

R&S® AFQ100B-K264

Digital Standard ECMA-368 IEEE 802.15 3a (Ultra Wide Band)

Operating Manual



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ROHDE & SCHWARZ

Test & Measurement

Operating Manual

This document describes the following software options:

- R&S®AFQ100B-K264
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The following abbreviations are used throughout this manual: R&S®AFQ is abbreviated as R&S AFQ, 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 attached 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 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 product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and 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.

Symbols and safety labels

							
Notice, general danger location Observe product documentation	Caution when handling heavy equipment	Danger of electric shock	Warning! Hot surface	PE terminal	Ground	Ground terminal	Be careful when handling electrostatic sensitive devices

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

Tags 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 the possibility of incorrect operation which can result in damage to the product.

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

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 in other economic areas or military applications. It is therefore essential to make sure that the tags described here are always used only in connection with the related product documentation and the related product. The use of tags 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, pollution severity 2, overvoltage category 2, use only indoors, max. operating altitude 2000 m above sea level, max. transport altitude 4500 m above sea level. A tolerance of $\pm 10\%$ shall apply to the nominal voltage and $\pm 5\%$ to the nominal frequency.
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 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 death.

Electrical safety

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

1. Prior to switching on the product, always ensure that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
2. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with an earthing contact and protective earth connection.
3. 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.
4. If the product does not have a power switch for disconnection from the AC supply network, the plug of the connecting cable is regarded as the disconnecting device. In such cases, always ensure that the power plug is easily reachable and accessible at all times (corresponding to the length of connecting cable, approx. 2 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, a disconnecting device must be provided at the system level.
5. Never use the product if the power cable is damaged. Check the power cable on a regular basis to ensure that it is in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, you can ensure that the cable will not 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 fused 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. 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 $V_{\text{rms}} > 30 \text{ V}$, suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
10. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC60950-1/EN60950-1 or IEC61010-1/EN 61010-1 standards that apply in each case.
11. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
12. If a product is to be permanently installed, the connection between the 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 licensed electrician.
13. 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 anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.

Basic Safety Instructions

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", 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. 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).

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, PE 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. Keep cells and batteries out of the hands of children. If a cell or a battery has been swallowed, seek medical aid immediately.
5. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.
6. 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.
7. 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.
8. 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

1. 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.
2. 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.

Informaciones elementales de seguridad

Es imprescindible leer y observar 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 adjunto 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.







Informaciones elementales de seguridad

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.

Símbolos y definiciones de seguridad

							
Aviso: punto de peligro general Observar la documentación del producto	Atención en el manejo de dispositivos de peso elevado	Peligro de choque eléctrico	Advertencia: superficie caliente	Conexión a conductor de protección	Conexión a tierra	Conexión a masa	Aviso: Cuidado en el manejo de dispositivos sensibles a la electrostática (ESD)

					
Tensión de alimentación de PUESTA EN MARCHA / PARADA	Indicación de estado de espera (Standby)	Corriente continua (DC)	Corriente alterna (AC)	Corriente continua / Corriente alterna (DC/AC)	El aparato está protegido en su totalidad por un aislamiento doble (reforzado)

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 identifica un peligro inminente con riesgo elevado que provocará muerte o lesiones graves si no se evita.



ADVERTENCIA identifica un posible peligro con riesgo medio de provocar muerte o lesiones (graves) si no se evita.



ATENCIÓN identifica un peligro con riesgo reducido de provocar lesiones leves o moderadas si no se evita.



AVISO indica la posibilidad de utilizar mal el producto y, como consecuencia, dañarlo.

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, grado de suciedad 2, categoría de sobrecarga eléctrica 2, uso solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar, transporte hasta 4500 m sobre el nivel del mar. Se aplicará una tolerancia de $\pm 10\%$ sobre el voltaje nominal y de $\pm 5\%$ sobre la frecuencia nominal.
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, pueden causarse lesiones o 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, se deberá considerar el enchufe del cable de conexión como interruptor. En estos casos se deberá asegurar que el enchufe siempre sea de fácil acceso (de acuerdo con la longitud del cable de conexión, 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 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 $U_{\text{eff}} > 30 \text{ V}$ se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
10. Para la conexión con dispositivos informáticos como un PC o un ordenador industrial, debe comprobarse que éstos cumplan los estándares IEC60950-1/EN60950-1 o IEC61010-1/EN 61010-1 válidos en cada caso.
11. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. Esto pone a descubierto los cables y componentes eléctricos y puede causar lesiones, fuego o daños en el producto.

12. Si un producto se instala en un lugar fijo, se deberá primero conectar el conductor de protección fijo con el conductor de protección del producto antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efectuadas por un electricista especializado.
13. En el caso de dispositivos fijos que no estén provistos de fusibles, interruptor automático ni otros mecanismos de seguridad similares, el circuito de alimentación debe estar protegido de modo que todas las personas que puedan acceder al producto, así como el producto mismo, estén a salvo de posibles daños.
14. Todo producto debe estar protegido contra sobretensión (debida p. ej. a una caída del rayo) mediante los correspondientes sistemas de protección. Si no, el personal que lo utilice quedará expuesto al peligro de choque eléctrico.
15. No debe introducirse en los orificios de la caja del aparato ningún objeto que no esté destinado a ello. Esto puede producir cortocircuitos en el producto y/o puede causar choques eléctricos, fuego o lesiones.
16. Salvo indicación contraria, los productos no están impermeabilizados (ver también el capítulo "Estados operativos y posiciones de funcionamiento", punto 1). Por eso es necesario tomar las medidas necesarias para evitar la entrada de líquidos. En caso contrario, existe peligro de choque eléctrico para el usuario o de daños en el producto, que también pueden redundar en peligro para las personas.
17. No utilice el producto en condiciones en las que pueda producirse o ya se hayan producido condensaciones sobre el producto o en el interior de éste, como p. ej. al desplazarlo de un lugar frío a otro caliente. La entrada de agua aumenta el riesgo de choque eléctrico.
18. Antes de la limpieza, desconecte por completo el producto de la alimentación de tensión (p. ej. red de alimentación o batería). Realice la limpieza de los aparatos con un paño suave, que no se deshilache. No utilice bajo ningún concepto productos de limpieza químicos como alcohol, acetona o diluyentes para lacas nitrocelulósicas.

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", punto 1.

5. Ciertos productos, como p. ej. las instalaciones de radiocomunicación RF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. Deben tomarse todas las medidas necesarias para la protección de las mujeres embarazadas. También las personas con marcapasos pueden correr peligro a causa de la radiación electromagnética. El empresario/operador tiene la obligación de evaluar y señalar las áreas de trabajo en las que exista un riesgo elevado de exposición a radiaciones.
6. Tenga en cuenta que en caso de incendio pueden desprenderse del producto sustancias tóxicas (gases, líquidos etc.) que pueden generar daños a la salud. Por eso, en caso de incendio deben usarse medidas adecuadas, como p. ej. máscaras antigás e indumentaria de protección.
7. 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).

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. Mantener baterías y celdas fuera del alcance de los niños. En caso de ingestión de una celda o batería, avisar inmediatamente a un médico.
5. Las celdas o baterías no deben someterse a impactos mecánicos fuertes indebidos.

Informaciones elementales de seguridad

6. 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.
7. 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).
8. 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

1. 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.
2. 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.

Qualitätszertifikat

Certificate of quality

Certificat de qualité

Certified Quality System
ISO 9001

Certified Environmental System
ISO 14001

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde&Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde&Schwarz-Qualitätsmanagementsystem ist u.a. nach ISO9001 und ISO14001 zertifiziert.

Der Umwelt verpflichtet

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

Dear Customer,

You have decided to buy a Rohde&Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards. The Rohde&Schwarz quality management system is certified according to standards such as ISO9001 and ISO14001.

Environmental commitment

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

Cher client,

Vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité. Le système de gestion qualité de Rohde&Schwarz a été homologué, entre autres, conformément aux normes ISO9001 et ISO14001.

Engagement écologique

- ▮ Produits à efficience énergétique
- ▮ Amélioration continue de la durabilité environnementale
- ▮ Système de gestion de l'environnement certifié selon ISO 14001

Customer Support

Technical support – where and when you need it

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

Up-to-date information and upgrades

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

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1 Preface

1.1 Documentation Overview

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

- Online Help system on the instrument,
- "Quick Start Guide" printed manual,
- Documentation CD-ROM with:
 - Online help system (*.chm) as a standalone help,
 - Operating Manuals for base unit and options,
 - Service Manual,
 - Data sheet and specifications,
 - Links to useful sites on the R&S internet.

Online Help

The Online Help is embedded in the instrument's firmware. It offers quick, context-sensitive access to the complete information needed for operation and programming. The online help contains help on operating the R&S Signal Generator and all available options.

Quick Start Guide

The Quick Start Guide is delivered with the instrument in printed form and in PDF format on the Documentation CD-ROM. It provides the information needed to set up and start working with the instrument. Basic operations and an example of setup are described. The manual includes also general information, e.g., Safety Instructions.

Operating Manuals

The Operating Manuals are a supplement to the Quick Start Guide. Operating Manuals are provided for the base unit and each additional (software) option.

These manuals are available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument. In the Operating Manual for the base unit, all instrument functions are described in detail. Furthermore, it provides an introduction to remote control and a complete description of the remote control commands with programming examples. Information on maintenance, instrument interfaces and error messages is also given.

In the individual option manuals, the specific instrument functions of the option are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S Signal Generator is not included in the option manuals.

These manuals can also be orderd in printed form (see ordering information in the data sheet).

Release Notes

The release notes describe new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes. The current release notes are provided in the Internet.

1.2 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.
<i>Input</i>	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 Introduction

The R&S Signal Generator provides you with the ability to generate UWB MB-OFDM signals in accordance with the WiMedia Alliance and MultiBand OFDM Alliance Unapproved Release Candidate Version 1.2.

A brief description of the standard is given in the following. For a detailed description see the corresponding WiMedia Alliance and MultiBand OFDM Alliance specifications.

The R&S Signal Generator simulates UWB MB-OFDM at the physical layer. A sequence of data packets with the frame structure defined by the standard is generated. A MAC header can be activated.

The following list gives an overview of the options provided by the R&S Signal Generator for generating a UWB MB-OFDM signal:

- Physical Layer mode MB-OFDM
- Data rates 53.3 Mbps, 80 Mbps, 106.7 Mbps, 160 Mbps, 200 Mbps, 320 Mbps, 400 Mbps, 480 Mbps
- Modulation according to the standard:
 - QPSK for data rates from 53.3 to 200 Mbps
 - DCM for data rates from 320 to 480 Mbps
- Support of all standard compliant Time-Frequency Codes (TFC1 to TFC10), as well as configuration of user-definable hopping sequences.
- Generation of frames for both standard frame and burst mode
- Standard compliant and user-definable cover synchronization sequence, minimum and short inter-frame spacing interval duration for both burst and standard mode
- Data scrambling, bit interleaving and convolutional encoding can be activated or deactivated.
- Clipping for reducing the crest factor.

2.1 Physical Layer MB-OFDM

In the MB-OFDM (Multiband Orthogonal Frequency Division Multiplexing) approach, the available spectrum of 7.5 GHz (3100...10600 MHz) is divided into 14 bands, 528 MHz each. The information transmitted on each 528 MHz band is modulated using OFDM. OFDM distributes the data over 122 useful subcarriers with 4.125 MHz subcarrier spacing.

2.1.1 Band Groups

To achieve a MB-OFDM, the 528 MHz bands are grouped together into 6 band groups as shown on the figure below.

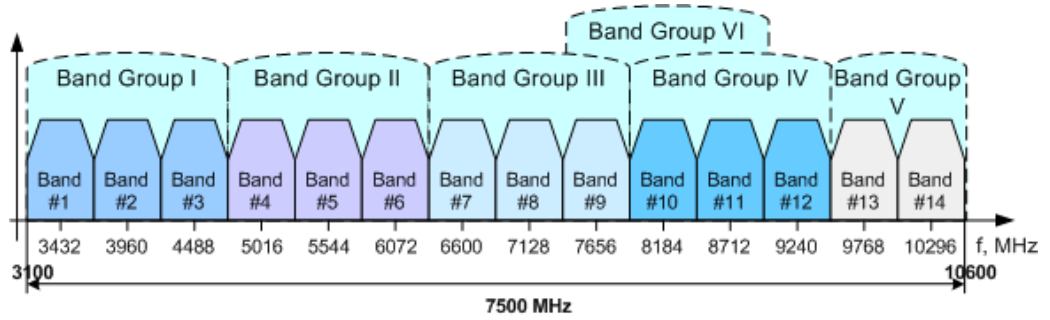


Fig. 2-1: MB-OFDM Frequency Band Plan

2.1.2 Band Hopping

A total number of 49 logical channels are achieved with the help of TFCs (Time-Frequency Code). For each of the band group 1, 2, 3, 4 and 6, 10 TFCs are defined. However, only three TFCs are used in band group 5.

The combination for the band group and TFC defines the band hopping within the selected band group. The band switching time is 9.47 ns.

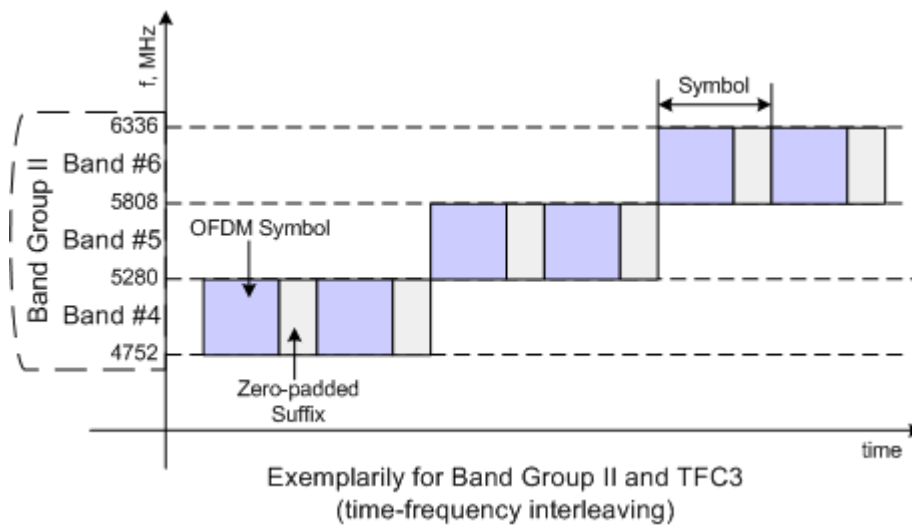


Fig. 2-2: Band Hopping

2.1.3 UWB MB-OFDM Parameters

The table below gives an overview of the main UWB MB-OFDM parameters.

Table 2-1: Parameters of UWB MB-OFDM modulation

Parameters	Value
Number of data subcarriers	100
Number of pilot subcarriers	12

Parameters	Value
Total of subcarriers used	122
Subcarrier frequency spacing	4.125 MHz
IFFT/FFT period	242.42 ns
Zero padded suffix duration	70.08 ns
Symbol interval	312.5 ns
Number of samples per zero padding suffix	37
Total number of samples per symbol	165
Symbol rate	3.2 MHz
Subcarrier modulation	QPSK (for data rates \leq 200 Mbps) DCM (for data rates $>$ 200 Mbps)
Code rates	1/3, 1/2, 5/8, 3/4

A 128 point IFFT is used to generate the 122 subcarriers (12 pilot subcarrier, 110 data subcarriers and 10 guard subcarriers). Six of the 128 possible carriers are not used (null subcarrier). One is the carrier in the middle of the band, which would otherwise be impaired by the carrier leakage of the I/Q modulator, the others are the remaining carriers at the upper and lower end of the spectrum. The figure below shows an example of the Band #1 (3168 - 3696 MHz).

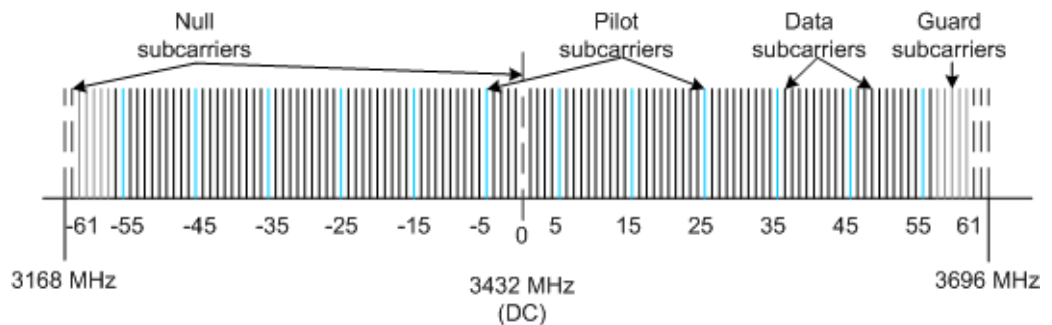


Fig. 2-3: Structure of UWB MB-OFDM Signal

The required subcarrier spacing of 4.125 MHz is implicitly observed when the time signal generated by the IFFT with a sampling rate of 528 MHz is output. An OFDM symbol generated in this way would have a period of 242.42 ns. To compensate for multipath propagation, a so-called zero-padded suffix with a duration of 70.08 ns is attached to each symbol so that a total symbol interval of 312.5 ns is obtained.

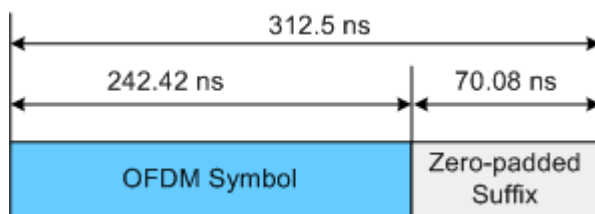


Fig. 2-4: OFDM Symbol

Either QPSK or DCM (Dual-Carrier Modulation) modulation can be used on the subcarriers. Prior to the modulation, the raw data are convolutionally coded with code rates of 1/3, 1/2, 5/8 and 3/4 being possible.

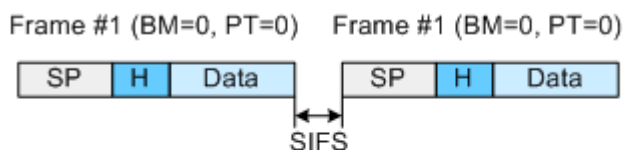
2.1.4 Transport Modes

At the physical level, the standard defines transmission of the frames in two modes, a standard (single frame) mode and a burst mode.

- Standard mode**

In standard transport mode, a single frame will be transmitted.

In this mode, the frames are separated by a SIFS (Short Inter Frame Spacing) interval.



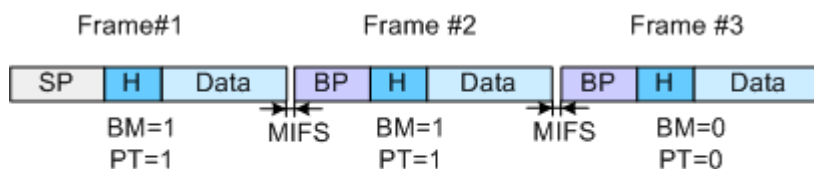
SP - Standard Preamble BM - Burst Mode
 BP - Burst Preamble PT - Preamble Type
 H - Header SIFS - Short Inter Frame Spacing

Fig. 2-5: Standard Transport Mode

- Burst mode**

A burst of frames from the same source will be transmitted.

The frames in the burst are separated by a minimum inter-frame separation interval (MIFS).



Exemplarily for Data Rate > 200Mbps, Burst Preamble Used
 and # Frames per Burst = 3

Fig. 2-6: Burst Transport Mode

2.2 UWB MB-OFDM Frame Structure and PPDU Format

The UWB MB-OFDM frame structure is very similar to the frame structure of other wireless formats, such as WLAN, etc.

The table below gives an overview of the UWB MB-OFDM physical parameters, related to the frame structure.

Table 2-2: Frame Structure of UWB MB-OFDM

Parameters	Value
PLCP Preamble Length	30 Symbols (standard preamble) 18 Symbols (burst preamble)
PLCP Preamble Duration	9.375 μ s (standard preamble) 5.625 μ s (burst preamble)
Packet/Farme Synchronization Length	24 Symbols (standard preamble) 12 Symbols (burst preamble)
Channel Estimation Sequence	6 Symbols (standard and burst preamble)
PLCP Header Duration	3.75 μ s
PLCP Header Rate	39.4 Mbps
PSDU Data Rate	53.3 Mbps, 80 Mbps, 106.7 Mbps, 160 Mbps, 200 Mbps, 320 Mbps, 400 Mbps, 480 Mbps
PSDU Frame Payload	0(standard preamble)/ 1(burst preamble)...4095 bytes

The data packet on the physical layer is referred to as PPDU (PLCP Protocol Data Unit). A PPDU consists of three components; the PLCP (Physical Layer Convergence Protocol) preamble, the PLCP header and the PSDU (PLCP Service Data Unit), which contains the actual information data (coming from higher layers).

The PLCP preamble and header are used for synchronization and signaling purposes, and are themselves divided into fields.

The figure below shows the frame structure (also indicated in the "PPDU Configuration" submenu).

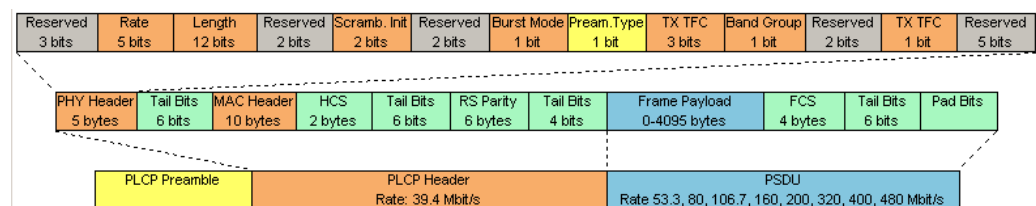


Fig. 2-7: UWB MB-OFDM Frame Structure

2.2.1 PLCP Preamble

Each frame starts with the PLCP preamble for time synchronization and channel estimation purposes. There are two PLCP preambles defined, a standard preamble for frames in standard mode and a burst preamble for frames in burst mode respectively.

The standard PLCP preamble is 9.375 µs long and thus corresponds to the duration of 30 OFDM symbols.

The burst PLCP preamble is 5.625 µs long that corresponds to the duration of 18 OFDM symbols.

Both the standard and the burst preamble can be subdivided into two parts: a packet/frame synchronization sequence and a channel sequence each created by spreading an appropriate base sequence with a cover sequence.

2.2.2 PLCP Header

The PLCP Header is sent at 39.4 Mbps and carries information about the data rate, the data length, the transport mode and preamble type, as well as the MAC Header.

Prior to scrambling, the PLCP Header is protected with shortened Reed-Solomon code (23, 17) and Header Check Sequence ($x^{16}+x^{12}+x^5+1$). Tail bits are added to reset the convolutional encoder to zero.

2.2.3 PSDU

The user data in the data section of the frame is finally taken to the receiver. The data section can be transmitted with one of the defined data rates between 53.3 and 480 Mbps. The data section of the frame is subdivided into the fields Payload, FCS (Frame Check Sequence), tail and pad bits.

The 6 tail bits are used to reset the convolutional coder to zero. The data field must be filled with the full number of OFDM symbols and is therefore rounded up. Additional bits that may be available are set to 0 as pad bits.

2.3 Protection

The R&S Signal Generator simulates UWB MB-OFDM signals in accordance with ECMA 368 on the physical layer. In the standard, the MAC sublayer provides the input data for this layer. The following graph illustrates the signal generation process.

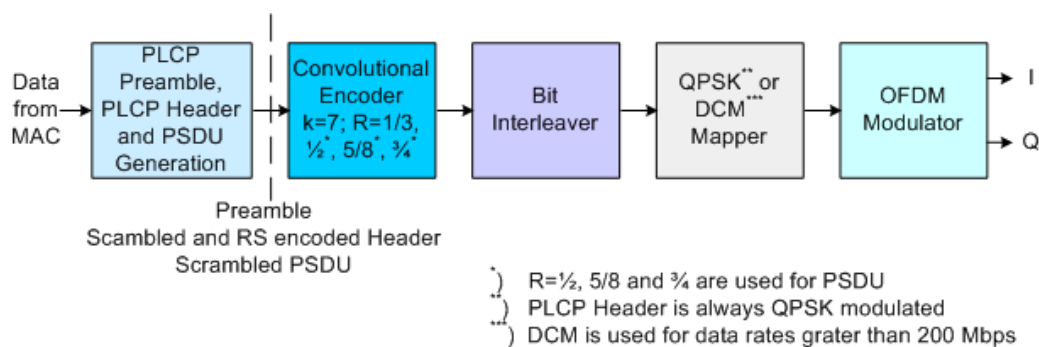


Fig. 2-8: Principle of UWB MB-OFDM signal generation

The scrambled and RS encoded PLCP Header and the scrambled PSDU are subjected to usual signal processing consisting of convolutional coding, interleaving, subcarrier modulation, pilot carrier generation and OFDM modulation.

2.3.1 Data Scrambler

Data from the source (the next higher protocol layer, the MAC) must first be scrambled, i.e. multiplied with a PN sequence. The standard defines a side-stream scrambler. The scrambling sequence is given by the following generator polynomial:

$$g(D)=1+D^{14}+D^{15}$$

The start value of the register is determined from the seed identifier contained in the PLCP Header.

2.3.2 Convolutional Encoder

A subsequent convolutional coder adds redundancies to the bits. The coder uses the rate $R=1/3$, has 64 possible states ($k = 7$) and is described by the polynomials $g_0=133_8$, $g_1=165_8$ and $g_2=171_8$.

To obtain the data rates of 53.3 to 480 Mbps defined by the standard, different channel code rates are required. Bits generated by the convolutional coder are therefore punctured (i.e. omitted) depending on the setting so that 1/2, 1/3, 3/4 or 5/8 code rates are attained.

Increasing the redundancy by channel coding is generally mandatory in case of OFDM modulations since complete subcarriers may be eliminated by frequency selective fading so that the loss of bits on the transmission path is in many cases unavoidable.

The PLCP header always has a data rate of 39.4 Mbps, and is therefore always encoded with rate $R=1/3$.

2.3.3 Bit Interleaving

To increase the performance of the convolutional coder, the coded data are interleaved in the next step. Employing frequency diversity within a band and across subcarriers and time domain spreading, three interleaver stages ensure robustness against burst errors.

The adjacent bits of the convolutional coder are first symbol interleaved, i.e. the coded and padded bit stream is distributed across 6 consecutive OFDM symbols.

The second stage is the inter-symbol tone interleaving, which distributes the bits across the data subcarrier within one OFDM symbol.

Finally, the bits are cyclically shifted in successive OFDM symbols.

2.3.4 Constellation Mapping and OFDM Modulator

The coded and interleaved data sequence is mapped onto a complex constellation.

The PLCP header is always QPSK-modulated. Depending on the data rate, the useful carriers are subjected to a QPSK or DCM modulation. For data rate between 53.3 Mbps and 200 Mbps, the data sequence is mapped onto a QPSK constellation. A dual-carrier modulation (DCM) is employed for data with data rates between 320 Mbps and 480 Mbps.

3 UWB MB-OFDM User Interface



To access the dialog for setting the UWB MB-OFDM digital standard, select "Baseband Block > UWB MB-OFDM" or use the menu tree under "Baseband".

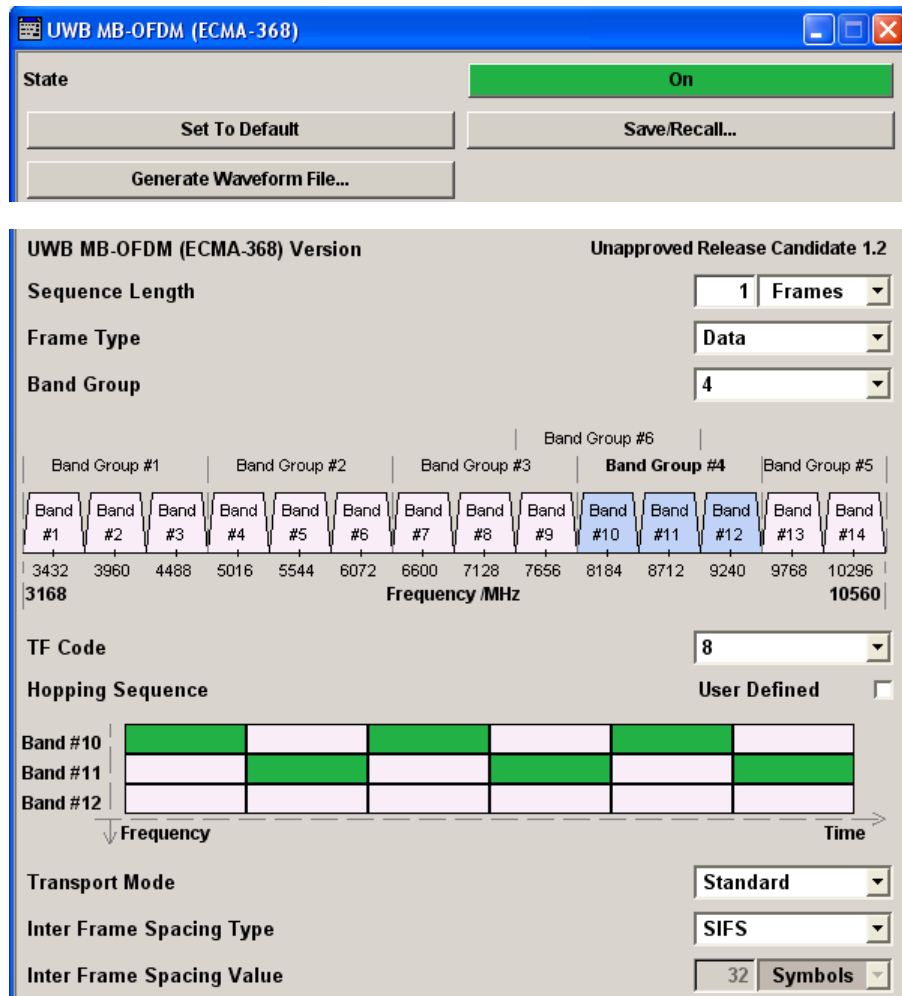
3.1 General Settings for UWB MB-OFDM Signals

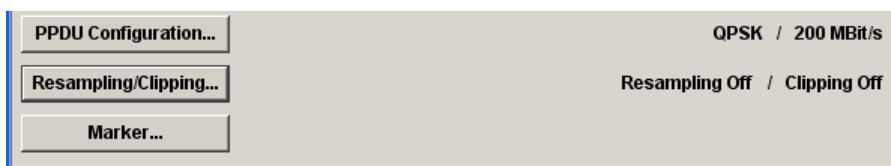
The menu is split into several sections for configuring the standard.

The upper section of the menu is where the UWB MB-OFDM digital standard is enabled and the default settings are called.

In the middle section the sequence length, the frame type, the band group, the time-frequency code and the transport mode are selected.

The buttons of the lower menu section lead to submenus for configuring the PPDU and for setting the filter, clipping and marker parameters.





State

Enables/disables the UWB MB-OFDM standard.

Enabling this standard disables all the other digital standards and digital modulation modes (in case of two-path instruments, this affects the same path)

SCPI command:

[:SOURce<hw>] :BB:UWBMb:STATe on page 42

Set to default

Calls the default settings. The following table gives an overview of the settings. The preset value for each parameter is specified in the description of the remote-control commands.

Parameter	Value
State	Not affected by Set to default
UWB MB-OFDM (ECMA-368) Version	Unapproved release Candidate 1.2
Sequence Length	1 Frame
Frame Type	Data
Band Group	I
TF Code	1
Hopping Sequence	User Defined Off
Transport Mode	Standard
Inter Frame Spacing Type	SIFS
Inter Frame Spacing Value	32 Symbols
Filter	Cosine
Clipping	Off
PPDU Configuration (QPSK, 200 Mbps)	
PDSU Data Rate	200 Mbps
PDSU Modulation	QPSK
PSDU Data Length	2048 bytes
PSDU Data Source	PN9
PLCP Cover Sequence	TF Code 1
PLCP Standard Preamble	++++ +--- +--- +--- +--- +---
Scrambler	On
Convolutional Encoder	On

Parameter	Value
Bit Interleaver	On
MAC Header	Off

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PRESet on page 40

Save/Recall

Calls the "Save/Recall" menu.

From the "Save/Recall" menu the "File Select" windows for saving and recalling UWB MB-OFDM configurations and the "File Manager" can be called.



UWB MB-OFDM configurations are stored as files with the predefined file extension * .uwb. The file name and the directory they are stored in are user-definable.

The complete settings in the "UWB MB-OFDM" menu are saved and recalled.

- "Recall UWB MB-OFDM setting" Opens the "File Select" window for loading a saved UWB MB-OFDM configuration. The configuration of the selected (highlighted) file is loaded by pressing the "Select" button.
- "Save UWB MB-OFDM setting" Opens the "File Select" window for saving the current UWB MB-OFDM signal configuration. The name of the file is specified in the "File name" entry field, the directory selected in the "save into" field. The file is saved by pressing the "Save" button.
- "File Manager" Calls the "File Manager". The "File Manager" is used to copy, delete and rename files and to create new directories.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:SETTing:CATalog on page 40

[:SOURce<hw>] :BB:UWBMb:SETTing:LOAD on page 41

[:SOURce<hw>] :BB:UWBMb:SETTing:STORe on page 41

[:SOURce<hw>] :BB:UWBMb:SETTing:DELeTe on page 41

Generate Waveform File...

Calls the "Generate Waveform" menu. This menu is used to store the current UWB MB-OFDM signal as ARB signal in a waveform file.

This file can be loaded in the "ARB" menu and processed as multicarrier or multisegment signal.

The file name is entered in the submenu. The file is stored with the predefined file extension * .wv. The file name and the directory it is stored in are user-definable.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:WAVeform:CREate on page 43

UWB MB-OFDM (ECMA-368) Version

Displays the current version of the UWB MB-OFDM standard.

The default settings and parameters provided are oriented towards the specifications of the version displayed.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:VERSion](#) on page 43

Sequence Length

Sets the sequence length of the signal in number of frames.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:SENGth](#) on page 42

Frame Type

Selects the frame type of the generated signal. The selection defines parameters of the MAC layer, e.g. the Frame Type and ACK Policy bit fields of the MAC Header.

"Data"	Frames containing useful data.
"Beacon"	Beacon frames will be generated. Beacons are used for synchronization to a shared channel.
"Control"	Control frames will be generated.
"Command"	Command frames will be generated.
"Aggregated"	Aggregated frames will be generated. The payload of these frames contains an aggregation header and multiple MSDUs (MAC service data units).

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:FTYPE](#) on page 38

Band Group

Selects the band group for which a signal will be generated.

The selection of band group defines the signal parameter Time-Frequency Code ("TF Code"). The combination for the parameters "Band Group" and "TF Code" defines the band hopping within the selected band group (see also [chapter 2.1, "Physical Layer MB-OFDM"](#), on page 7). The currently selected hopping sequence is displayed in the TFC Graph.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:BGRoup](#) on page 38

Band Group Graph

In the band group graph, the currently selected band group is highlighted.

SCPI command:

n.a.

TF Code

Selects the time-frequency code of the generated signal.

The value of the parameter "TF Code" depends on the selected "Band Group".

For band groups 1, 2, 3, 4 and 6, one of 10 possible TF Codes can be selected.

For band group 5 only three TF Codes (TF Code 5, 6 and 8) are enabled.

Depending on the standard TF Code selected here, the parameter [Cover Sequence \(Sync.\)](#) will be set.

The combination for the parameters "Band Group" and "TF Code" defines the band hopping within the selected band group (see also [chapter 2.1, "Physical Layer MB-OFDM"](#), on page 7).

The currently selected hopping sequence is displayed in the TFC Graph.

However, the user is enabled to re-configure any standard TF Code hopping sequence by simply double click on a band in the TFC Graph.

This will automatically enable parameter "Hopping Sequence User Defined" and the configured user hopping sequence will be saved as the last used user hopping sequence.

Disabling the parameter "Hopping Sequence User Defined" restores the last used standard TF Code pattern.

Any further enabling of the parameter "Hopping Sequence User Defined" restores the last used user hopping sequence.

The configuration of used redefined hopping sequence does not affect the selection made for the parameter "Cover Sequence".

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:TFCode](#) on page 42

Hopping Sequence User Defined

Indicates a user definable hopping sequence. This parameter triggers the TFC Graph to display the last user defined hopping sequence.

The re-configuration of any standard TF Code hopping sequence by simply double click on a band in the TFC Graph automatically enables parameter "Hopping Sequence User Defined".

The configured user hopping sequence is saved as the last used user hopping sequence.

Disabling the parameter "Hopping Sequence User Defined" restores the last used standard TF Code pattern.

Any further enabling of the parameter "Hopping Sequence User Defined" restores the last used user hopping sequence.

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:HSEquence:USER\[:STATe\]](#) on page 39

[\[:SOURce<hw>\]:BB:UWBMb:HSEquence](#) on page 38

TFC Graph

The TFC graph indicates the selected band hopping mechanism, according to the selection made for the parameters "TF Code", "Band Group" and "Hopping Sequence User Defined".

The user is also enabled to re-configure any standard TF Code hopping sequence by simply double click on a band in the TFC Graph.

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:HSEquence:USER\[:STATe\]](#) on page 39

[\[:SOURce<hw>\]:BB:UWBMb:HSEquence](#) on page 38

Transport Mode

Selects the transport mode of the signal.

The selection defines the values enabled for the parameters "PLCP Preamble" and "Data Length".

- | | |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "Standard" | In standard transport mode, a single frame will be transmitted. The frames are separated by a short inter-frame separation interval (SIFS). According to the standard, the duration of the SIFS is 32 symbols but you can change it (see Inter Frame Spacing Value). A frame in a standard mode uses always the Standard Preamble . |
| "Burst" | A burst of frames from the same source will be transmitted. The frames in the burst are separated by a minimum inter-frame separation time (MIFS). According to the standard, the duration of the MIFS is 6 symbols but you can change it. For "Data Rates" \leq 200Mbps, all the frames will have a "Standard Preamble". For "Data Rates" $>$ 200Mbps, only the first frame uses the Standard Preamble; the rest of the frame may use standard or burst preamble (see Burst Preamble and Burst Preamble Used). For burst transport mode the data length cannot be 0, i.e. the minimum Data Length is 1 byte. |

SCPI command:

[:SOURce<hw>] :BB:UWBMB:TMODE on page 43

Inter Frame Spacing Type

Selects the type of the Inter Frame Spacing Interval.

- | | |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "SIFS" | Short Inter Frame Spacing Interval (SIFS) is the interval between two frames in standard transmission mode. According to the standard, SIFS has duration of 32 Symbols. |
| "MIFS" | Minimum Inter Frame Spacing Interval (MIFS) is the interval between two frames in burst transmission mode. According to the standard, MIFS has duration of 6 Symbols. |
| "User" | The duration of the Inter Frame Spacing interval can be defined by the user (see "Inter Frame Spacing Value" on page 20). |

SCPI command:

[:SOURce<hw>] :BB:UWBMB:IFS:TYPE on page 39

Inter Frame Spacing Value

Displays the duration in symbols of the Inter Frame Spacing interval, depending on the selection made for the parameter "Inter Frame Spacing Type".

For "Inter Frame Spacing Type" set to SIFS or MIFS, the value is read-only.

For "Inter Frame Spacing Type" set to User, the duration can be defined by the user.

SCPI command:

[:SOURce<hw>] :BB:UWBMB:IFS:VALUE on page 39

PPDU Configuration

Calls the menu for configuration of the PPDU. The current setting is displayed next to the button.

The menu is described in [chapter 3.2, "PPDU Configuration"](#), on page 21.

SCPI command:

n.a.

Resampling/Clipping...

Calls the menu for setting the clipping and resampling. The current setting is displayed next to the button.

The menu is described in [chapter 3.4, "Resampling/Clipping"](#), on page 33.

SCPI command:

n.a.

Marker...

Calls the menu for configuring the marker signals (see [chapter 3.5, "Marker Settings"](#), on page 35).

SCPI command:

n.a.

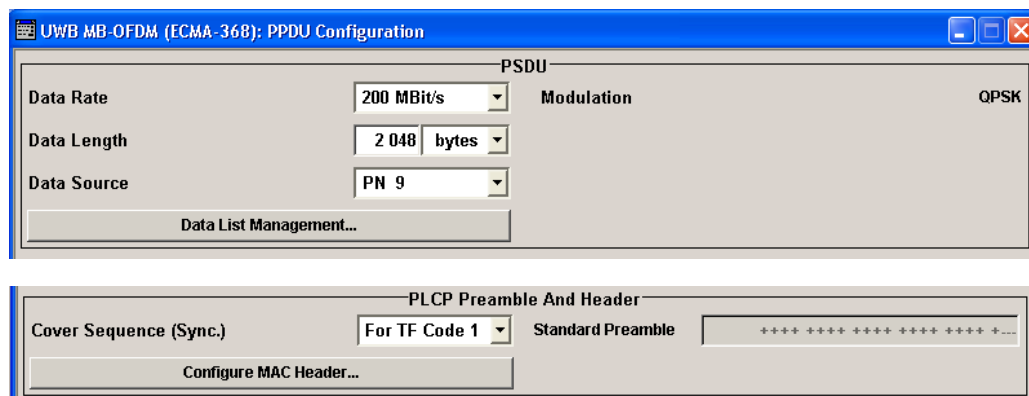
3.2 PPDU Configuration

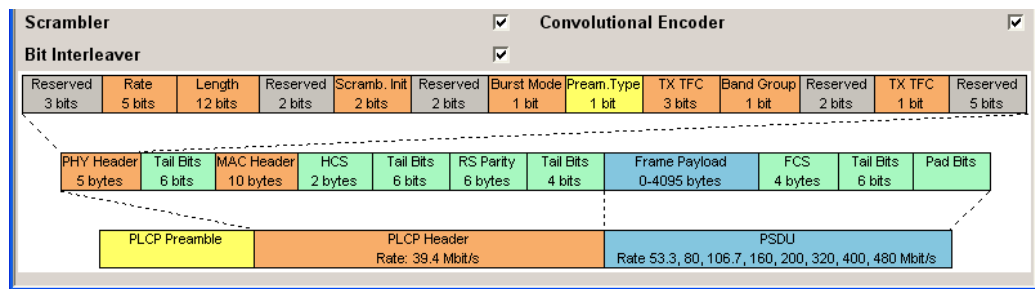
In the upper section of the menu, the parameters of the data part (PSDU) such as data rate, data length, and data source are set.

In the middle section, the PLCP Preamble and PLCP Header are configured.

In the lower section, enabling and disabling of the scrambler, bit interleaver and convolution encoder is possible.

A graph in the lower sections illustrates the structure of the PPDU.





3.2.1 PSDU Settings

Data Rate

Selects the data rate of the PSDU.

All data rates defined by the standard are supported. The selection of the PSDU bit rate automatically determines the code rate of the convolutional coder and the sub carrier modulation (see [table 3-1](#)).

Table 3-1: Data rates

Data Rate, Mbps	Modulation	Coding Rate
53.3	QPSK	1/3
80	QPSK	1/2
106.7	QPSK	1/3
160	QPSK	1/2
200	QPSK	5/8
320	DCM	1/2
400	DCM	5/8
480	DCM	3/4

SCPI command:

`[:SOURce<hw>] :BB:UWBMb:PPDU:DRATE` on page 51

Modulation

Indicates the modulation type. The modulation mode depends on the selected [Data Rate](#).

SCPI command:

`[:SOURce<hw>] :BB:UWBMb:PPDU:MODulation` on page 57

Data Length

Sets the data length of the frame payload of PSDU.

For standard transport mode (see [Transport Mode](#)), the minimum data length is 0 bytes.

For burst transport mode however, the data length cannot be 0, i.e. the minimum data length is 1 byte.

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:PPDU:DLENgth](#) on page 51

Data Source

Selects the data source for the data field.

- "All 0, All 1" 0 data or 1 data is internally generated.
- "PNxx" PRBS data in accordance with the IUT-T with period lengths between 2^9-1 and $2^{23}-1$ are internally generated.
- "Pattern" A user-definable bit pattern with a maximum length of 64 bits is internally generated.
The bit pattern is defined in the "Pattern" input box.

Data Pattern	0000 0000 0000 0000 0011 1111 1111 1111 1111
--------------	-------------------------------------------------

- "Data List..." Data lists will be used.
Data lists can be generated internally in the data editor or externally. Data lists are selected in the "File Select" window, which is called by means of the "Data List Management" button.
The "File Manager" is used to transmit external data lists to the R&S Signal Generator, and can be called within every File Select window by means of the "File Manager" button.

SCPI command:

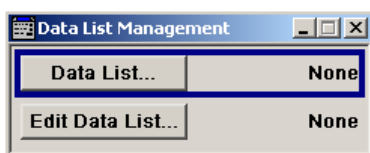
[\[:SOURce<hw>\]:BB:UWBMb:PPDU:DATA](#) on page 50

[\[:SOURce<hw>\]:BB:UWBMb:PPDU:DATA:PATtern](#) on page 51

[\[:SOURce<hw>\]:BB:UWBMb:PPDU:DATA:DSElect](#) on page 50

Data List Management...

Calls the "Data List Management" menu. This menu is used to create and edit a data list.



All data lists are stored as files with the predefined file extension *.dm_iqd. The file name and the directory they are stored in are user-definable.

Note: All data lists are generated and edited by means of the `SOURce:BB:DM` subsystem commands. Files containing data lists usually end with *.dm_iqd. The data lists are selected as a data source for a specific function in the individual subsystems of the digital standard.

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:PPDU:DATA](#) on page 50

[\[:SOURce<hw>\]:BB:UWBMb:PPDU:DATA:DSElect](#) on page 50

3.2.2 PLCP Preamble and PLCP Header

Cover Sequence (Sync.)

Selects which cover sequence will be used to spread the packet/frame synchronization sequence of the PLCP preamble.

The parameter is automatically set depending on the selection made for the parameter "TF Code". However, the Cover Sequence is always enabled for re-configuration.

"For TF Code 1...10" Standard compliant cover sequence will be used to spread the synchronization sequence of the PLCP preamble (see tables below). Each of the cover sequences can be selected, irrespective of the selected "Band Group".

The cover sequence for standard preamble is a 24 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively.

Table 3-2: Cover Sequences for Standard Preamble

For TF Code 1, 2	++++ +++++ +---
For TF Code 3, 4	++++ +++++ +-+-
For TF Code 5,6,7	---- +--- -+- -+- -+-
For TF Code 8,9,10	++- ++- ++- ++++ ++-

The cover sequence for burst preamble is a 12 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively.

Table 3-3: Cover Sequences for Burst Preamble

For TF Code 1, 2	++++ +++++ +---
For TF Code 3, 4	++++ +--- +-+-
For TF Code 5,6,7	---+ +--- -+++
For TF Code 8,9,10	++- ++++ ++-

If one of the standard compliant cover sequences is selected, the used sequence is displayed as "Standard Preamble" and/or "Burst Preamble", depending on the selected "Transport Mode".

"User" The cover sequence can be defined by the user. Depending on the selected "Transport Mode", either the "Standard Preamble" and/or the "Burst Preamble" will be enabled for configuration.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:CSSync on page 50

Standard Preamble

Displays the selected cover sequence used to spread the packet/frame synchronization sequence of the PLCP preamble.

The standard preamble is a 24 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively. The displayed sequence depends on the selected "Cover Sequence" (see [table 3-2](#)).

Note: This parameter is configurable only if the parameter "Cover Sequence (Sync.)" is set to User.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:SPReamble on page 58

Burst Preamble

Displays the selected cover sequence used to spread the packet/frame synchronization sequence of the PLCP preamble.

Note: This parameter is enabled only for "Burst Transport Mode", "Data Rate" greater than 200 Mbps and enabled "Burst Preamble Used".

The burst preamble is a 12 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively. The displayed sequence depends on the selected "Cover Sequence" (see [table 3-3](#)).

Note: This parameter is configurable only if the parameter "Cover Sequence (Sync.)" is set to User.

According to the standard, applying a Burst preamble for data rates greater than 200 Mbps is optional. Whether the selected Burst Preamble or a Standard Preamble will be used, can be configured with parameter "Burst Preamble Used".

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:BPReamble on page 49

Burst Preamble Used

Enables/disables using of burst preamble.

Note: This parameter is enabled only for "Burst Transport Mode" and "Data Rate" greater than 200 Mbps.

According to the standard, applying a Burst preamble for data rates greater than 200 Mbps is optional.

"Burst Preamble Used" defines whether a burst preamble selected with a combination of the parameters "Cover Sequence" and "Burst Preamble" or a selected "Standard Preamble" will be used.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:BPReamble:USED on page 49

Configure MAC Header...

Calls the menu for configuration of the MAC Header.

The menu is described in [chapter 3.3, "MAC Header"](#), on page 26.

SCPI command:

n.a.

Scrambler

Activates/deactivates the scrambler.

See [chapter 2.3.1, "Data Scrambler"](#), on page 13.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:SCRambler:STATe on page 58

Convolutional Encoder

Activates/deactivates the coder.

See [chapter 2.3.2, "Convolutional Encoder"](#), on page 13.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:ENCoder:STATe on page 52

Bit Interleaver

Activates/deactivates the interleaver.

See [chapter 2.3.3, "Bit Interleaving"](#), on page 14.

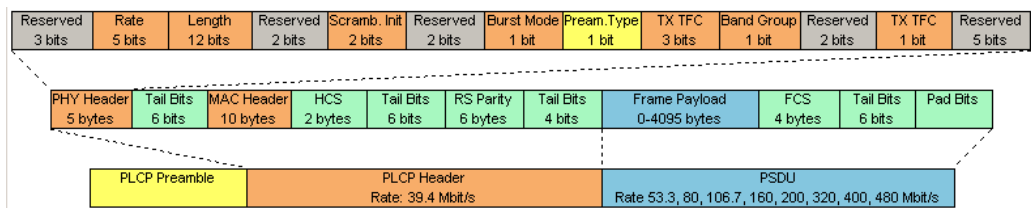
SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:ILEaver:STATe on page 52

3.2.3 PPDU Graph

The frame graph in the lower part of the menu indicates the configuration of the PPDU.

A packet contains a PLCP Preamble, PLCP Header and PSDU payload. The general packet structure is described in [chapter 2.2, "UWB MB-OFDM Frame Structure and PPDU Format"](#), on page 11.

**3.3 MAC Header**

In the real UWB system, a MAC (medium access control) header is transmitted in the PSDU prior to the actual data section. This header comprises control information of the MAC layer and checksum for protection of the PSDU. In the MAC Header menu, several MAC fields can be configured.

Field	Value	Length
Frame Control (hex)	C000	2 bytes
Destination Address (hex)	0000	2 bytes
Source Address (hex)	0000	2 bytes
Access Info	0000	2 bytes
Frame Body	0 - 4095 bytes	0 - 4095 bytes
FCS		4 bytes
Start Number (hex)	0	3 bit
Start Number (hex)	000	11 bit
Incremented Every	1 frame(s)	3 bit
Incremented Every	1 frame(s)	11 bit
More Fragments	<input type="checkbox"/>	
Reserved	00	2 bit (MSBit)
Retry	0	1 bit
Frame Subtype / Delivery ID	0000	4 bit
Frame Type	011	3 bit
ACK Policy	00	2 bit
Secure	0	1 bit
Protocol Version	000	3 bit (LSBits)

MAC Header

Activates/deactivates the generation of the MAC Header for the PSDU.

If the MAC header is deactivated, all the MAC fields are set to 0.

If the MAC header is activated, most of the MAC header fields are enabled for operation. Exceptions are the MAC Frame Control Fields. The values of these fields are set automatically depending on the selection made for the parameter [Frame Type](#).

The individual fields of the MAC header are described in the following.

All values of the MAC fields are entered in hexadecimal form with LSB in right notation. In the data stream, the values are output standard-conformal with the LSB coming first.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:SCONtrol:STATe](#) on page 57

Frame Control (hex)

Enters the value of the frame control field.

The Frame control field has a length of 2 bytes (16 bits) and is used to define the protocol version, the frame type, ACK policy, etc.

As an alternative, the individual bits can be set in the lower part of the graph.

Field	Value	Length
Reserved	00	2 bit (MSBit)
Retry	0	1 bit
Frame Subtype / Delivery ID	0000	4 bit
Frame Type	100	3 bit
ACK Policy	00	2 bit
Secure	0	1 bit
Protocol Version	000	3 bit (LSBits)

The value of parameter "Frame Control" is automatically set according to the settings for the "MAC Frame Control Field" and vice versa.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:FCONtrol](#) on page 53

Reserved

Sets the reserved bits.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMB:PPDU:MAC:FCONTROL:RESERVED](#) on page 54

Retry

Sets the Retry bit.

Note: This parameter is enabled for data, aggregated data and command frames only. A value of 1 indicates that the current frame is a retransmission of an earlier frame.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMB:PPDU:MAC:FCONTROL:RETRY](#) on page 54

Frame Subtype/ Delivery ID

Sets the frame Subtype/ Delivery ID bits. This field is used to assist a receiver in the proper processing of received frames.

Note: This parameter is not enabled for bacon frames.

For data and aggregated data frames, this field is used as Delivery ID. For control and command frames, this field is used as Frame Subtype.

Table 3-4: Control Frame Subtypes

Value	Frame Subtype
0000	Imm-Ack (Immediate Acknowledgement)
0001	B-ACK (Block Acknowledgement)
0010	RTS (Request to Send)
0011	CTS (Clear to Send)
0100	UDA (Unused DRP Reservation Announcement)
0101	UDR (Unused DRP Reservation Response)
0110 ... 1101	Reserved
1110	Application-specific
1111	Reserved

Table 3-5: Command Frame Subtypes

Value	Frame Subtype
0000	DRP (Distributed Reservation Protocol) Reservation Request
0001	DRP reservation Response
0010	Probe
0011	Pair-wise Temporal Key (PTK)
0100	Group Temporal Key (GTK)
0101	Range Measurement
0110 ... 1101	Reserved

Value	Frame Subtype
1110	Application-specific
1111	Reserved

The value of the Frame Subtype determines the allowed value of "Secure" bit.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:FCONtrol:SUBType on page 54

Frame Type

Displays the value of the frame type bits. This parameter is automatically set depending on the selection made for the parameter "Frame Type".

Table 3-6: Frame Types

Value	Frame Type
000	Beacon Frame
001	Control Frame
010	Command Frame
011	Data Frame
100	Aggregated data frame
101, 110, 111	Reserved

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:FCONtrol:TYPE on page 55

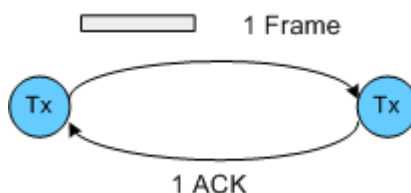
ACK Policy

Sets the ACK Policy bit, i.e. sets the type of acknowledgement requested by the transmitter. Acknowledgement policy is used if a verification of frame delivery is necessary.

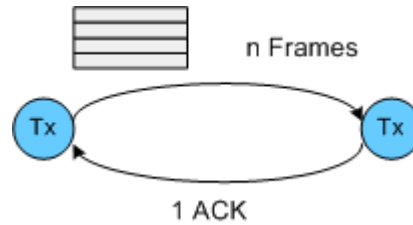
"00" "No-ACK Policy" is a transmission without acknowledgement. The frames are considered as successfully transmitted. This policy can be used for frames that do not require guaranteed delivery or for delay sensitive frames.



"01" "Imm-ACK Policy" is a transmission with an immediate individual acknowledgement of each frame after correct reception.



"10" "B(lock)-ACK Policy" allows a single-frame acknowledgement of multiple frame transmission. The acknowledgement frame is send after receiving a request (B-ACK Request) from the transmitter.



"11" "B-ACK Request" indicates the last frame of a multiple frame transmission with B-ACK Policy. Upon receiving such a frame, the receiver answers with single frame.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:FCONtrol:APOLicy](#) on page 53

Secure

Sets the secure bit.

A value of 1 indicates a secure frame. A Secure frame has special frame payload format and is protected with temporal keys.

The allowed value of the secure bit depends on the "Frame Type" and "Frame Sub-type".

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:FCONtrol:SECure](#) on page 54

Protocol Version

Enters protocol version.

Protocol Version must be set to 0 to be standard compliant.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:FCONtrol:PVERsion](#) on page 53

Destination Address (hex)

Enters the destination address of the intended receiver.

Receiver can be:

- a single device by unicast transmission
- a group of devices for a multicast transmission or
- all devices in case of broadcast.

The destination address is 2 bytes long. The value is in hexadecimal form.

SCPI command:

[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:DADDRESS](#) on page 52

Source Address (hex)

Enters the address of the transmitter.

The source address is 2 bytes long. The value is in hexadecimal form.

SCPI command:

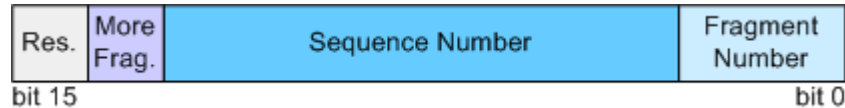
[\[:SOURCE<hw>\]:BB:UWBMb:PPDU:MAC:SADDRESS](#) on page 55

Sequence Control

Activates/deactivates the sequence control field.

Note: Sequence Control is not enabled for control frames.

The sequence control field has a length of 2 bytes and is divided in four parts, the fragment number field (3 bits), the sequence number field (11 bits), the more fragments bit (1 bit) and one reserved bit.



A long user data stream to be transmitted is first split up into MSDUs (MAC Service Data Units) which can either be transmitted as PSDU frames or further divided into fragments. The sequence number and the fragment number are then used to number the individual sub packets of the user data stream to be transmitted. Thus, all PSDUs are assigned a consecutive number. This allows the receiver to arrange the data packets in the correct order, to determine whether an incorrectly transmitted packet was retransmitted and to find out whether packets are missing.

If the receiver can detect a frame without an error and does not request a retransmission, the sequence number is incremented by 1 for each frame (the field is reset to 0 at the latest after a count of 1024). The fragment number field is incremented by 1 when another fragment of the current MPDU is transmitted. The start count for the transmission (normally 0) and the number of frames required to increment the corresponding counter can be defined for both numbers. This is done with the parameters "Start Number" and "Incremented every ... frame(s)" (see below).

Example:

An error-free transmission of 50 frames (no frame retransmission) is to be simulated. The sequence number should be incremented by 1 for each frame. Since no frame is fragmented, the fragment counter can always remain at 0.

In this case the following values have to be set:

Frame Control (hex) C000 2 bytes	Destination Address (hex) 0000 2 bytes	Source Address (hex) 0000 2 bytes	Sequence Control Enable <input checked="" type="checkbox"/> Frag 3 bit	Sequ 11 bit	Access Info 0000 2 bytes	Frame Body 0 - 4095 bytes	FCS 4 bytes
----------------------------------------	----------------------------------------------	-----------------------------------------	---------------------------------------------------------------------------------	----------------	--------------------------------	------------------------------	----------------

Start Number (hex) 0	Start Number (hex) 000
Incremented Every 0.00 frame(s)	Incremented Every 1 frame(s)
More Fragments	

If it is to be simulated that some frames are received incorrectly or if the response of the receiver should be tested when the same frame arrives several times, the number of frames required to increment the sequence number can be set to 2, for example.

SCPI command:

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:STATe` on page 57

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:START`

on page 56

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:INCRement`

on page 56

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:MORE` on page 56

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:START`

on page 57

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:INCRement`

on page 56

Start Number

Sets the start number of the fragment bits or the sequence bits of the sequence control.

SCPI command:

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:START`

on page 56

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:START`

on page 57

Increment Every

Defines the number of frames required to increment the counter of the fragment bits or the sequence bits of the sequence control (see example above).

SCPI command:

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:INCRement`

on page 56

`[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:INCRement`

on page 56

More Fragments

Enables/disables sending of More Fragments.

Disabling of More Fragments sets the value of the bit to 0, i.e. the current fragment is the sole or the final fragment of the current MSDU or MCDU.

Enabling of More Fragments sets the value of the More Fragments bit to 1.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:MORE on page 56

Access Info

Sets the access information for the security functions.

SCPI command:

[:SOURce<hw>] :BB:UWBMb:PPDU:MAC:AINFo on page 52

Frame Body

Indicates the length of the user data (frame body).

SCPI command:

n.a.

FCS

Indicates the length of the check sum. The FCS is 4 bytes long that corresponds to a CRC polynomial of degree 31.

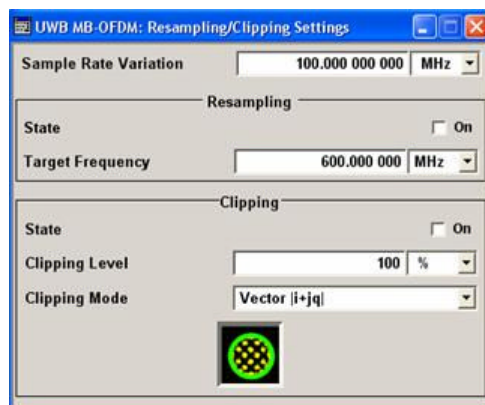
SCPI command:

n.a.

3.4 Resampling/Clipping

The "Resampling/Clipping..." menu is reached via the UWB MB-OFDM main menu.

The sample rate variation, the resampling and clipping ("Clipping" section) are defined in this menu.



3.4.1 Resampling

Sample Rate Variation

Sets the sample rate of the signal.

A variation of this parameter only affects the ARB clock rate; all other signal parameters remain unchanged.

The sample rate depends on the selected digital standard and on the configured instrument. If the configured instrument is changed, the value range of this parameter is changed as well.

The default sample rate of the UWB MB-OFDM signal is 528 MHz.

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:SRATe:VARiation](#) on page 45

State Resampling

Enables/disables resampling of the signal.

Resampling has to be performed to match the waveform's sample rate to the one supported by an instrument.

If the resampling is activated, the software resampler interpolates the waveform to a clock rate of the frequency selected with the parameter "Target Frequency".

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:RESampling:STATe](#) on page 45

Target Frequency

Sets the target frequency for the resampled signal.

The target frequency has to be lower or equal to the maximum clock frequency of the target instrument.

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:RESampling:TF](#) on page 45

3.4.2 Clipping

The settings for clipping are collected in the "Clipping" section.

Clipping State

Switches baseband clipping on and off.

Baseband clipping is a very simple and effective way of reducing the crest factor of the UWB MB-OFDM signal.

High crest factors entail two basic problems:

- The nonlinearity of the power amplifier (compression) causes intermodulation which expands the spectrum (spectral regrowth).
- Since the level in the D/A converter is relative to the maximum value, the average value is converted with a relatively low resolution. This results in a high quantization noise.

Both effects increase the adjacent-channel power.

With baseband clipping, all the levels are limited to a settable value ("Clipping Level"). This level is specified as a percentage of the highest peak value. Since clipping is done prior to filtering, the procedure does not influence the spectrum. The EVM however increases. Since clipping the signal not only changes the peak value but also the average value, the effect on the crest factor is unpredictable.

SCPI command:

`[:SOURce<hw>] :BB:UWBMb:CLIPping:STATe` on page 44

Clipping Level

Sets the limit for clipping.

This value indicates at what point the signal is clipped. It is specified as a percentage, relative to the highest level. 100% indicates that clipping does not take place.

SCPI command:

`[:SOURce<hw>] :BB:UWBMb:CLIPping:LEVel` on page 44

Clipping Mode

Selects the clipping method. A graphic illustration of the way in which these two methods work is given in the menu.

"Vector $|i + jq|$ " The limit is related to the amplitude $|I + jQ|$. The I and Q components are mapped together, the angle is retained.



"Scalar $|i| + |q|$ " The limit is related to the absolute maximum of all the $|I|$ and $|Q|$ values. The I and Q components are mapped separately, the angle changes.



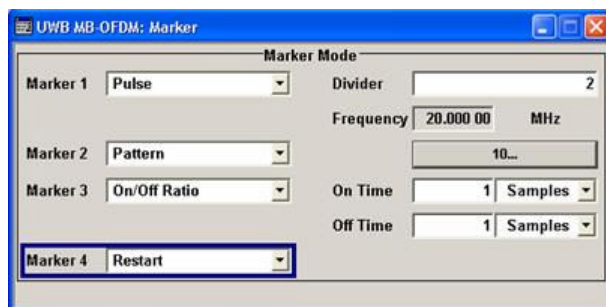
SCPI command:

`[:SOURce<hw>] :BB:UWBMb:CLIPping:MODE` on page 44

3.5 Marker Settings

The "Marker" dialog can be reached via the UWB MB-OFDM main menu.

The "Marker Mode" section is where the marker signals at the MARKER output connectors are configured.



Marker x Mode

Selects a marker signal for the associated MARKER output.

- "Restart" A marker signal is generated at the start of each signal sequence (period = selected number of frames).
- "Frame Start" A marker signal is generated at the start of each frame (period = PPDU).
- "Pulse" A regular marker signal is generated. The clock frequency is defined by entering a divider. The frequency is derived by dividing the chip rate by the divider. The input box for the divider opens when "Pulse" is selected, and the resulting pulse frequency is displayed below it.

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:DIVider](#)
on page 47

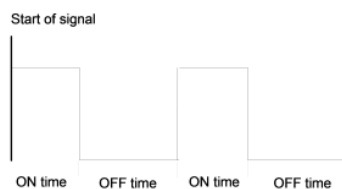
[\[:SOURce<hw>\]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:FREQuency](#)
on page 47

- "Pattern" A marker signal that is defined by a bit pattern is generated. The pattern has a maximum length of 32 bits and is defined in an input field which opens when "pattern" is selected.

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:TRIGger:OUTPut<ch>:PATTern](#) on page 47

- "ON/OFF ratio" 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.



SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:TRIGger:OUTPut<ch>:ONTIME](#) on page 46

[\[:SOURce<hw>\]:BB:UWBMb:TRIGger:OUTPut<ch>:OFFTime](#) on page 46

SCPI command:

[\[:SOURce<hw>\]:BB:UWBMb:TRIGger:OUTPut<ch>:MODE](#) on page 46

4 Remote-Control Commands

This subsystem contains commands for the primary and general settings of the UWB MB-OFDM standard. These settings concern activation and deactivation of the standard, filter, clipping and marker settings, defining the frame type, the band group and the sequence length, as well as the preset setting.

The commands for defining the frame configuration are described in the next section. The commands are divided up in this way to make the comprehensive `SOURce:BB:UWBMB` subsystem clearer.

SOURce<hw>

For one-path instruments, the keyword `SOURce` is optional and can be omitted.

The numeric suffix to `SOURce` distinguishes between signal generation for path A and path B in the case of two-path instruments:

- `SOURce[1]` = path A
The keyword `SOURce` is optional and can be omitted
- `SOURce2` = path B
The keyword `SOURce` is mandatory, i.e. the command must contain the keyword with suffix 2.

OUTPut<ch>

The numeric suffix to `OUTPut` distinguishes between the available markers.

4.1 General Commands

<code>[:SOURce<hw>]:BB:UWBMB:BGRoup</code>	38
<code>[:SOURce<hw>]:BB:UWBMB:FTYPE</code>	38
<code>[:SOURce<hw>]:BB:UWBMB:HSEquence</code>	38
<code>[:SOURce<hw>]:BB:UWBMB:HSEquence:USER[:STATE]</code>	39
<code>[:SOURce<hw>]:BB:UWBMB:IFS:TYPE</code>	39
<code>[:SOURce<hw>]:BB:UWBMB:IFS:VALUE</code>	39
<code>[:SOURce<hw>]:BB:UWBMB:PRESet</code>	40
<code>[:SOURce<hw>]:BB:UWBMB:SETTing:CATalog</code>	40
<code>[:SOURce<hw>]:BB:UWBMB:SETTing:DELeTe</code>	41
<code>[:SOURce<hw>]:BB:UWBMB:SETTing:LOAD</code>	41
<code>[:SOURce<hw>]:BB:UWBMB:SETTing:STORe</code>	41
<code>[:SOURce<hw>]:BB:UWBMB:SETTing:STORe:FAST</code>	41
<code>[:SOURce<hw>]:BB:UWBMB:SLENgth</code>	42
<code>[:SOURce<hw>]:BB:UWBMB:STATe</code>	42
<code>[:SOURce<hw>]:BB:UWBMB:TFCoDe</code>	42
<code>[:SOURce<hw>]:BB:UWBMB:TMODe</code>	43
<code>[:SOURce<hw>]:BB:UWBMB:VERSiOn</code>	43
<code>[:SOURce<hw>]:BB:UWBMB:WAVeform:CREate</code>	43

[[:SOURce<hw>]:BB:UWBMb:BGRoup <BGroup>

Selects the band group for which a signal will be generated.

Parameters:

<BGroup> BG1 | BG2 | BG3 | BG4 | BG5 | BG6
 *RST: BG1

Example:

BB:UWBM:BGR BG2
 sets the band group 2.

[[:SOURce<hw>]:BB:UWBMb:FTYPe <FType>

Selects the frame type of the generated signal.

Parameters:

<FType> DATA | BEACon | CONTrol | COMMand | AGGRegated

DATA

Frames containing useful data.

BEACon

Beacons are used for synchronization to a shared channel.

CONTrol

Control frames will be generated.

COMMand

Command frames will be generated.

AGGRegate

Aggregated frames will be generated. The payload of these frames contains an aggregation header and multiple MSDUs (MAC service data units).

*RST: DATA

Example:

BB:UWBM:FTYP CONTR
 sets the frame type to control.

[[:SOURce<hw>]:BB:UWBMb:HSEQuence <HSequence>

Sets a user defined hopping sequence.

Parameters:

<HSequence> string

Example:

BB:UWBM:HSEQ:USER:STAT ON

enables deffining of user hopping sequence.

BB:UWBM:BGR BG1

selects the band group the hopping sequene will be deffined for.

BB:UWBM:HSEQ 1,2,3,1,2,3

enables deffining of user hopping sequence.

[[:SOURce<hw>]:BB:UWBMb:HSEQ:USER[:STATe] <State>

Enables/disables defining of user hopping sequence.

Parameters:

<State> 0 | 1 | OFF | ON
 *RST: 0

Example:

BB:UWBM:HSEQ:USER:STAT ON
 enables defining of user hopping sequence.
 BB:UWBM:BGR BGL
 selects the band group the hopping sequence will be defined for.
 BB:UWBM:HSEQ 1,2,3,1,2,3
 enables defining of user hopping sequence.

[[:SOURce<hw>]:BB:UWBMb:IFS:TYPE <Type>

Selects the frame type of the inter frame spacing interval.

Parameters:

<Type> SIFS | MIFS | USER
 *RST: SIFS

Example:

BB:UWBM:TMOD BURST
 sets the transmission mode to burst.
 BB:UWBM:IFS:TYPE MIFS
 sets the inter frame spacing type to MIFS.
 BB:UWBM:IFS:VAL?
 queries the duration of the inter frame spacing interval.
 Response: '6'

[[:SOURce<hw>]:BB:UWBMb:IFS:VALUE <Value>

Sets the duration in symbols of the inter frame spacing interval.

Parameters:

<Value> integer
 Range: 0 to 99
 Increment: 1
 *RST: 32(for SIFS); 6(for MIFS)

Example:

```
BB:UWBM:IFS:TYPE MIFS
sets the inter frame spacing type to MIFS.
BB:UWBM:IFS:VAL?
queries the duration of MIFS.
Response: '6'
BB:UWBM:IFS:TYPE SIFS
sets the inter frame spacing type to SIFS.
BB:UWBM:IFS:VAL?
queries the duration of SIFS.
Response: '32'
BB:UWBM:IFS:TYPE USER
sets the inter frame spacing type to User.
BB:UWBM:IFS:VAL 10
sets the inter frame spacing duration to 10 symbols.
```

[:SOURce<hw>]:BB:UWBMb:PRESet

Produces a standardized default for the UWB MB-OFDM standard.

All UWB MB-OFDM settings are preset.

Example:

```
BB:UWBM:PRES
resets all the UWB MB-OFDM settings to default values.
```

Usage: Event

[:SOURce<hw>]:BB:UWBMb:SETTING:CATalog?

Reads out the files with UWB MB-OFDM settings in the default directory. The default directory is set using command `MMEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only files with the file extension `*.uwb` will be listed.

Return values:

<Catalog> string

Example:

```
MMEM:CDIR 'D:\user\uwb'
sets the default directory to D:\user\uwb.
BB:UWBM:SETT:CAT?
reads out all the files with UWB MB-OFDM settings in the default
directory.
Response: 'uwb_1','uwb_2'
the files uwb_1 and uwb_2 are available.
```

Usage: Query only

[[:SOURce<hw>]:BB:UWBMb:SETTING:DELeTe <Filename>

Deletes the selected file with UWB MB-OFDM settings. The directory is set using command `M MEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.uwb` will be deleted.

Setting parameters:

<Filename> string

Example: `BB:UWBM:SETT:DEL 'uwb_2'`
deletes file `uwb_3`.

Usage: Setting only

[[:SOURce<hw>]:BB:UWBMb:SETTING:LOAD <Filename>

Loads the selected file with UWB MB-OFDM settings.. The directory is set using command `M MEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. The file extension may be omitted. Only files with the file extension `*.uwb` will be loaded.

Setting parameters:

<Filename> string

Example: `BB:UWBM:SETT:LOAD 'uwb_1'`
loads file `uwb_1`.

Usage: Setting only

[[:SOURce<hw>]:BB:UWBMb:SETTING:STORe <Filename>

Stores the current UWB MB-OFDM settings into the selected file. The directory is set using command `M MEM:CDIRectory`. A path can also be specified, in which case the files in the specified directory are read. Only the file name has to be entered. UWB MB-OFDM settings are stored as files with the specific file extensions `*.uwb`.

Setting parameters:

<Filename> string

Example: `BB:UWBM:SETT:STOR 'uwb_3'`
stores the current settings into file `uwb_3`.

Usage: Setting only

[[:SOURce<hw>]:BB:UWBMb: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: 0

[[:SOURce<hw>]:BB:UWBMb:SLENgth <SLength>

Selects the number of frames.

Parameters:

<SLength> integer
 Range: 1 frame to 10000 frames
 *RST: 1

Example:

BB:UWBM:SLEN 4
 selects the generation of 4 frames.

[[:SOURce<hw>]:BB:UWBMb:STATe <State>

Activates modulation in accordance with the UWB MB-OFDM standard. Activating this standard deactivates all the other digital standards and digital modulation modes.

BB:UWBM:STAT ON deactivates the other standards and digital modulation.

Parameters:

<State> 0 | 1 | OFF | ON
 *RST: OFF

Example:

BB:UWBM:STAT ON
 activates modulation in accordance with the UWB MB-OFDM standard.

[[:SOURce<hw>]:BB:UWBMb:TFCodE <TfCode>

Selects the time-frequency code (TF Code) of the generated signal.

Note: For band group 5 (BB:UWBM:BGR BG5) only TFC5, TFC6, TFC8 and User are allowed.

Parameters:

<TfCode> TFC1 | TFC2 | TFC3 | TFC4 | TFC5 | TFC6 | TFC7 | TFC8 | TFC9 | TFC10
 *RST: TFC1

Example:

BB:UWBM:BGR BG5
 sets the band group of the generated signal to 5.
 BB:UWBM:TFC TFC5
 sets the time-frequency code of the generated signal to TF Code 5.

[[:SOURce<hw>]:BB:UWBMb:TMODe <TMode>

Selects the transport mode of the signal.

Parameters:

<TMode> STANdard | BURSt
*RST: STANdard

Example:

BB:UWBM:TMOD BURSt
sets the transport mode of the generated signal to Burst.

[[:SOURce<hw>]:BB:UWBMb:VERSion?

The command queries the version of the WB MB-OFDM standard underlying the definitions.

Return values:

<Version> string

Example:

BB:UWBM:VERS?
queries the UWB MB-OFDM version.
Response: '1st Edition, Dec. 2005'
The version used is the 1st Edition, Dec. 2005

Usage:

Query only

[[:SOURce<hw>]:BB:UWBMb:WAVeform:CREate <Filename>

Creates a waveform using the current settings of the "UWB MB-OFDM" menu. The file name is entered with the command. The file is stored with the predefined file extension *.wv. The file name and the directory it is stored in are user-definable.

Setting parameters:

<Filename> string

Example:

BB:UWBM:STAT ON
activates modulation in accordance with the UWB MB-OFDM standard.
MMEM:CDIR 'D:\user\waveform'
sets the default directory to D:\user\waveform.
BB:UWBM:WAV:CRE 'uwb_1'
creates the waveform file uwb_1.wv in the default directory.

Usage:

Setting only

4.2 Clipping Settings

[[:SOURce<hw>]:BB:UWBMb:CLIPping:LEVel.....	44
[[:SOURce<hw>]:BB:UWBMb:CLIPping:MODE.....	44
[[:SOURce<hw>]:BB:UWBMb:CLIPping:STATe.....	44
[[:SOURce<hw>]:BB:UWBMb:SRATe:VARiation.....	45

<code>[:SOURce<hw>]:BB:UWBMb:RESampling:STATe</code>	45
<code>[:SOURce<hw>]:BB:UWBMb:RESampling:TF</code>	45

`[:SOURce<hw>]:BB:UWBMb:CLIPping:LEVel <Level>`

Sets the limit for level clipping. This value indicates at what point the signal is clipped. It is specified as a percentage, relative to the highest level. 100% indicates that clipping does not take place.

Level clipping is activated with `SOUR:BB:UWBM:CLIP:STAT ON`

Parameters:

<Level> integer
 Range: 0 PCT to 100 PCT
 Increment: 1
 *RST: 100 PCT

Example:

```
BB:UWBM:CLIP:LEV 80PCT
sets the limit for level clipping to 80% of the maximum level.
BB:UWBM:CLIP:STAT ON
activates level clipping.
```

`[:SOURce<hw>]:BB:UWBMb:CLIPping:MODE <Mode>`

Sets the method for level clipping (Clipping).

Parameters:

<Mode> VECTor | SCALar
VECTor
 The reference level is the amplitude $|i+jq|$.
SCALar
 The reference level is the absolute maximum of the I and Q values.
 *RST: VECTor

Example:

```
BB:UWBM:CLIP:MODE SCAL
selects the absolute maximum of all the I and Q values as the
reference level.
BB:UWBM:CLIP:LEV 80PCT
sets the limit for level clipping to 80% of this maximum level.
BB:UWBM:CLIP:STAT ON
activates level clipping.
```

`[:SOURce<hw>]:BB:UWBMb:CLIPping:STATe <State>`

Activates level clipping (Clipping). The value is defined with the command `[SOURce:]BB:UWBMb:CLIPping:LEVel`, the mode of calculation with the command `[SOURce:]BB:UWBMb:CLIPping:MODE`.

Parameters:

<State> 0 | 1 | OFF | ON
 *RST: OFF

Example: `BB:UWBM:CLIP:STAT ON`
activates level clipping.

[:SOURce<hw>]:BB:UWBMb:SRATe:VARiation <Variation>

Sets the sample rate of the signal.

A variation of this parameter only affects the ARB clock rate; all other signal parameters remain unchanged.

Parameters:

<Variation> float
Range: 400 Hz to 40 MHz
*RST: 40 MHz

Example: `BB:UWBM:SRAT:VAR 4 MHz`
sets the sample rate of the signal to 4 MHz.

[:SOURce<hw>]:BB:UWBMb:RESampling:STATe <State>

Enables/disables resampling of the signal.

Resampling has to be performed to match the waveform's sample rate to the one supported by an instrument.

If the resampling is activated, the software resampler interpolates the waveform to a clock rate of the frequency selected with the command `BB:UWBM:RES:TF`.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: OFF

Example: `BB:UWBM:RES:STAT ON`
enables resampling.

[:SOURce<hw>]:BB:UWBMb:RESampling:TF <Tf>

Sets the target frequency for the resampled signal.

The target frequency has to be lower or equal to the maximum clock frequency of the target instrument.

Parameters:

<Tf> integer
Range: 100 MHz to 600 MHz
*RST: 100 MHz

Example: `BB:UWBM:RES:TF 300`
sets the target frequency to 300 MHz.

4.3 Marker Settings

This section lists the remote control commands, necessary to configure the markers.

OUTput<ch>

The numeric suffix to OUTPut distinguishes between the available markers.

<code>[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:MODE</code>	46
<code>[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:OFFTime</code>	46
<code>[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:ONTime</code>	46
<code>[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PATTern</code>	47
<code>[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:DIVider</code>	47
<code>[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:FREQuency</code>	47

`[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:MODE <Mode>`

Defines the signal for the selected marker output.

Parameters:

<Mode>

REStart | FRAMe | PULSe | PATTern | RATio

REStart

A marker signal is generated at the start of each signal sequence (period = selected number of frames; the sequence length is set with command `SOUR:BB:UWBMb:SLen`).

FRAMe

A marker signal is generated at the start of each frame (period = PPDU).

PATTern

A marker signal is generated according to the user defined pattern (command `SOURce:BB:UWBMb:TRIGger:OUTPut:PATTern`).

PULSe

A pulsed marker signal is generated. The pulse frequency

RATio

A marker signal corresponding to the Time Off / Time On specifications in the commands

`SOURce:BB:UWBMb:TRIGger:OUTPut:OFFT` and

`SOURce:BB:UWBMb:TRIGger:OUTPut:ONT` is generated.

*RST: REStart

Example:

`BB:UWBM:TRIG:OUTP2:MODE FRAM`

selects the frame marker signal on output MARKER 2.

`[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:OFFTime <OffTime>`

`[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:ONTime <OnTime>`

Sets the number of samples in a period (ON time + OFF time) during which the marker signal in setting `SOURce:BB:UWBMb:TRIGger:OUTPut:MODE RATio` on the marker outputs is ON.

Parameters:

<OnTime> integer
 Range: 1 to $2^{24} - 1$ (16 777 215)
 Increment: 1
 *RST: 1

Example:

BB:UWBM:TRIG:OUTP2:MODE FRAM
 selects a ratio marker signal on output MARKER 2.
 BB:UWBM:TRIG:OUTP2:ONT 200
 sets an ON time of 200 chips for marker 2.

[[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PATTern <Pattern>

Defines the bit pattern used to generate the marker signal in the setting
 SOURce:BB:UWBMb:TRIGger:OUTPut:MODE PATTern.

0 is marker off, 1 is marker on.

Parameters:

<Pattern> 32 bit pattern
 *RST: #B,1

Example:

BB:UWBM:TRIG:OUTP2:PATT #B000000011111111,15
 sets a bit pattern.
 BB:UWBM:TRIG:OUTP2:MODE PATT
 activates the marker signal according to a bit pattern on output
 MARKER 2.

[[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:DIVider <Divider>

Sets the divider for Pulse marker mode (SOUR:BB:UWBM:TRIG:OUTP:MODE PULSe).
 The resulting pulse frequency is derived by dividing the symbol rate by the divider.

Parameters:

<Divider> integer
 Range: 2 to 1024
 *RST: 2

Example:

BB:UWBM:TRIG:OUTP2:PULS:DIV 10
 sets the divider to 2 for the marker signal on output MARKER 2.
 BB:UWBM:TRIG:OUTP2:FREQ?
 queries the resulting pulse frequency of the marker signal.
 Response: '4 000 000'
 the resulting pulse frequency is 4 MHz.

[[:SOURce<hw>]:BB:UWBMb:TRIGger:OUTPut<ch>:PULSe:FREQUency?

Queries the pulse frequency of the pulsed marker signal in the setting
 SOURce:BB:UWBMb:TRIGger:OUTPut:MODE PULSe. The pulse frequency is derived
 by dividing the symbol rate by the divider.

Return values:

<Frequency> float

Example:

BB:UWBM:TRIG:OUTP2:PULS:DIV 2

sets the divider marker signal on output MARKER 2 to the value 2.

BB:UWBM:TRIG:OUTP2:MODE PULS

enables the pulsed marker signal.

BB:UWBM:TRIG:OUTP2:PULS:FREQ?

queries the pulse frequency of the marker signal.

Response: '20 000 000'

the resulting pulse frequency is 20 MHz.

Usage:

Query only

4.4 PPDU Settings

The `SOURCE:BB:UWBM:PPDU` system contains commands for setting the characteristics of the data packet on the physical layer (PPDU).

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`[:SOURCE<hw>]:BB:UWBMB:PPDU:BPreamble <BPreamble>`

Selects the burst preamble. The burst preamble is a 12 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively.

Note:

This parameter is enabled for configuration only for Cover Sequence set to User, Burst Transport Mode, Data Rate greater than 200 Mbps and enabled Burst Preamble.

For Cover Sequence set to one of the standard compliant sequences, burst preamble is read-only.

Parameters:

<BPreamble> string
 *RST: ++++++++---

Example:

```
BB:UWB:TMOD BURS
selects burst transport mode.
BB:UWB:PPDU:CSS TFC3
sets the packet/frame synchronization cover sequence to TFC3.
BB:UWB:PPDU:BPR?
queries the burst preamble.
Response: '++++++-+-'
BB:UWB:PPDU:CSS USER
sets the packet/frame synchronization cover sequence to user-
defined.
BB:UWB:PPDU:DRAT DR320M
sets the data rate to 320 Mbps.
BB:UWB:PPDU:BPR:USED ON
enables using the burst preamble.
BB:UWB:PPDU:BPR "+-+-+-+-"
sets the burst preamble to '+-+-+-+'.
```

`[:SOURCE<hw>]:BB:UWBMB:PPDU:BPreamble:USED <Used>`

Enables/disables using of burst preamble.

Note:

This parameter is enabled only for Burst Transport Mode and Data Rate greater than 200 Mbps.

Parameters:

<Used> 0 | 1 | OFF | ON
 *RST: ON

Example: `BB:UWBM:TMOD BURSt`
selects burst transport mode.
`BB:UWBM:PPDU:DRAT DR320M`
sets the data rate to 320 Mbps.
`BB:UWBM:PPDU:BPR:USED OFF`
enables using the burst preamble.

[:SOURce<hw>]:BB:UWBMb:PPDU:CSSync <CsSync>

Selects which cover sequence will be used to spread the packet/frame synchronization sequence of the PLCP preamble.

Parameters:

<CsSync> TFC1 | TFC2 | TFC3 | TFC4 | TFC5 | TFC6 | TFC7 | TFC8 | TFC9 |
TFC10 | USER
*RST: TFC1

Example: `BB:UWBM:PPDU:CSSync TFC3`
sets the packet/frame synchronization cover sequence to TFC3.

[:SOURce<hw>]:BB:UWBMb:PPDU:DATA <Data>

Determines the data source for the data field.

Parameters:

<Data> ZERO | ONE | PATTErn | PN9 | PN11 | PN15 | PN16 | PN20 |
PN21 | PN23 | DLISt

PNxx

The pseudo-random sequence generator is used as the data source. Different random sequence lengths can be selected.

DLISt

A data list is used. The data list is selected with the command `BB:UWBMb:PPDU:DATA:DSElect`.

ZERO | ONE

Internal 0 and 1 data is used.

PATTErn

Internal data is used. The bit pattern for the data is defined by the command `BB:UWBMb:PPDU:DATA:PATTErn`.

*RST: PN9

Example: `BB:UWBM:PPDU:DATA PATT`
selects as the data source for the data fields of burst 0, the bit pattern defined with the following command.
`BB:UWBM:PPDU:DATA:PATT #H3F,8`
defines the bit pattern.

[:SOURce<hw>]:BB:UWBMb:PPDU:DATA:DSElect <DSelect>

Selects the data list for the DLISt data source selection.

The lists are stored as files with the fixed file extensions `*.dm_iqd` in a directory of the user's choice. The directory applicable to the following commands is defined with the command `MMEMoRY:CDIR`. To access the files in this directory, you only have to give the file name, without the path and the file extension.

Parameters:

<DSelect> string

Example:

```
BB:UWBM:PPDU:DATA DLIS
selects the Data Lists data source.
MMEMoRY:CDIR 'D:\Lists\DM\IqData'
selects the directory for the data lists.
BB:UWBM:PPDU:MAC:DATA:DSEL 'uwb_list1'
selects file uwb_list1 as the data source. This file must be in the
directory D:\Lists\DM\IqData and have the file extension
*.dm_iqd.
```

[:SOURce<hw>]:BB:UWBMb:PPDU:DATA:PATtern <Pattern>

Determines the bit pattern for the PATtern selection. The maximum length is 64 bits.

Parameters:

<Pattern> integer
*RST: 0

Example:

```
BB:UWBM:PPDU:DATA PATT
selects as the data source for the data fields of burst 0, the bit
pattern defined with the following command.
BB:UWBM:PPDU:MAC:DATA:PATT #H3F,8
defines the bit pattern.
```

[:SOURce<hw>]:BB:UWBMb:PPDU:DLENgth <DLength>

Sets the data length in bytes.

Parameters:

<DLength> integer
Range: 0 (standard transport mode) / 1 (burst transport
mode) to 4095 Bytes
*RST: 2048

Example:

```
BB:UWBM:PPDU:DLEN 256
sets a data length of 256.
```

[:SOURce<hw>]:BB:UWBMb:PPDU:DRATe <DRate>

Selects the data rate of the PSDU. The selection of the PSDU bit rate automatically determines the code rate of the convolutional coder and the subcarrier modulation.

Parameters:

<DRate> DR53M3 | DR80M | DR106M7 | DR160M | DR200M | DR320M |
DR400M | DR480M
*RST: 200

Example:

BB:UWBM:PPDU:DRAT DR320M
sets a data rate to 320 Mbps.

[[:SOURce<hw>]:BB:UWBMb:PPDU:ENCoder:STATe <State>

Activates/deactivates the coder.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: ON

Example:

BB:UWBM:PPDU:ENC OFF
deactivates the coder.

[[:SOURce<hw>]:BB:UWBMb:PPDU:ILEaver:STATe <State>

Activates/deactivates the interleaver.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: ON

Example:

BB:UWBM:PPDU:ILE OFF
deactivates the interleaver.

[[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:AInfo <AInfo>

Sets the access information for security functions.

The destination address is 2 bytes long.

Parameters:

<AInfo> integer
Range: #H0000,16 to #HFFFF,16
*RST: #H0000,16

Example:

BB:UWBM:PPDU:MAC:AInfo #H1FA5,16
set the access information to H1FA5,16.

[[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:DAddress <DAddress>

Enters the destination address of the intended receiver.

The destination address is 2 bytes long. The value is in hexadecimal form.

Parameters:

<DAddress> integer
 Range: #H0000,16 to #HFFFF,16
 *RST: #H0000,16

Example:

BB:UWBM:PPDU:MAC:DADD #H8F5A,16
 set the value for the destination address.

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONTROL <FControl>

Enters the value of the frame control field. The Frame control field has a length of 2 bytes (16 bits) and is used to define the protocol version, the frame type, etc.. As an alternative, the individual bits can be set.

Parameters:

<FControl> integer
 Range: #H0000,16 to #HFFFF,16
 *RST: #HC000,16

Example:

BB:UWBM:PPDU:MAC:FCON #H100A,16
 sets the value of the frame control field.

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONTROL:APOLICY <APolicy>

Sets the ACK Policy bit, i.e. sets the type of acknowledgement requested by the transmitter. Acknowledgement policy is used if a verification of frame delivery is necessary.

The ACK Policy field has a length of 2 bits.

Parameters:

<APolicy> integer
 Range: #H0,2 to #H3,2
 *RST: #H0,2

Example:

BB:UWBM:PPDU:MAC:FCON:APOL #H2,2
 sets the acknowledgement type to Block-ACK.

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:FCONTROL:PVERSION <PVersion>

Enters protocol version.

The Protocol Version field has a length of 3 bits. Protocol Version must be set to 0 to be standard compliant.

Parameters:

<PVersion> integer
 Range: #H0,3 to #H7,3
 *RST: #H0,3

Example:

BB:UWBM:PPDU:MAC:FCON:PVER #H1,3
 sets the value of the Protocol Version field.

[[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:REServed <Reserved>

Sets the reserved bits.

The Reserved field has a length of 2 bits.

Parameters:

<Reserved> integer
 Range: #H0,2 to #H3,2
 *RST: #H0,2

Example:

BB:UWBM:PPDU:MAC:FCON:RES #H1,2
 sets the value of the Reserved field.

[[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:RETRy <Retry>

Sets the Retry bit.

Note:

This parameter is enabled for data, aggregated data and command frames only.

A value of 1 indicates that the current frame is a retransmission of an earlier frame.

The Retry field has a length of 1 bit.

Parameters:

<Retry> 0 | 1
 *RST: 0

Example:

BB:UWBM:FTYP DATA
 sets the frame type to data.
 BB:UWBM:PPDU:MAC:FCON:RETR 1
 sets the value of the Retry field to 1, i.e. the current frame is a retransmission of an earlier frame.

[[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:SECure <Secure>

Sets the secure bit.

A value of 1 indicates a secure frame. The Secure field has a length of 1 bit.

Parameters:

<Secure> 0 | 1
 *RST: 0

Example:

BB:UWBM:PPDU:MAC:FCON:SEC 1
 sets the value of the Secure field to 1, i.e. the current frame is a secure frame.

[[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:SUBType <Subtype>

Sets the frame Subtype/ Delivery ID bits.

This field is used to assist a receiver in the proper processing of received frames.

Note:

This parameter is not enabled for bacon frames.

For data and aggregated data frames, this field is used as Delivery ID.

For control and command frames, this field is used as Frame Subtype.

The Frame Subtype/ Delivery ID field has a length of 4 bits.

Parameters:

<Subtype> integer
 Range: #H0,4 to #HF,4
 *RST: #H0,4

Example:

BB:UWBM:FTYP CONT
 sets the frame type to control.
 BB:UWBM:PPDU:MAC:FCON:SUBT #H3,4
 sets the frame subtype to CTS (Clear to Send).
 BB:UWBM:FTYP COMM
 sets the frame type to control.
 BB:UWBM:PPDU:MAC:FCON:SUBT #H3,4
 sets the frame subtype to PTK (Pair-wise Temporal Key).

[[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:FCONtrol:TYPE?

Queries the frame type set with the command BB:UWBMb:FTYPE.

The Frame Type (Frame Control) field has a length of 3 bits.

Return values:

<Type> integer

Example:

BB:UWBM:FTYP AGGR
 sets the frame type to aggregated.
 BB:UWBM:PPDU:MAC:FCON:TYPE?
 queries the frame type.
 Response: '#H4,3'

Usage: Query only

[[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:SADDress <SAddress>

Enters the address of the transmitter.

The source address is 2 bytes long. The value is in hexadecimal form.

Parameters:

<SAddress> integer
 Range: #H0000,16 to #HFFFF,16
 *RST: #H0000,16

Example: BB:UWBM:PPDU:MAC:SADD #H5A3B,16
set the value for the destination address.

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:INCRement
<Increment>

Defines the number of packets required to increment the counter of the fragment bits of the sequence control.

Parameters:

<Increment> integer
Range: 0 to 1024
*RST: 1

Example: BB:UWBM:PPDU:MAC:SCON:FRAG:INCR 2
two packets are required to increment the counter of the fragment bits.

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:MORE <More>

Enables/disables sending of More Fragments.

Parameters:

<More> 0 | 1
*RST: 0

Example: BB:UWBM:PPDU:MAC:SCON:FRAG:MORE 0
current fragment is the sole or the final fragment of the current MSDU or MCDU.

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:FRAGment:STARt <Start>

Enters the start number of the fragment bits of the sequence control.

Parameters:

<Start> integer
Range: #H0,1 to #H7,1
*RST: #H0,1

Example: BB:UWBM:PPDU:MAC:SCON:FRAG:STAR #H4,1
sets the start value of the fragment bits of the sequence control.

[:SOURCE<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:INCRement
<Increment>

Defines the number of packets required to increment the counter of the sequence bits of the sequence control.

Parameters:

<Increment> integer
 Range: 0 to 1024
 *RST: 1

Example:

BB:UWBM:PPDU:MAC:SCON:SEQ:INCR 2
 two packets are required to increment the counter of the sequence bits.

[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:SEQuence:STARt <Start>

Enters the start number of the fragment bits of the sequence control.

Parameters:

<Start> integer
 Range: #H0,11 to #HFFF,11
 *RST: #H0,12

Example:

BB:UWBM:PPDU:MAC:SCON:SEQ:STAR #HFF,11
 sets the start value of the sequence bits of the sequence control.

[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:SCONtrol:STATe <State>

Activates/deactivates the sequence control field.

Note:

Sequence Control is not enabled for control frames.

Parameters:

<State> 0 | 1 | OFF | ON
 *RST: OFF

Example:

BB:UWBM:PPDU:MAC:SCON:SEQ:STAT ON
 activates sequence control field.

[:SOURce<hw>]:BB:UWBMb:PPDU:MAC:STATe <State>

Activates/deactivates the generation of the MAC Header.

Parameters:

<State> 0 | 1 | OFF | ON
 *RST: OFF

Example:

BB:UWBM:PPDU:MAC:SCON:STAT ON
 activates the generation of the MAC Header.

[:SOURce<hw>]:BB:UWBMb:PPDU:MODulation?

Queries the modulation type. The modulation mode depends on the selected PSDU data rate.(SOURce:BB:UWBM:PPDU:DRAT).

Return values:

<Modulation> QPSK | DCM

Example:

```
BB:UWBM:PPDU:DRAT DR80M
sets a data rate to 80 Mbps
BB:UWBM:PPDU:MOD?
queries the modulation mode.
Response: "QPSK"
BB:UWBM:PPDU:DRAT DR320M
sets a data rate to 320 Mbps
BB:UWBM:PPDU:MOD?
queries the modulation mode.
Response: "DCM"
```

Usage: Query only**[:SOURCE<hw>]:BB:UWBMb:PPDU:SCRambler:STATE <State>**

Activates/deactivates the scrambler.

Parameters:

```
<State> 0 | 1 | OFF | ON
*RST: ON
```

Example:

```
BB:UWBM:PPDU:SCR OFF
deactivates the scrambler.
```

[:SOURCE<hw>]:BB:UWBMb:PPDU:SPReamble <SPreamble>

Selects the standards preamble. The standard preamble is a 24 symbols long sequence. A "+" corresponds to 1 and a "-" to -1 respectively.

Note:

This parameter is enabled for configuration only for Cover Sequence set to User.

For Cover Sequence set to one of the standard compliant sequences, standard preamble is read-only.

Parameters:

```
<SPreamble> string
*RST: ++++++
```


Example:

```
BB:UWBM:TMOD STAN
selects standard transport mode.
BB:UWBM:PPDU:CSS TFC3
sets the packet/frame synchronization cover sequence to TFC3.
BB:UWBM:PPDU:SPR?
queries the standard preamble.
Response: '+++++-----'
BB:UWBM:PPDU:CSS USER
sets the packet/frame synchronization cover sequence to user-
defined.
BB:UWBM:PPDU:SPR "+++++-----"
'sets the standard preamble to '+-+-+-+-+-----'.
```

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