready for operation and reads.

```

{TYPE: WV, 0}           _____ 20 I/Q pairs = 80 bytes _____
{WAVEFORM-83:□0, # IQIQIQIQIQIQ ... IQ}
                        _____ 83 bytes _____
```

The tags TYPE and WAVEFORM are mandatory for each waveform. All other tags described in section „ARB Waveform Format“ are optional and can be inserted after the TYPE tag in arbitrary order, e.g.

```

{TYPE: WV, 0}
{COMMENT: I/Q=sine/cosine, 20 points, clock 10 MHz}
{CLOCK: 10e6}
{FILTER: 2,5MHz}
{WAVEFORM-83:□0, #IQIQIQIQIQIQ ... IQ}
```

C-program for creating the file SICO.TXT containing 20 sine and cosine pairs:

```

#include <stdlib.h>
#include <stdio.h>
#include <math.h>

void main (void)
{
#define SAMPLES 20
int i;
float grad,rad;
FILE *logging_fp;

logging_fp = fopen("SICO.TXT", "w");

for (i = 0; i < SAMPLES; i++)
{
grad = (360.0 / (float)(SAMPLES)) * (float)i;
rad = grad * (3.141592654/180.0);
fprintf (logging_fp,"%f %f\n",sin(rad),cos(rad));
}
fclose(logging_fp);
}

```

Contents of the file
SICO.TXT:

Sinus (I)	Cosinus (Q)
0.000000	1.000000
0.309017	0.951057
0.587785	0.809017
0.809017	0.587785
0.951057	0.309017
1.000000	-0.000000
0.951056	-0.309017
0.809017	-0.587785
0.587785	-0.809017
0.309017	-0.951056
-0.000000	-1.000000
-0.309017	-0.951057
-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

Extract from a C-program 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_i,*fp_sour_q,*fp_dest;
unsigned int i_uint, q_uint;
:
fp_sour = fopen("SICO.TXT", "rt" );
fp_dest = fopen("SICO.WV", "wb" );
:
while (1)
{
//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 integer
i_uint = (unsigned int)(32768.0 + (i_float*32000.0)+0.5);
i_uint &= 0xFFFC; //Mask marker bits
q_uint = (unsigned int)(32768.0 + (q_float*32000.0)+0.5);
q_uint &= 0xFFFC; //Mask marker bits

//Write converted I/Q pair to waveform file
fwrite (&i_uint,1,2,fp_dest);
fwrite (&q_uint,1,2,fp_dest);
}
:

```

3.2.2 Converting a Waveform with the Application Software AMIQ-K2

The application software AMIQ-K2 from R&S is distributed free of charge and allows to convert a large variety of I/Q data sets to SMIQ waveform. Moreover, AMIQ-K2 can be used to remote-control some important SMIQ functions, to load and to store waveforms.

This application software is available in the internet (<http://www.rsd.de>) under the path:

- Products →
- Test and Measurement →
- Signal Generation →
- IQ modulation generator AMIQ →
- or
- IQ simulation software WinIQSIM →

or from each R&S representative.

The control sequence

```

Select Source File(s)
  Type           Mathcad (mixed)
  Source File    SICO.TXT
Transmit
  Destination
  WV formatted   SICO.WV
    
```

allows to quickly generate a waveform that is ready to operate from the file SICO.TXT containing the I/Q pairs in alternate order.

3.2.3 AMIQ Compatible Commands for Transmission and Administration of Waveforms

See AMIQ Operating Manual for a detailed description of the commands.

AMIQ command	Parameter	SMIQ command and Parameter
:MMEMory		:ARB
:DATA	'listname', <blockdata>	:WAVEform:
:DATA?	'listname', 'tagname' ⇒ tag	DATA 'listname', <blockdata>
:DELeTe	'listname'	:DATA? 'listname', 'tagname' ⇒ tag
:CATalog?	⇒ name[,name]...	:DELeTe 'listname'
:LENGth?	⇒ n	:CATalog? ⇒ name[,name]...
:LOAD	RAM, 'listname'	LENGth? ⇒ n
:MEMory		:SELeCt 'listname'
:DATA?	RAM, 'tagname' ⇒ tag	:TAG? 'tagname' ⇒ tag
:NAME?	⇒ listname	:SELeCt?

4 Performance Test

4.1 Test Instructions

4.1.1 Frequency Response

Test equipment	RF spectrum analyzer (SMIQ manual, Table 5-1, item 2) PC with WinIQSIM version 3.30 or higher and IEEE/IEC bus connection to SMIQ
Test setup	➤ Connect spectrum analyzer to I/Q socket on front panel of SMIQ.
Measurement	<ul style="list-style-type: none"> ➤ Settings on spectrum analyzer <ul style="list-style-type: none"> - LEVEL REF 0.0 dBm - START FREQUENCY 0 Hz - STOP FREQUENCY 20 MHz ➤ Settings in WinIQSIM <ul style="list-style-type: none"> - File -> New -> Multi Carrier Ok - Carrier Settings <ul style="list-style-type: none"> - No. of Carriers 37 - Carrier Spacing 1000 - CW only Mode - Channel Definition -> to ch. 30 - Accept - Channel Definition -> to ch. 18 - Channel Definition -> State OFF - Accept - Ok <p style="margin-left: 20px;">At present the frequency spacing is 1 MHz from 1 MHz to 12 MHz.</p> - SMIQ(ARB) -> Transmission... - ARB Waveform -> Waveform Name „ARBTEST“ - Select - Transmit <p style="margin-left: 20px;">At present the waveform is in the SMIQ.</p> ➤ SMIQ <ul style="list-style-type: none"> - ARB MOD -> SELECT WAVEFORM... -> WAVEFORM... „ARBTEST“ - ARB MOD -> STATE ON ➤ Test run <ul style="list-style-type: none"> - Marker to 1 MHz - Delta Marker to 12 MHz • The read level difference is the frequency response. - Perform same measurement for I and Q

4.1.2 DC Voltage Offset

- Test setup ➤ Connect AC/DC voltmeter to I/Q socket on front panel of SMIQ.
- Measurement of DC voltage offset ➤ Measurement sequence
- Switch on 100 Hz input lowpass of voltmeter.
 - Measure DC voltage at I = U_I
 - Measure DC voltage at Q = U_Q
 - Calculate offset:

$$Offset = 20 \cdot \log \left(\frac{1.0V}{\sqrt{U_I^2 + U_Q^2}} \right)$$

Perform same measurement for I and Q.

4.1.3 Spurious-Free Dynamic Range (SFDR)

- Test equipment RF spectrum analyzer (SMIQ manual, table 5-1, item 2)
PC with WinIQSIM version 3.30 or higher and IEEE/IEC bus connection to SMIQ
- Test setup ➤ Connect spectrum analyzer to I/Q socket on front panel of SMIQ.
- Measurement ➤ Settings on spectrum analyzer
- LEVEL REF 10.0 dBm
 - START FREQUENCY 0 Hz
 - STOP FREQUENCY 20 MHz
- Settings in WinIQSIM
- File -> New -> Multi Carrier Ok
 - Carrier Settings
 - No. of Carriers 3
 - Carrier Spacing 1000
 - CW only Mode
 - Channel Definition -> to ch. 1
 - Channel Definition -> State OFF
 - Accept
 - Ok
 - At present there is a sinewave of 1 MHz for I and Q.
 - SMIQ(ARB) -> Transmission...
 - ARB Waveform -> Waveform Name „ARBTEST“
 - Select
 - Transmit
 - At present the waveform is in the SMIQ.
- SMIQ
- ARB MOD -> SELECT WAVEFORM... -> WAVEFORM... „ARBTEST“
 - ARB MOD -> STATE ON
- Test procedure
- Marker to 1 MHz
 - Delta marker to maximum spurious (0 to 12 MHz).
 - Read SFDR
 - Perform same measurement for I and Q

4.1.4 Level Difference of Channels

Test equipment	AC/DC voltmeter (SMIQ manual, Table 5-1, item 19) PC with WinIQSIM version 3.30 or higher and IEEE/IEC bus connection to SMIQ
Test setup	➤ Connect AC/DC voltmeter to I/Q socket on front panel of SMIQ.
Measurement	<p>➤ Settings on AC/DC voltmeter</p> <ul style="list-style-type: none"> - Mode AC - Unit V <p>➤ Settings in WinIQSIM</p> <ul style="list-style-type: none"> - File -> New -> Multi Carrier Ok - Carrier Settings <ul style="list-style-type: none"> - No. of Carriers 3 - Carrier Spacing 1 - CW only Mode - Channel Definition -> to ch. 1 - Channel Definition -> State OFF - Accept - Ok <p>At present there is a sinewave of 1 MHz for I and Q.</p> <ul style="list-style-type: none"> - SMIQ(ARB) -> Transmission... - ARB Waveform -> Waveform Name "ARBTEST" - Select - Transmit <p>At present the waveform is in the SMIQ.</p> <p>➤ SMIQ settings</p> <ul style="list-style-type: none"> - ARB MOD -> SELECT WAVEFORM... -> WAVEFORM... "ARBTEST" - ARB MOD -> STATE ON <p>➤ Test procedure</p> <ul style="list-style-type: none"> - Read RMS voltage on I = U_I - Read RMS voltage on Q = U_Q - Calculate level difference: $\text{Level difference} = \frac{ U_Q - U_I }{U_I} \cdot 100\%$

4.2 Performance Test Report

For nominal data and limit values refer to the data sheet supplied with the instrument.

Characteristic	Min.	Actual	Max.	Unit
ARB MOD SMIQB60				
Frequency response up to 12 MHz				dB
Offset in Normal mode				dB
Spurious-Free Dynamic Range, sine wave 1 MHz to 12 MHz				dB
Level difference of channels, sine wave 1 kHz				%