R&S®EX-IQ-BOX
Digital Interface Module
R&S®DigIConf Software
User Manual

1409.5570.32 — 04

Test & Measurement

User Manual

ROHDE&SCHWARZ

This document describes the R&S®EX-IQ-BOX models:

- R&S®EX-IQ-BOX 1409.5505K04 and its options,
- R&S®EX-IQ-BOX 1409.5505.02,

and the R&S®DigIConf (**D**igital **I**nterface **C**onfigurator) software.

The firmware of the instrument makes use of several valuable open source software packages. The most important of them together with their corresponding open source license and the verbatim license texts are provided on the user documentation CD-ROM (included in delivery).

The Signal Generation Software makes use of several valuable open source software packages. The most important of them together with their corresponding open source license and the verbatim license texts are provided on the user documentation CD-ROM (included in delivery).

The OpenSSL Project for use in the OpenSSL Toolkit (http://www.openssl.org/) includes cryptographic software written by Eric Young (eay@cryptsoft.com) and software written by Tim Hudson (tjh@cryptsoft.com).

Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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Throughout this manual R&S® is abbreviated as R&S and applies to the following R&S products: R&S®EX-IQ-BOX , R&S®DigIConf, R&S®AMU200A, R&S®SMU200A, R&S®SMJ100A, R&S®FSQ, R&S®FSG, R&S®FMU36, R&S®FSV, R&S®CMW500 and R&S®WinIQ-SIM2.

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

⚠	⚠ 18 kg	⚡	♨	⏚	⏚	⊥	⚠
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

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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.

⚠ DANGER	indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	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 ±10 % shall apply to the nominal voltage and ±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_{rms} > 30 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.

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!

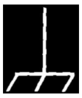
El principio del grupo de empresas Rohde & Schwarz consiste en tener nuestros productos siempre al día con los estándares de seguridad y de ofrecer a nuestros clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas 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.

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)

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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**	PELIGRO identifica un peligro inminente con riesgo elevado que provocará muerte o lesiones graves si no se evita.
⚠ **ADVERTENCIA**	ADVERTENCIA identifica un posible peligro con riesgo medio de provocar muerte o lesiones (graves) si no se evita.
⚠ **ATENCIÓN**	ATENCIÓN identifica un peligro con riesgo reducido de provocar lesiones leves o moderadas si no se evita.
AVISO	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 ±10 % sobre el voltaje nominal y de ±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 $U_{eff} > 30$ V se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).

10. Para la conexión con dispositivos informáticos como un PC o un ordenador industrial, debe comprobarse que éstos cumplan los estándares IEC60950-1/EN60950-1 o IEC61010-1/EN 61010-1 válidos en cada caso.

11. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. Esto pone a descubierto los cables y componentes eléctricos y puede causar lesiones, fuego o daños en el producto.

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

Funcionamiento

1. El uso del producto requiere instrucciones especiales y una alta concentración durante el manejo. Debe asegurarse que las personas que manejen el producto estén a la altura de los requerimientos necesarios en cuanto a aptitudes físicas, psíquicas y emocionales, ya que de otra manera no se pueden excluir lesiones o daños de objetos. El empresario u operador es responsable de seleccionar el personal usuario apto para el manejo del producto.
2. Antes de desplazar o transportar el producto, lea y tenga en cuenta el capítulo "Transporte".
3. Como con todo producto de fabricación industrial no puede quedar excluida en general la posibilidad de que se produzcan alergias provocadas por algunos materiales empleados, los llamados alérgenos (p. ej. el níquel). Si durante el manejo de productos Rohde & Schwarz se producen reacciones alérgicas, como p. ej. irritaciones cutáneas, estornudos continuos, enrojecimiento de la conjuntiva o dificultades respiratorias, debe avisarse inmediatamente a un médico para investigar las causas y evitar cualquier molestia o daño a la salud.
4. Antes de la manipulación mecánica y/o térmica o el desmontaje del producto, debe tenerse en cuenta imprescindiblemente el capítulo "Eliminación", punto 1.

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

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.

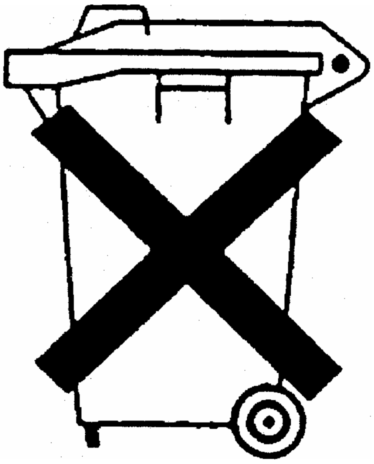
Kundeninformation zur Batterieverordnung (BattV)

Dieses Gerät enthält eine schadstoffhaltige Batterie. Diese darf nicht mit dem Hausmüll entsorgt werden.

Nach Ende der Lebensdauer darf die Entsorgung nur über eine Rohde&Schwarz-Kundendienststelle oder eine geeignete Sammelstelle erfolgen.

Safety Regulations for Batteries (according to BattV)

This equipment houses a battery containing harmful substances that must not be disposed of as normal household waste.



After its useful life, the battery may only be disposed of at a Rohde & Schwarz service center or at a suitable depot.

Normas de Seguridad para Baterías (Según BattV)

Este equipo lleva una batería que contiene sustancias perjudiciales, que no se debe desechar en los contenedores de basura domésticos.

Después de la vida útil, la batería sólo se podrá eliminar en un centro de servicio de Rohde & Schwarz o en un depósito apropiado.

Consignes de sécurité pour batteries (selon BattV)

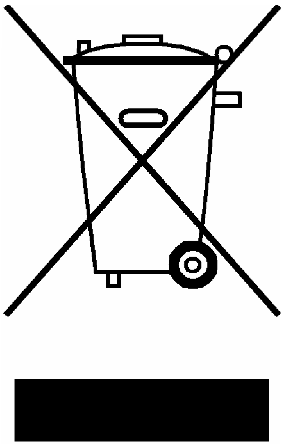
Cet appareil est équipé d'une pile comprenant des substances nocives. Ne jamais la jeter dans une poubelle pour ordures ménagéres.

Une pile usagée doit uniquement être éliminée par un centre de service client de Rohde & Schwarz ou peut être collectée pour être traitée spécialement comme déchets dangereux.

Customer Information Regarding Product Disposal

The German Electrical and Electronic Equipment (ElektroG) Act is an implementation of the following EC directives:

- 2002/96/EC on waste electrical and electronic equipment (WEEE) and
- 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS).



Product labeling in accordance with EN 50419

Once the lifetime of a product has ended, this product must not be disposed of in the standard domestic refuse. Even disposal via the municipal collection points for waste electrical and electronic equipment is not permitted.

Rohde & Schwarz GmbH & Co. KG has developed a disposal concept for the environmental-friendly disposal or recycling of waste material and fully assumes its obligation as a producer to take back and dispose of electrical and electronic waste in accordance with the ElektroG Act.

Please contact your local service representative to dispose of the product.

ROHDE&SCHWARZ

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 ISO 9001 und ISO 14001 zertifiziert.

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

Dear Customer,
You have decided to buy a Rohde & Schwarz product. 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 ISO 9001 and ISO 14001.

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 ISO 9001 et ISO 14001.

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

ROHDE & SCHWARZ

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 2009-35

This is to certify that:

Equipment type	Stock No.	Designation
EX-IQ-BOX	1409.5505.04	EX-IQ-BOX DIG. INTERFACE MODULE

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

- relating to electrical equipment for use within defined voltage limits (2006/95/EC)
- relating to electromagnetic compatibility (2004/108/EC)

Conformity is proven by compliance with the following standards:

EN 61010-1: 2001
EN 61326-1: 2006
EN 61326-2-1: 2006
EN 55011: 2007 + A2: 2007
EN 61000-3-2: 2006
EN 61000-3-3: 1995 + A1: 2001 + A2: 2005

For the assessment of electromagnetic compatibility, the limits of radio interference for Class A equipment as well as the immunity to interference for operation in industry have been used as a basis.

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

Munich, 2009-07-24

Central Quality Management MF-QZ / Radde

ROHDE&SCHWARZ

EC Certificate of Conformity

Certificate No.: 2007-59

This is to certify that:

Equipment type	Stock No.	Designation
EX-IQ-BOX	1409.5505.02	Digital I/O Adapter Module for SMU, AFQ, AMU and FSQ

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

- relating to electrical equipment for use within defined voltage limits (2006/95/EC)
- relating to electromagnetic compatibility (2004/108/EC)

Conformity is proven by compliance with the following standards:

EN 61010-1 : 2001
EN 61326 : 2006
EN 55011 : 1998 + A1 : 1999 + A2 : 2002, Class A

For the assessment of electromagnetic compatibility, the limits of radio interference for Class A equipment as well as the immunity to interference for operation in_industry have been used as a basis.

Affixing the EC conformity mark as from 2007

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

Munich, 2007-10-25

Central Quality Management MF-QZ / Radde

ROHDE&SCHWARZ

EC Certificate of Conformity

Certificate No.: 2009-73

This is to certify that:

Equipment type	Stock No.	Designation
EXBOX-B84	1409.7108.02	OBSAI
EXBOX-B85	1409.7208.02	CPRI

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

- relating to electromagnetic compatibility (2004/108/EC)

Conformity is proven by compliance with the following standards:

EN 61326-1: 2006
EN 61326-2-1: 2006
EN 55011: 2007 + A2: 2007

For the assessment of electromagnetic compatibility, the limits of radio interference for Class A equipment as well as the immunity to interference for operation in industry have been used as a basis.

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

Munich, 2009-12-15 Central Quality Management MF-QZ / Radde

ROHDE&SCHWARZ

CE Declaration of Conformity

Certificate No.: 2011-47

This is to certify that:

Equipment type	Stock No.	Designation
EXBOX-B81	1409.7008.02	DIGRF BREAKOUT BOARD

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

- relating to electromagnetic compatibility
  (2004/108/EC)

Conformity is proven by compliance with the following standards:

EN 61326-1: 2006
EN 61326-2-1: 2006
EN 55011: 2007 + A2: 2007

For the assessment of electromagnetic compatibility, the limits of radio interference for Class A equipment as well as the immunity to interference for operation in industry have been used as a basis.

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

Munich, 2011-08-19 Central Quality Management GF-QP / Radde

Customer Support

Technical support – where and when you need it

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

Up-to-date information and upgrades

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

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

ROHDE&SCHWARZ

Contents

1 Preface

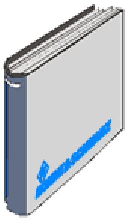
1.1 Documentation Overview

The user documentation describes the R&S EX-IQ-BOX and all related components.

It consists of the following parts:

- Quick start guide, printed manual,
- Online help system on the configurator software
- Documentation CD-ROM with:
  - Operating manuals for the R&S EX-IQ-BOX and options,
  - Service manual,
  - Online help system (`*.chm`) as a standalone help,
  - Data sheet and specifications,
  - Links to useful sites on the R&S internet,
  - Configuration software R&S DigIConf,
  - R&S DigRF Script Library and R&S DigRF Viewer software.

1.1.1 Quick Start Guide



The Quick Start Guide is delivered with the R&S EX-IQ-BOX in printed form and in PDF format on the user documentation CD-ROM. It provides the information needed to put the R&S EX-IQ-BOX into operation and get familiar with the device.

The guide gives an overview of the operating modes, available components (options) and information on how to get started. Some test setting examples provide an insight into various applications.

The quick start guide is subdivided into the data sheet, and the chapters listed in the following overview, and an index:

Data Sheet

Informs about specifications and characteristics of the R&S EX-IQ-BOX. The Data sheet is in printable form (pdf).

Introduction

Introduces the R&S EX-IQ-BOX with an overview about the functionality, features and components.

System Overview

Describes the operating modes of the R&S EX-IQ-BOX, including R&S instruments communicating with the R&S EX-IQ-BOX and available hardware and software components.

Getting Started

Describes the control elements and connectors of the R&S EX-IQ-BOX and the procedures required for putting the R&S EX-IQ-BOX into operation. It encloses the installation of the configuration software R&S DigIConf, installation of options, and connection of the R&S EX-IQ-BOX to an R&S instrument and the DUT.

Application Examples

Describes several application examples.

Interfaces

Contains a short description and information on the pin assignments of the user interface and the breakout boards.

This chapter is also a part of the operating manual. Additionally you find the connection schemes in the appendix of the operating manual.

Index

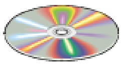
Contains an index of the quick start guide.

1.1.2 Help System

The online help is embedded in the system components R&S DigIConf and in the R&S signal generators, offering quick context-sensitive reference to the information needed for operating. The help contains the complete user documentation for the R&S EX-IQ-BOX including the contents of the quick start guide.

The help files (*.chm) are also available on the CD-ROM and can be used as a standalone help.

1.1.3 User Documentation CD-ROM



The CD-ROM provides the complete user documentation for the R&S EX-IQ-BOX, including quick start guide, operating manual and service manual in printable pdf format, a *.chm online help file and the configuration software R&S DigIConf. In addition, it provides links to useful sites of the R&S internet.

Version for pdf and chm

Use the ADOBE® Acrobat® Reader for PDF files and any browser HTML help.

Using the Internet Explorer® version 4.0 or later is required.

Manuals

Quick Start Guide, Operating Manual, Service Manual and the R&S DigRF Script Library in printable form (`*.pdf`).

Online Help

The standalone help file `eqiqbox.chm`.

Data Sheet

Informs about specifications and characteristics of the R&S EX-IQ-BOX. The Data sheet is in printable form (pdf).

Software

- `DigIConf_*.exe` (Digital Interface Configurator)
  R&S DigIConf is a software for configurating the R&S EX-IQ-BOX settings via USB interface and a PC.
- `DigRFViewer_*.exe` (DigRF Viewer)
  This program provides display of DigRF streams in raw format.

1.1.4 Operating Manual

The operating manual is available in PDF format - in printable form - on the Documentation CD-ROM delivered with the R&S EX-IQ-BOX.

It contains comprehensive information on the functions and remote control, in addition to the chapters of the quick start guide. The manual includes information on the interfaces and related breakout boards and on maintenance.

The operating manual covers the data sheet plus the chapters of the quick start guide plus the chapters of the operating manual, listed below. An index, a glossary an open source declaration and attachments are also part of the manual.

Data Sheet

Informs about specifications and characteristics of the R&S EX-IQ-BOX. The Data sheet is in printable form (pdf).

Introduction

Introduces the module with an overview about the functionality, features and components.

System Overview

Describes the operating modes of the R&S EX-IQ-BOX, including R&S instruments communicating with the R&S EX-IQ-BOX and available hardware and software components.

Getting Started

Describes the control elements and connectors of the R&S EX-IQ-BOX and the procedures required for putting the R&S EX-IQ-BOX into operation. It encloses the installation of the configuration software R&S DigIConf, installation of options, and connecting the device to an R&S instrument and the DUT.

Application Examples

Describes several application examples.

R&S EX-IQ-BOX Configuration

Describes the configuration software R&S DigIConf. Additionally this section encloses information on configuration of the R&S EX-IQ-BOX via software or via R&S instruments.

Protocol Settings

This part describes the configuration software R&S DigIConf in general, and the functions of the transmission protocols in detail. The chapter is divided according to the protocol types, i.e. user defined and standardized protocols. It provides a brief overview of the features of the protocol type, and describes all settings in detail.

Remote Control Basics

Provides an introduction to remote control and information needed to set up a remote control session, including some examples of remote access.

Remote Control Commands

Describes all remote-control commands available including programming examples.

The chapter is divided according to the main functions of the configuration software R&S DigIConf and the protocol types, i.e. user defined and standardized protocols.

Interfaces

Contains a short description and information on the pin assignments of the user interface and the breakout boards for user defined applications and specific information on the breakout boards of the standardized protocols.

Index

Contains an index of the operating manual.

Appendix

The appendix provides a list of common abbreviations used in the documentation and it contains an overview of the most important default settings. The appendix also includes an alphabetical list of all remote-control commands that are relevant for the remote control of the R&S EX-IQ-BOX.

Open Source

Covers information on software licensing.

Attachments

The attachments contain the connection schemes of the user interface and the breakout boards.

1.1.5 Service Manual

The service manaul describes some service functions provided for the R&S EX-IQ-BOX, and for the breakout boards of the digital standardized protocols CPRI and DigRF. Additionally, it contains information for customer support and service.

The service manual is subdivided into general safety instructions plus the service and maintenance chapters:

Service and Repair

These chapters include information on replacement and service tests of the R&S EX-IQ-BOX, the CPRI and the DigRF breakout boards.

Maintenance

Points to maintenance and environmental conditions.

Documents

Contains the spare parts list and mechanical drawings.

Index

Contains an index of the service manual.

1.1.6 Internet Site

The Rohde & Schwarz internet site provides the most up to date information on the R&S EX-IQ-BOX. Additonally firmware updates including the associated release notes, instrument drivers current data sheets and application notes are provided for download on the internet site.

The current manual is provided in the download area under "Manuals".

In the "Download > Software" tab, the website also offers the latest version of the configuration software R&S DigIConf, including information on changes and on the software update process.

http://www.rohde-schwarz.com/product/EX-IQ-BOX.html

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.

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

2 Welcome to the R&S EX-IQ-BOX...

...the Digital Interface Module

While in the past the transmission of the analog I/Q signals had played an important role, nowadays it is the digital I/Q signals that are significant. The utilization of digital I/Q signals leads to the employment of different transmission protocols and still involves the development of different interface types with a great variety of physical characteristics.

The R&S EX-IQ-BOX, as a configurable interface module, is designed to solve this problem. The main application field of this device is the conversion of signal properties and transmission protocols of the R&S instruments into User Defined or standardized signal formats and vice versa.

To digitally transmit I/Q signals, R&S instruments like signal generators, signal analyzers, communication testers and the R&S EX-IQ-BOX communicate with each other, using an R&S wide standardized transmission protocol, which is based on **LVDS** (**L**ow **V**oltage **D**ifferential **S**ignaling).

For applications with **User Defined protocols** the R&S EX-IQ-BOX enables either serial or parallel transmission of I/Q signals to a DUT, including variable clock modes, various data rates as well as different logical signal levels.

In applications with **standardized protocols** the R&S EX-IQ-BOX not only provides the I/Q data, but also the control information of the respective standard. Equipped with the respective options, the R&S EX-IQ-BOX supports the following standardized protocols:

- **CPRI** (**C**ommon **P**acket **R**adio **I**nterface) defines a combined interface for the transmission of I/Q and control data between the baseband and RF module of a base station.
- **DigRF** defines the interface for the transmission of I/Q signals and control data between the baseband and the RF chip of a mobile phone. The R&S EX-IQ-BOX supports **DigRF 3G** and **DigRF v4**.

The R&S EX-IQ-BOX is directly connected to the digital interface of an R&S instrument by using an LVDS cable. For connection to the DUT, various interchangeable adapters are available, so called **breakout boards**. Breakout boards adapt the signals physically. A breakout board is directly connected to the user interface on the front panel of the R&S EX-IQ-BOX.

- For **User Defined applications**, two different breakout boards are provided with the R&S EX-IQ-BOX, supporting single ended and differential signals.
- For **CPRI**, **DigRF 3G** and **DigRF v4 applications**, separate options support the respective signal formats.

The R&S EX-IQ-BOX is controlled via the USB interface. It is operated from a PC by using the configuration software **R&S DigIConf**.

Test setups of the R&S EX-IQ-BOX **1409.5505.02** with instruments of the R&S SMU or R&S FSQ families provide control of the R&S EX-IQ-BOX without using the digital interface configuration software R&S DigIConf. But this constellation applies only to **User Defined** applications.

Due to the enhanced capabilities of the **R&S EX-IQ-BOX 1409.5505K04**, this model is exclusively controlled by R&S DigIConf and applies to all applications.

- In **User Defined mode** R&S DigIConf controls the protocol settings, data format and multiple clock scenarios as internal or device clocking (external) for data transmission.
- For **standardized protocols** R&S DigIConf provides all settings of the respective standard. Additionally, control functions according to the standard are supported from the R&S EX-IQ-BOX and are set with the aid of R&S DigIConf.

In addition, the **R&S DigIConf** can be remote controlled, from a PC either directly or via a network.

Equipped with the respective options, the R&S EX-IQ-BOX has integrated a **Waveform Output Memory** (64 Msamples) as well as a **Multi Waveform Playback** to generate test signals which were created externally, e.g. by means of R&S WinIQSIM2 or Matlab simulation software. R&S DigIConf takes the generated data from the control PC, checks the data and loads it into the R&S EX-IQ-BOX. The Multi Waveform Playback provides simultaneous playback of up to four signals.

Also, for operating in receiver mode a **Recording Memory (512 MB)** option is available. The signal data can be recorded over a period of time and then saved in a file.

Waveform Memory, Recording Memory and Multi Waveform Playback can be performed only with R&S DigIConf and standardized protocols.

Software options for **Digital Standards with R&S®WinIQSIM2™** are also available. For example, GSM / EDGE, 3GPP FDD, EUTRA / LTE, etc., i.e. all those supported by CPRI or DigRF .

The Digital Standards are described in individual manuals available on the Rohde & Schwarz internet site or on the user documentation CD-ROM of R&S®WinIQSIM2™.

The signals that are generated with the aid of the R&S WinIQSIM2 software can be output by the Waveform Memory or the Multi Waveform Playback of the R&S EX-IQ-BOX. Signals calculated by Matlab software can be directly loaded.

For detailed information on all available options refer to chapter 3.2.2, "Options", on page 22".

Latest information on extensions and changes

The new R&S EX-IQ-BOX 1409.5505K04 offers enlarged functionalities which will not all be available yet in this release. Refer to the supplementary sheet at the beginning of this manual which informs you about the planned enlargements within the following releases.

Additionally, firmware and software updates as well as the release notes, describing the improvements and modifications are provided on the internet at the download site of Rohde & Schwarz:

http://www.rohde-schwarz.com/product/EX-IQ-Box.html

This website always offers the latest information about your R&S EX-IQ-BOX, about the current firmware and the software R&S DigIConf, e.g. also on changes of the software update procedure.

3 System Overview

This section comprises an overview of the instruments communicating with the R&S EX-IQ-BOX and some basic operating modes. It also describes available hardware and software components for operating the R&S EX-IQ-BOX.

The R&S EX-IQ-BOX provides transmission of I/Q data between R&S instruments and external devices (DUTs). In applications with standardized protocols, the R&S EX-IQ-BOX operates bidirectional. Data can be sent and received at the same time. In the User Defined mode only one data direction is possible at the same time.

In the following configurations, signal transmission is shown by means of an R&S instrument operating as transmitter to the DUT via the R&S EX-IQ-BOX. Vice versa, the R&S EX-IQ-BOX works as a receiver, while it receives a test signal from a DUT and transfers it to an R&S instrument for analyzing. For further configuration examples refer to chapter 5, "Application Examples", on page 47.

An overview of instruments working with the R&S EX-IQ-BOX is given in chapter 3.2.5, "R&S Instruments Working with the R&S EX-IQ-BOX", on page 25. For the available options and their respective part numbers refer to chapter 3.2.2, "Options", on page 22.

3.1 Basic Operating Modes

This chapter provides a short overview of the various operating modes to control the R&S EX-IQ-BOX, including waveform memory and recording:

- R&S DigIConf controlling the R&S EX-IQ-BOX
- R&S Instruments controlling the R&S EX-IQ-BOX
- Remote control of R&S DigIConf
- Waveform Memory, Multi Waveform Playback and Recording Memory

3.1.1 R&S DigIConf Controlling the R&S EX-IQ-BOX

The previous model **R&S EX-IQ-BOX 1409.5502.02** provides only User Defined protocols.

Standardized protocols, Waveform Memory, Multi Waveform Playback and Recording Memory require the **R&S EX-IQ-BOX 1409.5505K04** and the configuration software R&S DigIConf.

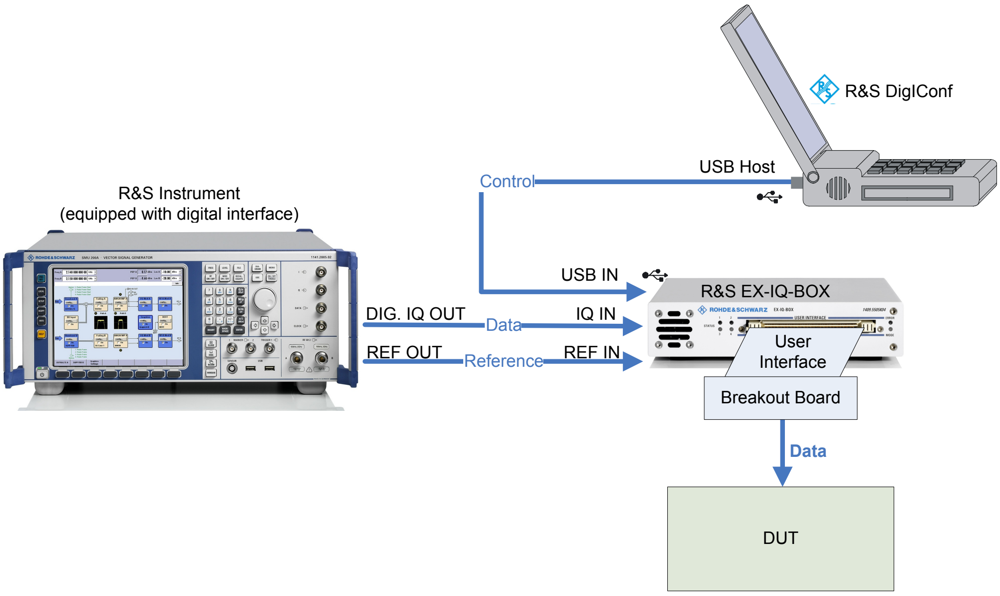


Fig. 3-1: Configuration example with R&S DigIConf

The example represents a basic configuration of the R&S EX-IQ-BOX, operated by the digital interface configuration software R&S DigIConf via PC.

In this configuration the R&S EX-IQ-BOX operates in transmitter mode from an R&S instrument to the DUT.

A configuration example of the R&S EX-IQ-BOX working in receiver mode is shown in the following picture:

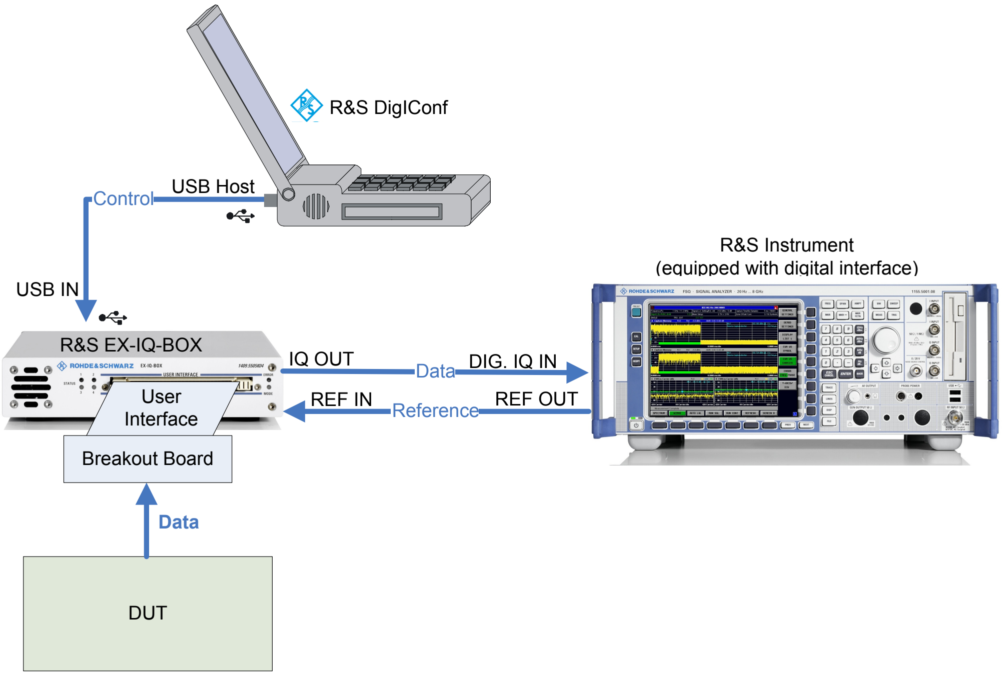


Fig. 3-2: R&S EX-IQ-BOX and R&S instrument working in receiver mode, controlled by R&S DigIConf

3.1.2 R&S Instruments Controlling the R&S EX-IQ-BOX

This operating mode applies to the previous model of the **R&S EX-IQ-BOX 1409.5502.02** and **User Defined** applications.

The **R&S EX-IQ-BOX"1409.5505K04"** is always controlled by R&S DigIConf.

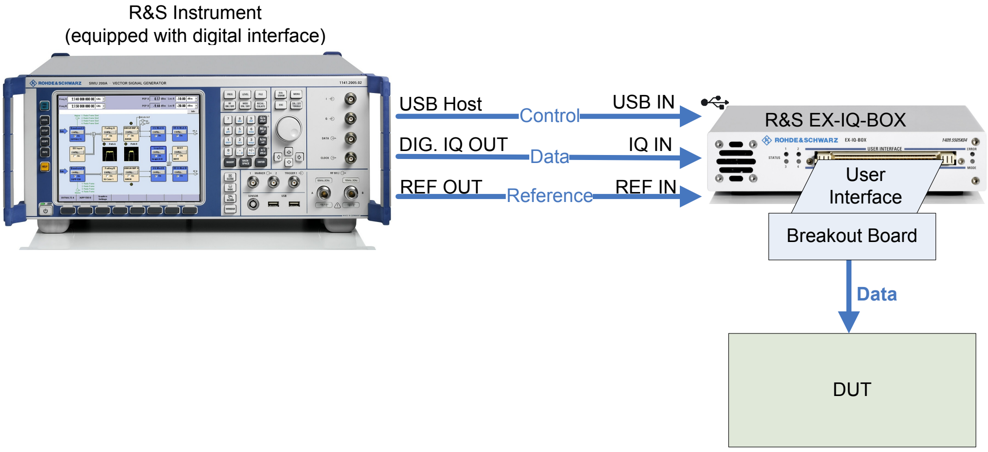


Fig. 3-3: Configuration example of the R&S EX-IQ-BOX, directly controlled by an R&S instrument

This example shows a basic configuration of the R&S EX-IQ-BOX 1409.5502.02, working with an R&S signal generator. The R&S EX-IQ-BOX operates in transmitter mode from the signal generator to the DUT.

3.1.3 Remote Control of the R&S EX-IQ-BOX

Remote control functionality provides access to the measurement from a remote computer (external controller). By means of remote commands, settings or data are transmitted to the R&S EX-IQ-BOX via R&S DigIConf. Remote programs automate repeated settings. The remote control programs can either run on the same computer as the R&S DigIConf or on any PC in the network.

Remote control of R&S DigIConf is performed via a LAN socket communication protocol, also referred to as **Raw Socket communication**.

Socket communication uses the TCP/IP network protocol. A VISA installation on remote controller side is not mandatory. Connection can also be performed with a **Win Socket communication**.

If you use a VISA library, the access is more convenient.

Information on the LAN Connector of the R&S EX-IQ-BOX

Data and settings of the R&S EX-IQ-BOX are controlled via the USB interface. The LAN connector is intended for future use and it is not possible to directly remote-control the R&S EX-IQ-BOX via the LAN interface.

For the control, **SCPI** (**S**tandard **C**ommands for **P**rogrammable **I**nstruments) commands are used.

An introduction to the structure and to the syntax of SCPI commands is given in the operating manual of the R&S EX-IQ-BOX, see chapter 8, "Remote Control Basics", on page 269.

3.1.3.1 Remote Control via R&S DigIConf

The remote control program controls R&S DigIConf, which then transmits the settings to the R&S EX-IQ-BOX via the USB interface. The remote program runs either on the same PC as the R&S DigIConf software or on any PC in a network.

Examples of the remote controlled R&S DigIConf

- The remote control program and R&S DigIConf run on the same computer.

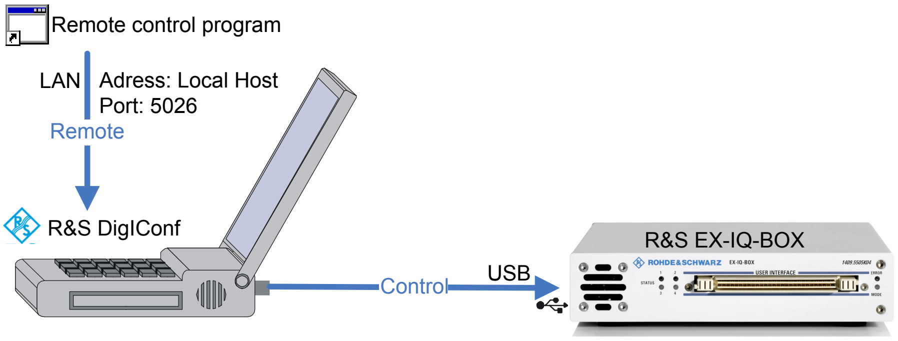


Fig. 3-4: Remote control program and R&S DigIConf running on the same PC

The remote connection is looped internally. The computer name, i.e. the IP address is "Local Host". R&S DigIConf uses port 5026 by default, the port can be set.

- The remote control program and R&S DigIConf run on different computers.

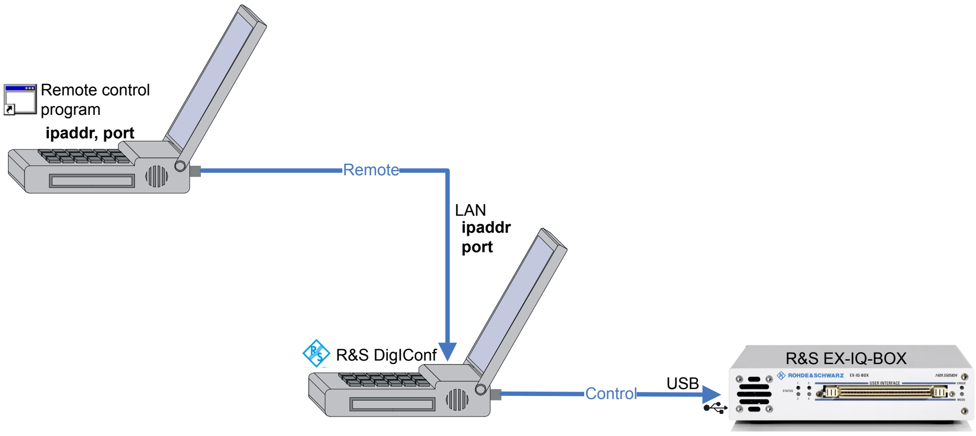


Fig. 3-5: Remote control program and R&S DigIConf running on different PCs

The LAN connection is established to the computer with R&S DigIConf with a commercial RJ-45 network cable. IP address and port are assigned accordingly.

For further information on LAN connection and IP address, see chapter 8, "Remote Control Basics", on page 269.

3.1.3.2 Remote Control via an R&S Instrument

This operating mode applies to the R&S EX-IQ-BOX 1409.5502.02 and User Defined protocols.

The R&S EX-IQ-BOX 1409.5505K04 is always controlled by R&S DigIConf.

If the R&S EX-IQ-BOX 1409.5502.02 works directly with an R&S instrument, i.e. without R&S DigIConf, the box is accessed by the instrument via the USB interface. Remote control is executed via the instrument, i.e. all remote control interfaces of the instrument can be usesd, as well as all remote-control modes.

R&S instruments usually provide remote control via LAN, GPIB, or USB interface. Refer to the operating manual of your instrument to receive detailed information on the available remote control interfaces and their use.

See the operating manual of your R&S instrument for detailed information:

- For setting up a connection, refer to sections "Connecting the Instrument to a Network", and "Manual Remote Control via an External Controller" in chapter "Putting into Operation".
- Chapter "Remote Control - Basics" describes the basics for setting up the instrument for remote control, programming syntax, command processing and the status reporting system.
- Chapter "Remote Control - Description of Commands" lists all the remote commands that are defined for the instrument.

The remote control commands for setting the parameters of the R&S EX-IQ-BOX are described in the operating manual; see chapter 9.3, "User Defined - Remote Control Commands", on page 313.

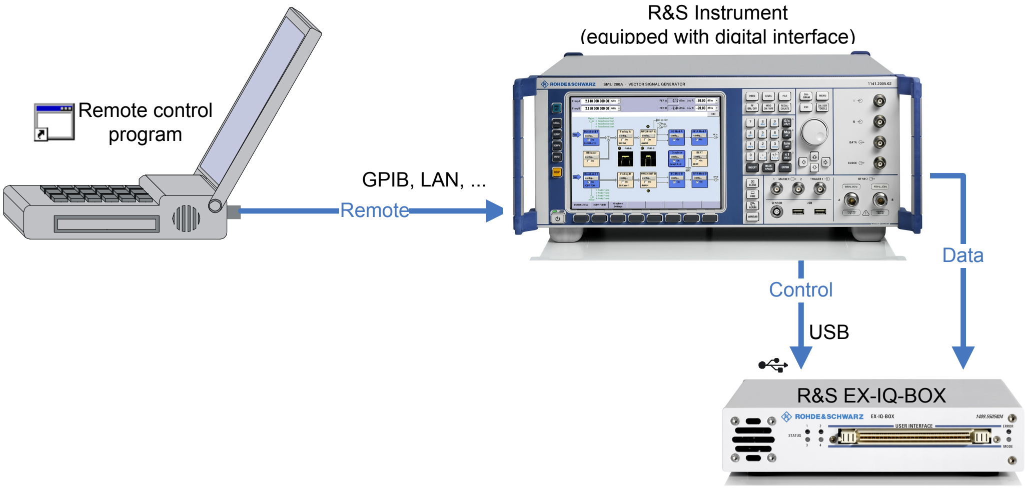


Fig. 3-6: Example of remote control of an R&S instrument with a connected R&S EX-IQ-BOX

3.1.4 Waveform Memory, Multi Waveform Playback and Recording Memory

Waveform Memory, Multi Waveform Playback and Recording Memory are performed with R&S DigIConf and standardized protocols.

The R&S EX-IQ-BOX "1409.5505K04" can also be used without an instrument as an I/Q source, while a signal is generated in the box by means of a Waveform Memory, or even a Multi Waveform Playback for simultaneous playback of up to four signals.

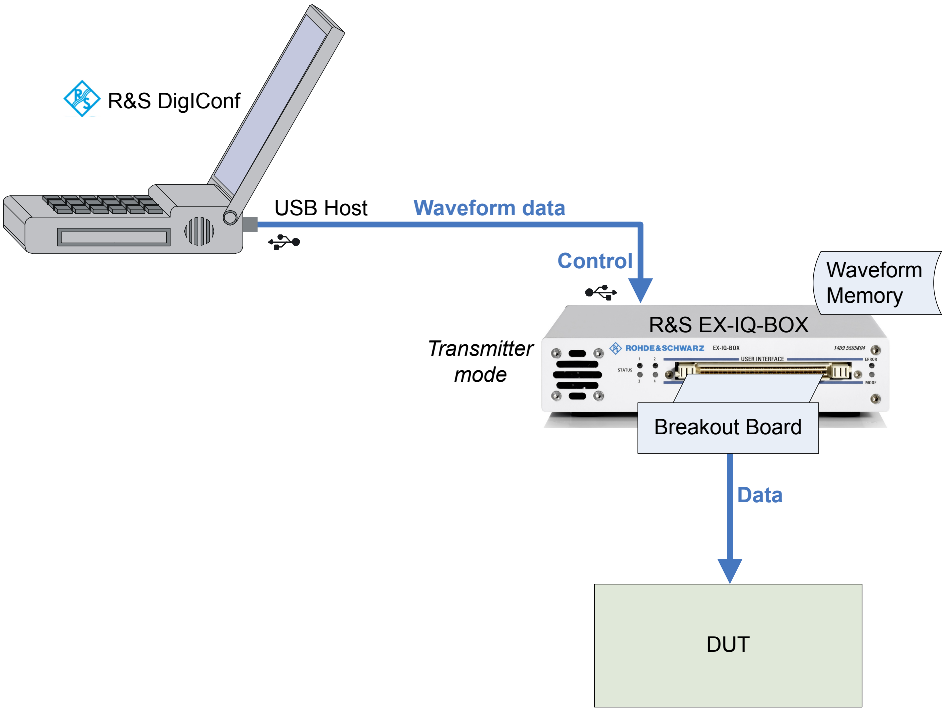


Fig. 3-7: Configuration example of the R&S EX-IQ-BOX equipped with a Waveform Memory

Equipped with the Recording Memory option, the R&S EX-IQ-BOX records received I/Q signals. With a suitable program, the data can be displayed on a PC and evaluated.

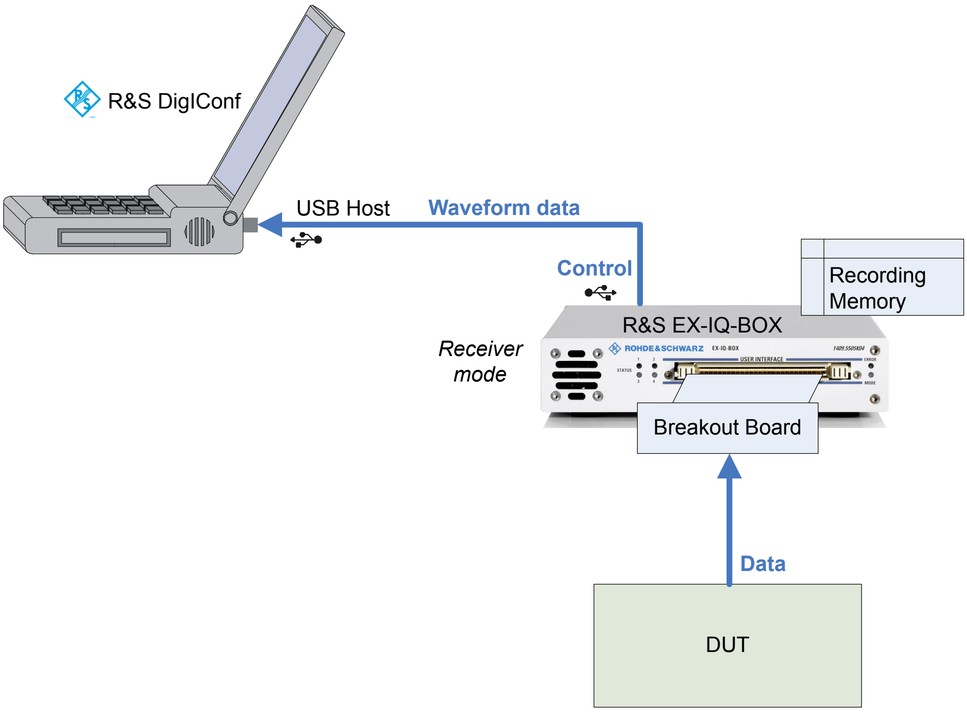


Fig. 3-8: Configuration example of the R&S EX-IQ-BOX recording incoming data

The R&S EX-IQ-BOX can execute signal generation from a Waveform Memory and data recording simultaneously.

3.2 Components

This chapter provides an overview of the available components for test setups with the R&S EX-IQ-BOX. Hardware and software components and the according part numbers are listed.

Ordering information as well as latest software and firmware versions are also provided on the internet at the R&S website:
http://www.rohde-schwarz.com/product/EX-IQ-Box.html

3.2.1 R&S EX-IQ-BOX

Digital Signal Interface module R&S EX-IQ-BOX (part number 1409.5505K04), including:

- power supply
- one USB cable
- one LVDS cable
- two breakout boards for User Defined protocols
  - single ended 090002-22x, type II
  - differential 090002-23x, type III
- Quick Start Guide
- CD-ROM with configuration software R&S DigIConf, data sheet, online help and user manual

3.2.2 Options

The options concept allows you to individually equip the R&S EX-IQ-BOX according to the requirements of the application. Additionally, note the following information in order to configure the R&S EX-IQ-BOX correctly:

- Standardized protocols always exist of the option for the hardware (Breakout Board) and one or several options for the software. To enable a standardized protocol order the respective software option in addition to the hardware option (EXBOX-Bxx + EXBOX-Kxx).
- Waveform Memory, Multi Waveform Playback and Recording Memory can be performed only with standardized protocols.
- Software options providing digital standards require R&S WinIQSIM2 software and the Waveform Memory or the Multi Waveform Playback.
- Standardized protocols, Waveform Memory, Multi Waveform Playback and Recording Memory require the R&S EX-IQ-BOX 1409.5505K04 and the configuration software R&S DigIConf.

3.2.2.1 Standardized Protocols

For applications with standardized protocols the following options are available:

Digital Interface Protocol...	Option R&S...	R&S part number
CPRI Breakout Board	EXBOX-B85	1409.7208.02
CPRI RE Test	EXBOX-K10	1417.1170.02
CPRI REC Test	EXBOX-K11	1417.1186.02
DigRF Breakout Board	EXBOX-B81	1409.7008.02
DigRF v3RF-IC	EXBOX-K13	1417.1192.02
DigRF v3BB-IC	EXBOX-K14	1417.1205.02
DigRF v4RF-IC	EXBOX-K15	1417.1211.02
DigRF v4BB-IC	EXBOX-K16	1417.1228.02
Note: Each option is delivered with a licence key for activation.		

Standardized protocols require R&S EX-IQ-BOX 1409.5505K04 and the configuration software R&S DigIConf.

3.2.2.2 User Defined Protocols

In addition to the two breakout boards **single ended** and **differential**, which are included in delivery, the following options are available:

...Breakout board	Option R&S...	R&S part number
Cadence Palladium ... 090002-24x	EXBOX-Z3	1417.3566.02
MDR (**M**ini **D**elta **R**ibbon) ... 090002-25x	EXBOX-Z4	1417.3614.02
These options only consist of the breakout boards and are used the same way as the breakout boards types single ended and differential.		

The R&S EX-IQ-BOX 1409.5502.02 provides only User Defined protocols.

3.2.2.3 Waveform Memory, Multi Waveform Playback and Recording Memory

	Option R&S...	R&S part number
Waveform Memory 64 MS	EXBOX-K90	1417.1005.02
Multi Waveform Playback	EXBOX-K91	1417.1011.02
Recording Memory 512 MByte	EXBOX-K94	1417.1028.02

Waveform Memory, Multi Waveform Playback and Recording Memory require the R&S EX-IQ-BOX 1409.5505K04 and the configuration software R&S DigIConf.

3.2.2.4 Digital Standards with R&S WinIQSIM2

The following software options providing digital standards are available. The signals generated with the aid of the R&S WinIQSIM2 software can be output by the Waveform Memory or the Multi Waveform Playback of the R&S EX-IQ-BOX. Digital standards are provided by the R&S EX-IQ-BOX 1409.5505K04 and the configuration software R&S DigIConf.

Digital Standard	Option R&S...	R&S part number
GSM/EDGE	EXBOX-K240	1417.1034.02
EDGE Evolution	EXBOX-K241	1417.1040.02
3GPP FDD	EXBOX-K242	1417.1057.02
3GPP FDD Enhanced	EXBOX-K243	1417.1063.02
3GPP FDD HSUPA	EXBOX-K245	1417.1070.02
CDMA 2000® incl. 1xEV-DV	EXBOX-K246	1417.1086.02
1xEV-DO REV. A	EXBOX-K247	1417.1092.02
IEEE 802.16 (WiMAXTM)	EXBOX-K249	1417.1111.02
TD-SCDMA	EXBOX-K250	1417.1128.02
TD-SCDMA Enhanced	EXBOX-K251	1417.1134.02
IEEE 802.11n (WLAN-N)	EXBOX-K254	1417.1105.02

Digital Standard	Option R&S...	R&S part number
EUTRA/LTE	EXBOX-K255	1417.1140.02
HSPA+	EXBOX-K259	1417.1157.02

3.2.3 R&S DigIConf - Digital Interface Configurator

The software R&S DigIConf (**Dig**ital **I**nterface **Conf**igurator for the R&S EX-IQ-BOX) controls the protocol, data and clock settings of the R&S EX-IQ-BOX independently from the connected R&S instrument. Besides basic functions of the User Defined protocols, this software utility supports the settings for standardized protocols, as e.g. CPRI or DigRF; provided that the appropriate options are available, see chapter 3.2.2, "Options", on page 22.

R&S DigIConf provides:

- the control of the R&S EX-IQ-BOX from a PC, or also from the R&S CMW
- parameter settings of the R&S EX-IQ-BOX 1409.5502.02 for User Defined protocols
- parameter settings of the R&S EX-IQ-BOX 1409.5502K04, for
  - User Defined protoocols
  - Standardized protocols
- data verification and transfer of Waveform Memory, Multi Waveform Playback and Recording Memory
- activation of Digital Standards with R&S WinIQSIM2

The program is designed to be installed on a PC running a Microsoft® Windows 2000 (SP4) / XP (SP1) / Windows 7 (32/64 bit) operating system. A setup file, included in delivery, covers an installation wizard, the executable program and all necessary program and data files.

For information on installation of R&S DigIConf refer to chapter 4.4, "Installing R&S DigIConf", on page 34.

Operating R&S DigIConf is described in the operating manual, chapter 6, "R&S EX-IQ-BOX Configuration", on page 54.

How to proceed for setting up an option refer to chapter 4.6, "Installation of R&S EX-IQ-BOX Options", on page 44.

Simulation mode

If no R&S EX-IQ-BOX is connected, R&S DigIConf runs in simulation mode. All options are active, but real operation cannot be performed.

The latest software versions can be downloaded free of charge from the R&S website:

http://www.rohde-schwarz.com/product/EX-IQ-Box.html

3.2.4 Accessories

Various accessories support specific test configurations or modifications.

For example, if you want to connect the R&S EX-IQ-BOX to a second R&S instrument, you need a second LVDS cable.

Or, if your application requires a specific cable, card or an individual pin assignment, the user interface connector, the Tyco Z-Dok adapter, is separately available as R&S EXBOX-Z1.

The breakout board R&S EXBOX-Z2 especially supports direct connection of two R&S EX-IQ-BOXes . It is used e.g. for demo purposes, whereby an R&S signal generator transmits an I/Q signal to the first R&S EX-IQ-BOX which forwards this signal to the second R&S EX-IQ-BOX via the breakout board. Finally, the signal can be evalutated and shown by an R&S signal analyzer.

Accessory	Option R&S...	R&S part number
LVDS cable for connecting digital baseband interfaces	SMU-Z6	1415.0201.02
Tyco Z-Dok connector, 168 pin (56 differential pairs)	EXBOX-Z1	1409.7437.01
Demo breakout board	EXBOX-Z2	1417.3514.02

3.2.5 R&S Instruments Working with the R&S EX-IQ-BOX

This sections provides an overview of the R&S instruments that work with the R&S EX-IQ-BOX, provided that the instrument is equipped with the respective digital interface option.

Digital interface options of R&S instruments

For detailed information on the digital input and output options of the instruments refer to the R&S EX-IQ-BOX data sheet, provided on the CD ROM, or the respective operating manual of your R&S instrument.

Signal Generation

- R&S AMU200A - baseband signal generator and fading simulator
- R&S SMU200A - vector signal generator
- R&S SMJ100A - vector signal generator

Signal Analysis

- R&S FSQ - signal analyzer
- R&S FMU36 - baseband signal analyzer
- R&S FSG - signal analyzer
- R&S FSV - signal and spectrum analyzer

Radio Communication

- R&S CMW500 - universal wideband radio communication tester

4 Getting Started

This section introduces the control elements and connectors of the R&S EX-IQ-BOX and explains how to put the device into operation. It encloses installation of the configuration software R&S DigIConf, installation of options, and connecting the device to an R&S instrument and the DUT.

4.1 Safety Instructions

General Precautions

⚠ **CAUTION**

Shock hazard

Do not open the device casing. As a rule, normal operation of the device does not require opening the casing. Observe the general safety instructions and regulations at the beginning of the manual.

NOTICE

Risk of device damage

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

Before putting the device into operation, make sure that the following conditions are met:

- All fan openings are unobstructed and the airflow perforations are unimpeded. The minimum distance from the wall is 10 cm.
- The device is dry and shows no sign of condensation.
- The interfaces of the device are correctly connected.
- The device is operated in the horizontal position on an even surface.
- The ambient temperature does not exceed the range specified in the data sheet.
- Signal levels at the input and output connectors are all within the specified ranges.

Failure to meet these conditions may cause damage to the R&S EX-IQ-BOX or other devices in the test setup.

Protection against Connector Overload

NOTICE

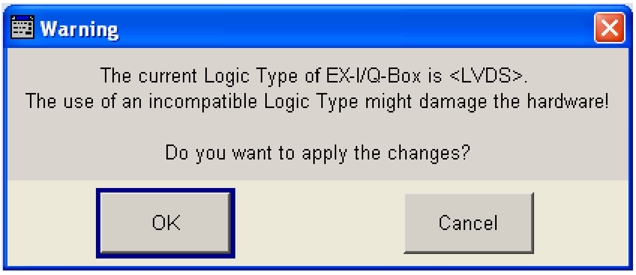
Avoid connector overload

The type of the electrical signals are based on various logic types (TTL or CMOS standard) performing different logic levels. The logic type of the connected DUT must be compatible to the set logic type of the R&S EX-IQ-BOX. Inappropriate logic types may cause damage to the R&S EX-IQ-BOX or to the DUT.

Make sure that the signal level is compatible to the set logic type and does not exceed the permissible limits.

Follow the allowed maximum values, listed in the data sheet!

As soon as a protocol is activated or the logic type is changed during the operation, the following warning message appears:



The current Logic Type of EX-I/Q-Box is <LVDS>.
The use of an incompatible Logic Type might damage the hardware!

Do you want to apply the changes?

The setting is executed only after confirmation of the warning message.

Protection against Electrostatics

NOTICE

Risk of electrostatic discharge

Protect the work area against electrostatic discharge to avoid damage to the electronic components in the modules. For details, refer to the safety instructions at the beginning of this manual.

EMI suppression

To suppress generated Electromagnetic Interfaces (EMI), operate the R&S EX-IQ-BOX only while it is closed, with all shielded cover fitted. Note the EMC classification in the data sheet.

Use appropriate shielded cables to ensure successfully control of electromagnetic radiation during operation, especially for the following connector types:

- Use only the power supply included in delivery.
- Use a suitable double-shielded BNC cable.
- Use only the USB cable included in delivery and ensure that the external USB devices comply with EMC regulations.
- Use only a CAT7 LAN cable.
- For digital interfaces only the LVDS cable R&S SMU-Z6 is permitted for connection. The associated cable is available under part number 1415.0201.02.

Power supply

NOTICE

Danger of instrument damage when using a power supply other than specified!

Use only with the approved power supply of type:

Vendor: **CINCON ELECTRONICS CA., LTD**.

Model: **TR45A05-11A01**

Input: **100-240VAC 1.5A 50-60Hz**

Output: **5VDC 6.0A**

The R&S EX-IQ-BOX must not be specially switched on or switched off, but is ready for operation after connection of the power supply and the USB. Also the device is powered off while the USB connection is disconnected and the net plug is pulled.

4.2 Unpacking the R&S EX-IQ-BOX

To remove the device from its packaging and check the equipment for completeness proceed as follows:

1. Remove the R&S EX-IQ-BOX and the various components from their packaging.
2. Check the equipment for completeness using the delivery list.
3. Check the device for any damage. If there is damage, immediately contact the carrier who delivered the device. Make sure not to discard the box and packing material.

Packing material

Retain the original packing material. If the R&S EX-IQ-BOX needs to be transported or shipped at a later date, you can use the material to prevent control elements and connectors from being damaged.

4.3 Control Elements and Connectors

This section explains the control elements and connectors of the R&S EX-IQ-BOX with the aid of the front and rear views.

4.3.1 Front Panel Tour

This section gives an overview of the control elements and the connectors at the front panel of the R&S EX-IQ-BOX. Each element/connector is briefly described and a reference is given to the chapters containing detailed information.

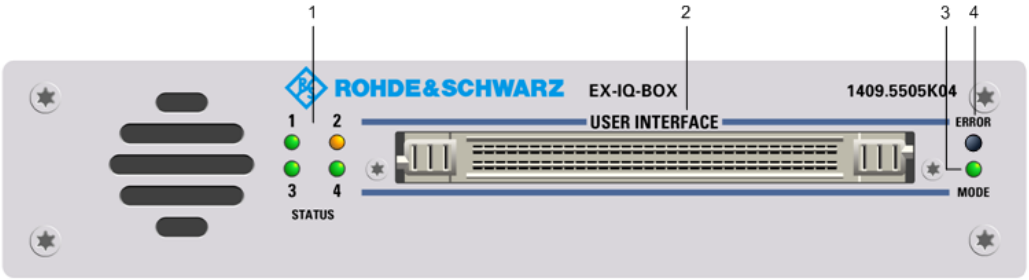
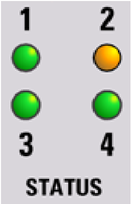


Fig. 4-1: Front panel view

4.3.1.1 STATUS - LEDs



1 Status LED for DIG I/Q IN/OUT 1

- **Green**: the interface is active.
- **Yellow**: the interface is initializing.
- **Off**: the interface is not connected.

2 Status LED for DIG I/Q IN/OUT 2

- **Green**: the interface is active.
- **Yellow**: the interface is initializing.

- **Off**: the interface is not connected.

3 Status LED for PLL (**P**hase **L**ocked **L**oop)

- **Green**: the PLL is active and locked.
- **Yellow**: the PLL is active and unlocked.
- **Off**: the PLL is switched off.

4 Status LED of the breakout board

- **Green**: the breakout board is active.
- **Yellow**: the breakout board is connected.
- **Off**: the breakout board is not connected.

4.3.1.2 User Interface

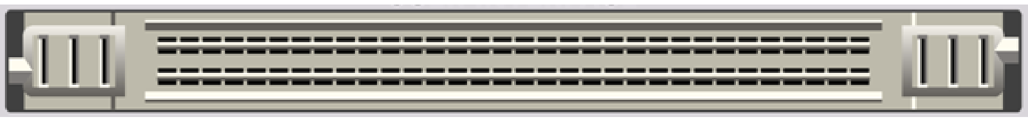


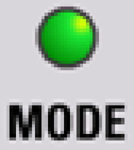
Fig. 4-2: TYCO Z-Dok adapter board connector, 56 differential pairs

See chapter 10.1.1, "Z-DOK-Adapter Board Connector", on page 441.

User interface for serial or parallel transmission of digital I/Q data (up to 20 bit wide data bus), data clock and control signals, connected by a 168 pin connector, type TYCO Z-Dok (56 differential pairs).

This interface is used to connect the breakout boards.

4.3.1.3 MODE - LED



The MODE LED indicates current activities of the R&S EX-IQ-BOX.

- **Green blinking**: the configuration file (application specific image) is loading.
- **Green continuous**: the configuration file (application specific image) is currently active. Data transmission is possible.
- **Yellow blinking**: the initialization (initial image) is loading.
- **Yellow continuous**: the initialization (initial image) is currently active.
- **Off**: there is no configuration file loaded. Therefore, data transmission is not possible.

4.3.1.4 ERROR - LED

The ERROR LED indicates an error of the R&S EX-IQ-BOX.

- **Off** : no error occurred.
- **Red**: an error has been detected. R&S DigIConf or the connected R&S instrument display an error message.

4.3.2 Rear Panel View

This section gives an overview of the control elements and the connectors on the rear panel of the R&S EX-IQ-BOX. Each element/connector is briefly described and a reference is given to the chapters containing detailed information.

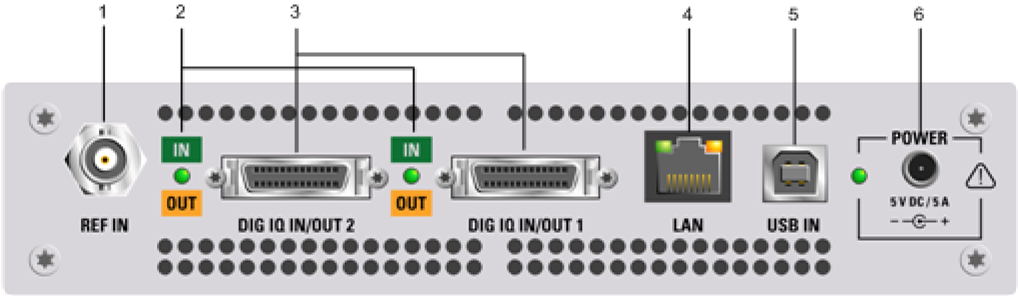


Fig. 4-3: Rear panel view

4.3.2.1 REF IN - Reference signal input

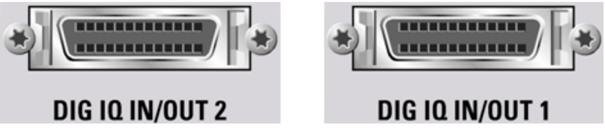
BNC connector for input of a reference signal provided by the R&S instrument.

4.3.2.2 IN / OUT - LED

The interface LEDs indicate the operating mode of the digital interfaces.

- **Green**: the interface is operating in input mode.
- **Yellow**: the interface is operating in output mode.

4.3.2.3 DIG I/Q IN/OUT2, 1 - Digital interfaces



Connectors for the input or output of the digital I/Q signal. The R&S EX-IQ-BOX covers two digital interfaces; both ports can be used for either signal input or output.

One cable for the connection between the digital I/Q interfaces of the R&S EX-IQ-BOX and an R&S instrument is included in delivery. Additional cables are available separately. Refer to chapter 3.2.4, "Accessories", on page 25 for the R&S part number of the associated cable.

4.3.2.4 LAN - Interface

The LEDs at the top indicate activity and status of the interface.

- **Green**: a link is active.
- **Yellow**: transmission is active.

The LAN connector is intended for future use and it is not possible to directly remote-control the R&S EX-IQ-BOX via this interface. Data and settings of the R&S EX-IQ-BOX are controlled via the USB interface.

The R&S EX-IQ-BOX is connected to the LAN with the aid of a commercial RJ-45 CAT7 cable. The interface supports 10/100/1000Mbps Ethernet IEEE 802.3u.

4.3.2.5 USB IN - USB interface type B

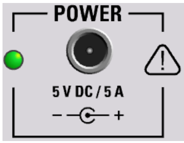
Universal **S**erial **B**us interface of type B (device "USB"). This port is used for communication with the host instrument.

The interface supports two data rates:

- High-speed data rate of 480 Mbit/s.
- Full-speed rate of 12 Mbit/s.

An USB cable for the connection is included in delivery.

4.3.2.6 POWER - Power supply



The R&S EX-IQ-BOX is supplied with an external power supply unit and a separate power cable, see chapter 4.5, "Connecting the R&S EX-IQ-BOX", on page 42.

The Power LED indicates the different operating states of the device, depending on the state of the external voltages.

- **OFF**: the external power supply unit is not connected ("Power Off state").
- **Yellow**: the main power of the device is **on** but the USB power is **off (Standby state)**.
- **Green**: the main power and the USB power are on. The device is ready for operation.

4.4 Installing R&S DigIConf

This section describes how to install the software R&S DigIConf (**Dig**ital **I**nterface **Conf**igurator), the tool for controlling the protocol settings of the R&S EX-IQ-BOX. It also encloses the hardware and software requirements which have to be met for installation.

Software and Hardware Requirements

It is recommended that your PC fulfills the following minimum requirements:

Component	**Minimum requirement**
Operating system	Windows 2000 SP4 / XP SP1 (32 bit)
CPU	Pentium 4, 1 GHz or higher
RAM	256 MB
Hard disk	100 MByte free space
Monitor	XGA monitor (1024 x 768)
Interfaces	USB 2.0 **Tip:** USB 1.1 is also supported, but due to the lower transmission speed, it is recommended to operate with USB 2.0.

For some Rohde & Schwarz instruments, e.g. the R&S CMW500, it is possible to install R&S DigIConf directly on the instrument. The operating manual of the instrument states if the instrument supports this mode of operation. The installation on the instrument is the same as on the PC, see below.

Prerequisites

- Uninstall the old software version, as described in chapter 4.4.3, "Uninstalling", on page 38.
- Close any running applications.
- Disconnect all R&S EX-IQ-BOXes and do not connect any during installation.

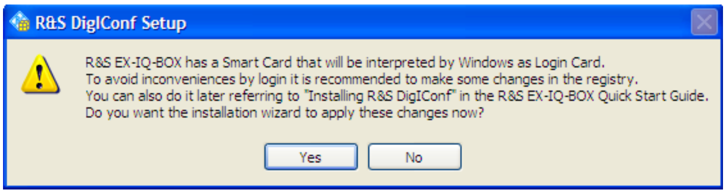
4.4.1 Installation

The setup file DigIConf_x.xx.xxx.exe for the installation of the R&S DigIConf is included in the delivery of your R&S EX-IQ-BOX or can be downloaded from the R&S website: http://www.rohde-schwarz.com/product/EX-IQ-Box.html

► Execute `DigIConf_x.xx.xxx.exe`
in the windows explorer and follow the installation instructions of the R&S DigIConf setup wizard.
The version number x.xx.xxx in the filename represents the current version. Each update has a new release number.

During installation the program creates various subdirectories needed by the application.

Additionally, the installation wizard checks the status of the registry entry "DisableCAD" in order to exclude logon conflicts during later operation. The wizard prompts you to modify the DisableCAD status accordingly, in order to fix these conflicts.



R&S EX-IQ-BOX has a Smart Card that will be interpreted by Windows as Login Card.
To avoid inconveniences by login it is recommended to make some changes in the registry.
You can also do it later referring to "Installing R&S DigIConf" in the R&S EX-IQ-BOX Quick Start Guide.
Do you want the installation wizard to apply these changes now?

Fig. 4-4: R&S DigIConf Installation > Modify DisableCAD

- "Yes"
  Accept modification.
  The installation wizard sets DisableCAD=0 in the registry.
  `[HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\policies\system]"DisableCAD"=dword:00000000`
  A connected R&S EX-IQ-BOX does not cause any conflicts at startup and logon.
- "No"
  Reject modification.
  The parameter `DisableCAD` remains 1 and you must disconnect the R&S EX-IQ-BOX before every login and connect it afterwards again.

Backgound: Depending on this registry entry, a connected R&S EX-IQ-BOX may cause an infinite loop at the Windows logon prompt. It occurs during a logon because Windows interprets the internal SmartCard of the R&S EX-IQ-BOX as a medium for login. You find more details also in chapter 4.4.4, "Known Restrictions on SmartCard Related Issues", on page 39.

It is recommended that you accept modification.

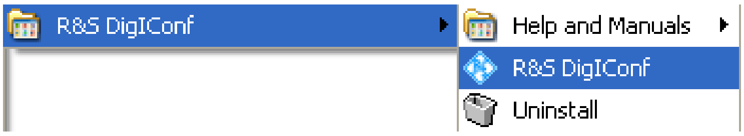
However, it is also possible, to modify the status later on. The installation wizard prepares the respective entries for a later modification.

In the last installation window the setup wizard provides a shortcut to the desktop and you can run R&S DigIConf.

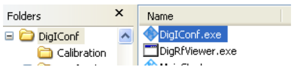
4.4.2 Starting

R&S DigIConf can either be started via:

- the menu item "Start > Programs > R&S DigIConf > DigIConf_x.xx.xxx",



- by starting `DigIConf.exe` in the MS®Windows explorer, located in the prgram files directory, `%Program Files%\Rohde-Schwarz\DigIConf`



or via

- the "application icon" on the desktop.

Startup takes several seconds. At runtime a startup window is indicated until the software is ready for operation. After startup, the R&S DigIConf main application window is displayed.

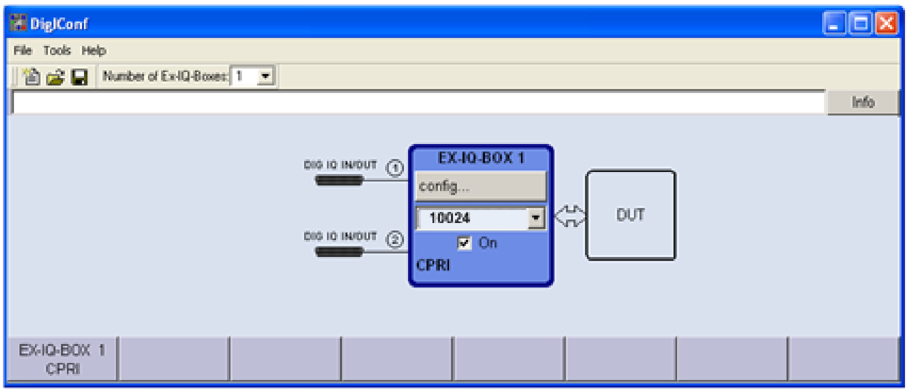


Fig. 4-5: R&S DigIConf main application window

The main application window shows the current configuration and the signal flow in form of a block diagram.

Depending on the test configuration different elements are indicated. For example, if the R&S EX-IQ-BOX is connected with an R&S instrument, R&S DigIConf shows a separate function block with information about the connected instrument. Input/Output symbols in the block diagram show the currently used inputs and outputs and the lines indicate the signal flow.

The following pictures show an example of how R&S DigIConf adjusts the display according to the test configuration. If several boxes are connected, the respective test configuration is indicated for every R&S EX-IQ-BOX.

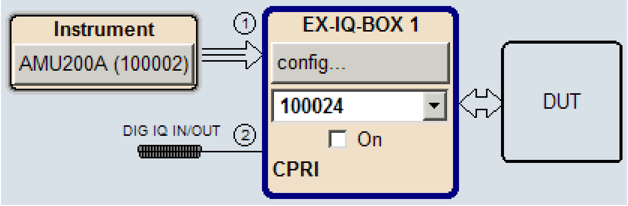


Fig. 4-6: R&S DigIConf display of the R&S EX-IQ-BOX connected to an R&S AMU200A

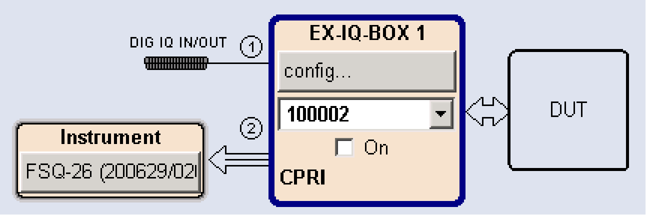


Fig. 4-7: R&S DigIConf display of the R&S EX-IQ-BOX connected to an R&S FSQ-26

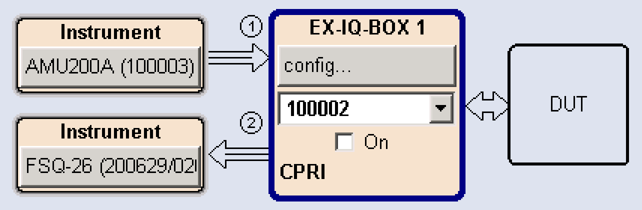


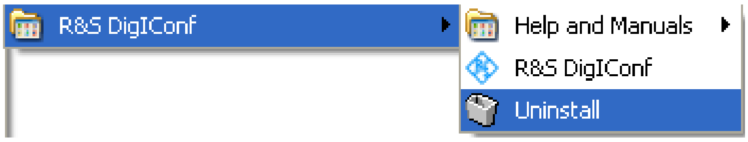
Fig. 4-8: R&S DigIConf display of the R&S EX-IQ-BOX operating in bidirectional mode

For a detailed description of the application window and its elements refer to the operating manual, chapter 6.1, "R&S DigIConf Configuration Software", on page 54.

4.4.3 Uninstalling

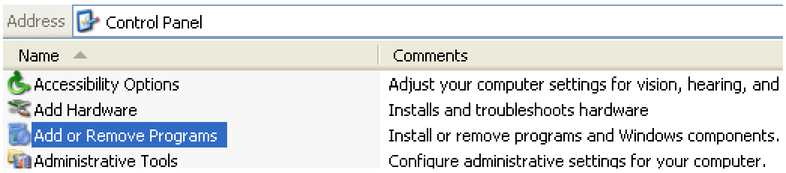
Uninstall the software with the aid of R&S DigIConf uninstaller,

1. "Start > Programs > R&S DigIConf > Uninstall"



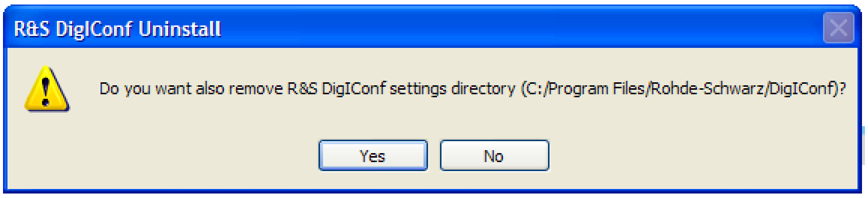
or the PC's control panel,

2. "Start > Settings > Control Panel" in the Windows task bar and open the "Add or Remove Programs" dialog. Uninstall the program with "Remove".



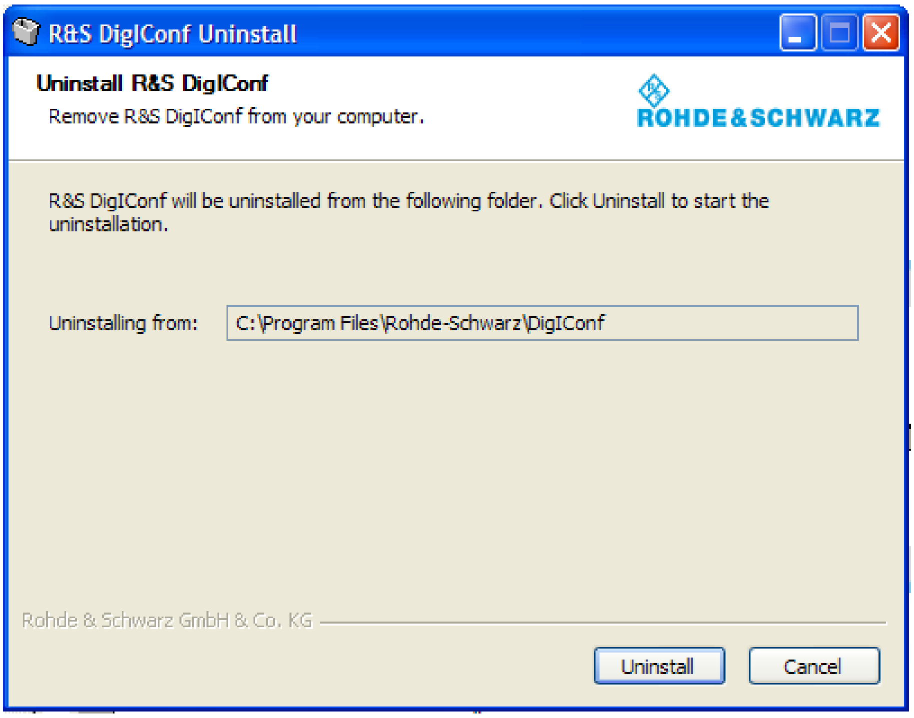
Name	Comments
Accessibility Options	Adjust your computer settings for vision, hearing, and
Add Hardware	Installs and troubleshoots hardware
Add or Remove Programs	Install or remove programs and Windows components.
Administrative Tools	Configure administrative settings for your computer.

The uninstall routine identifies all currently installed R&S DigIConf components, including the relevant files, such as files with user-specific settings.
Before uninstalling, the program asks whether you want to delete the settings directory as well.



Do you want also remove R&S DigIConf settings directory (C:/Program Files/Rohde-Schwarz/DigIConf)?

3. Confirm or reject, and start uninstalling.



Uninstall R&S DigIConf

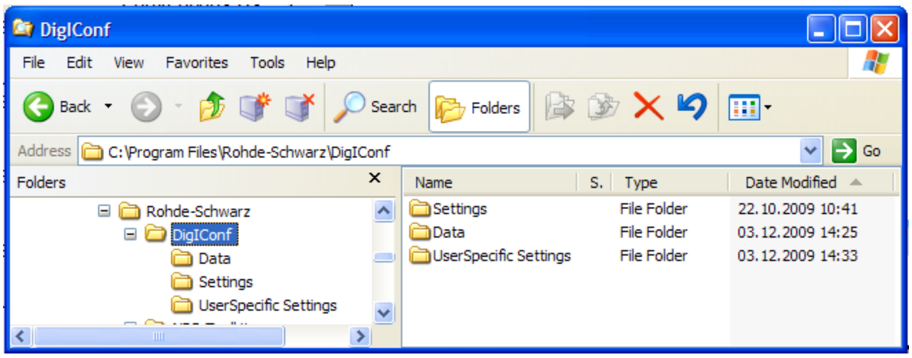
Remove R&S DigIConf from your computer.

R&S DigIConf will be uninstalled from the following folder. Click Uninstall to start the uninstallation.

Uninstalling from: C:\Program Files\Rohde-Schwarz\DigIConf

The uninstaller removes all currently installed R&S DigIConf software items. After completion the uninstall process is confirmed and can be finished with OK.

If you have decided to keep the preference files, the respective directories of DigIConf remain.



Address: C:\Program Files\Rohde-Schwarz\DigIConf

Name	S.	Type	Date Modified
Settings		File Folder	22.10.2009 10:41
Data		File Folder	03.12.2009 14:25
UserSpecific Settings		File Folder	03.12.2009 14:33

4.4.4 Known Restrictions on SmartCard Related Issues

If a R&S EX-IQ-BOX is connected while the computer is locked, login can be performed without any conflicts coming up. But if a R&S EX-IQ-BOX is already connected and you want to log in, the following "Logon Message" appears:

The card supplied requires drivers that are not present on this system. Please try another card.

Fig. 4-9: R&S DigIConf Installation > Logon message

Windows interprets the internal SmartCard of the R&S EX-IQ-BOX as a medium for login and therefore causes this message.

When trying to confirm, the system reacts in different ways, depending on the status of the "DisableCAD" registry entry:

1. **"Logon Message" remains**
   The system repeats the SmartCard error message and blocks the login. DisableCAD=1, i.e. the Windows security attention sequence (CTR-ALT-Del) for login is skipped. Windows tries to log in with the smart card and fails.
   To terminate:
   a) Disconnect the R&S EX-IQ-BOX to enable login.
   b) Log in.
   c) Connect the R&S EX-IQ-BOX again.

   Note: To solve this conflict for later operation, deactivate DisableCAD in the registry. The DisableCAD parameter determines whether you need to press CTRL+ALT+DEL keys to log in, or whether the login window directly appears after at startup or after locked desktop.
2. **"Logon Message" disappears**
   The system forwards to the "Computer Locked" dialog box. In this case, DisableCAD=0, Windows requires users to press CTR-ALT-Del (security attention sequence) for login.
   a) Press CTRL+ALT+DEL to unlock the computer and log in as usual.
   The connection to the R&S EX-IQ-BOX may remain.

4.4.4.1 How to avoid the SmartCard Conflict

The only way to avoid the conflict reliably, is to set DisableCAD=0. If the setting has not been modified yet, proceed as follows.

To modify this registry entry, R&S DigIConf provides the file `DisableCAD.reg` in the directory:

`%APPDATA%\Rohde-Schwarz\DigIConf\Registry`

► Execute `DisableCAD.reg` to deactivate the setting, i.e. to enable the "Press Ctrl-Alt-Del" security attention sequence.
The entry is automatically set to 0. Login can now be performed with connected R&S EX-IQ-BOXes without conflicts.

R&S DigIConf also provides the file `EnableCAD.reg` in the installation directory to disable the sequence accordingly.

4.4.4.2 DisableCAD - Background Information

The DisableCAD parameter determines whether you must press the (**C**TRL+**A**LT+**D**EL) security attention sequence for windows login, or whether the login window directly appears after startup or after locked desktop.

- `DisableCAD=0`
  This status requires users first to press CTRL+ALT+DEL, the windows security attention sequence to access the Windows login dialog box.

This computer is in use and has been locked.

Only User or an administrator can unlock this computer.

Press Ctrl-Alt-Del to unlock this computer.

Fig. 4-10: Windows security attention sequence check box

The Windows dialog box opens, as shown below.

- `DisableCAD=1`
  The Windows login dialog box appears immediately after booting, or locked desktop.

This computer is in use and has been locked.

Only User or an administrator can unlock this computer.

User name: R&S EX-IQ-Box User

Password: ••••••••••••••

Fig. 4-11: Windows login dialog box

The require users to "Press Ctrl-Alt-Del" check box is skipped.

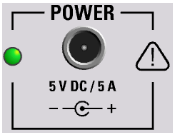
4.5 Connecting the R&S EX-IQ-BOX

This section describes how to connect the R&S EX-IQ-BOX in principle, i.e. to the power supply, to a PC, an R&S instrument and to the DUT. Connection and startup require no particular order, but it is recommended that you follow the procedure as described below.

Connection

It is assumed that all R&S instruments in the test setup are properly power supplied and switched on.

1. Power supply



Power supply: 30 W switching power supply adapter with an input voltage of 100 to 240 VAC.

The R&S EX-IQ-BOX is power supplied with an external power supply unit and a separate power cable. The external power supply unit provides all required voltages of the hardware.

► **Connect the R&S EX-IQ-BOX to the AC supply.**
The R&S EX-IQ-BOX is in **ready state**, if USB is already connected (POWER LED = green). Without USB connection the device R&S EX-IQ-BOX is in **standby state** (POWER LED = yellow).

The device is still power-supplied while it is in standby mode.

2. USB Connection

To establish a connection between the R&S EX-IQ-BOX and a PC or an R&S instrument (R&S EX-IQ-BOX 1409.5502.02), proceed as follows:

1. Connect the USB cable plug B to the R&S EX-IQ-BOX USB IN
2. Connect the USB cable plug A to the PC or to the instrument

Device driver

If the R&S EX-IQ-BOX is connected for the first time, the Windows Hardware Wizard requires the installation of the appropriate device driver. The same applies if you install a new update of R&S DigIConf.

Follow the wizard instructions until windows has finished the driver installation. If the installation is finished, a message is displayed in the info line.


EX-IQ-BOX-FX2: connected on USB

The software drivers need to be installed only once for a device. Due to the operation mode of USB, every new R&S EX-IQ-BOX needs a driver installation.

3. Data signal connection

1. Establish the connection for the reference frequency.
   a) Connect the coaxial cable to REF IN-BNC connector of the R&S EX-IQ-BOX.
   b) Connect the coaxial cable to REF OUT of the instrument.

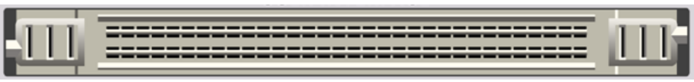
2. Establish the digital interface connection.
   a) Transmitter Mode
   Connect the LVDS cable between the R&S EX-IQ-BOX (DIG I/Q IN/OUT 2) and the BASEBAND DIGITAL IN of the R&S instrument

   b) Receiver Mode
   Connect the LVDS cable between the R&S EX-IQ-BOX "DIG I/Q IN/OUT 2" connector and the "BASEBAND DIGITAL IN" of the R&S instrument.

On connecting the LVDS cable the R&S instruments and the R&S EX-IQ-BOX detect the connection established between them. Depending on the instrument the indication for a successful connection differs, it is either a short message in the info line or a graphical message.

4. Connection to the DUT

1. Connect the respective breakout board (USER INTERFACE).



2. Establish the appropriate connection to the DUT.

4.6 Installation of R&S EX-IQ-BOX Options

This section explains how to install an option of the R&S EX-IQ-BOX.

Prerequisites

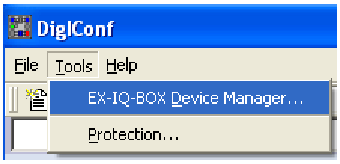
Before installing an option, make sure that the R&S EX-IQ-BOX is power supplied and an USB connection is established.

Keep the licence key ready that was provided with the software option.

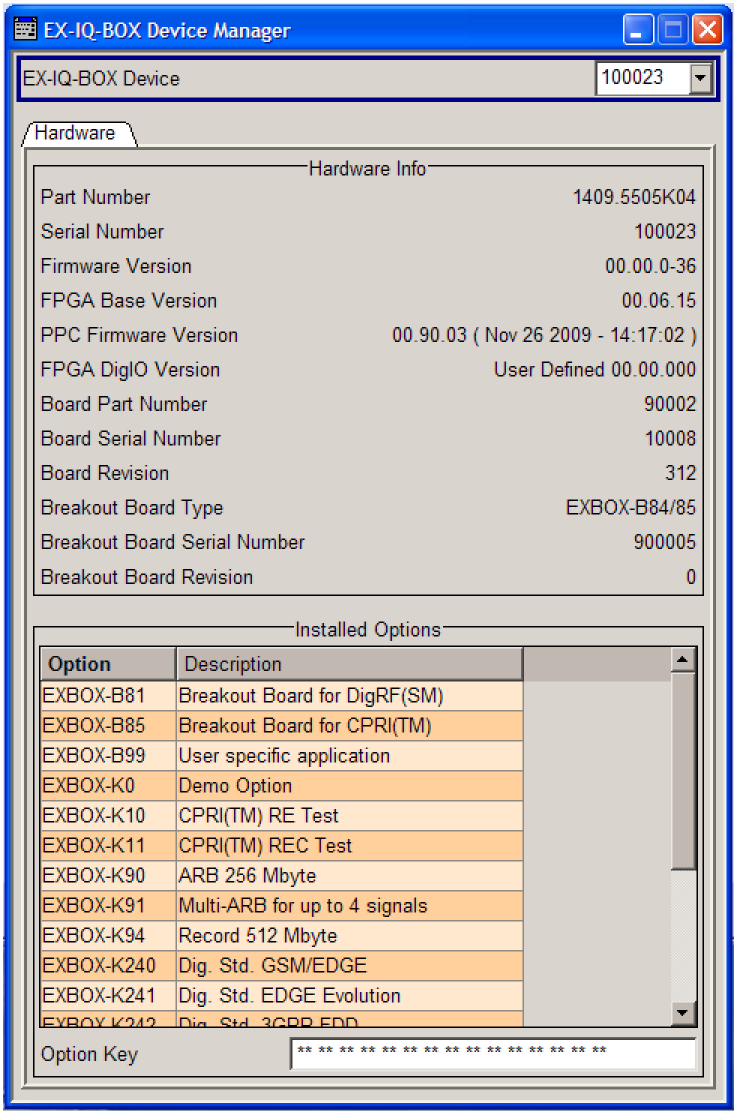
Installation

The software options are installed on the R&S EX-IQ-BOX using R&S DigIConf.

1. Start R&S DigIConf and select "EX-IQ-BOX Device Manager…" in the "Tools" menu.



The "EX-IQ-BOX Device Manager" dialog opens.
The selection field "EX-IQ-BOX Device" lists each connected device. The hardware tab below indicates various information on the selected device, e.g. part number, serial number, firmware version, etc. and the installed options:



EX-IQ-BOX Device: 100023

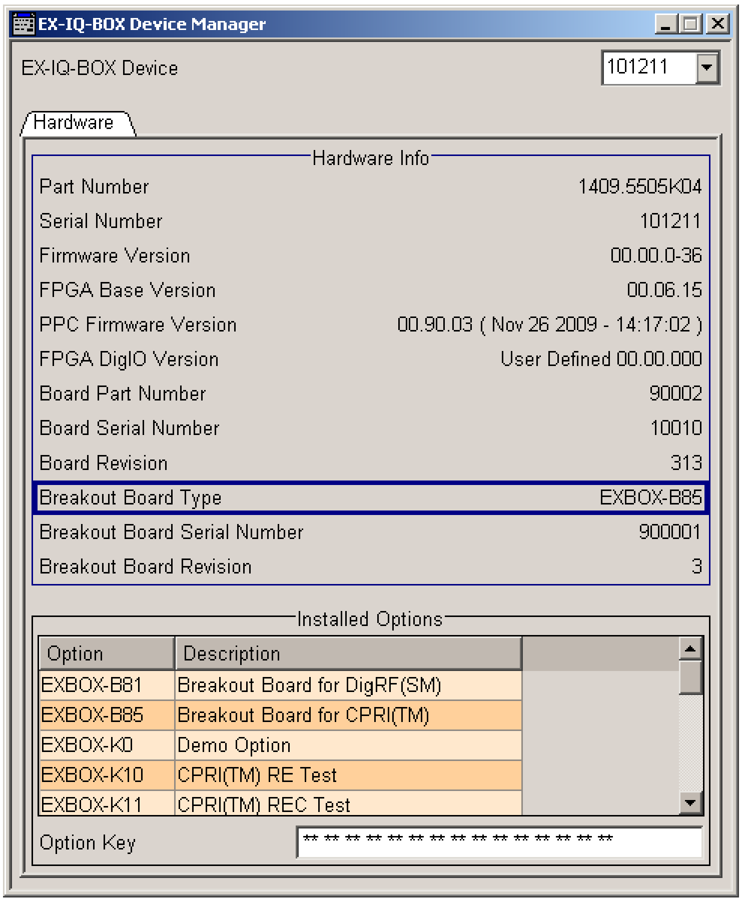
Hardware Info

Part Number	1409.5505K04
Serial Number	100023
Firmware Version	00.00.0-36
FPGA Base Version	00.06.15
PPC Firmware Version	00.90.03 (Nov 26 2009 - 14:17:02)
FPGA DigIO Version	User Defined 00.00.000
Board Part Number	90002
Board Serial Number	10008
Board Revision	312
Breakout Board Type	EXBOX-B84/85
Breakout Board Serial Number	900005
Breakout Board Revision	0

Installed Options

Option	Description
EXBOX-B81	Breakout Board for DigRF(SM)
EXBOX-B85	Breakout Board for CPRI(TM)
EXBOX-B99	User specific application
EXBOX-K0	Demo Option
EXBOX-K10	CPRI(TM) RE Test
EXBOX-K11	CPRI(TM) REC Test
EXBOX-K90	ARB 256 Mbyte
EXBOX-K91	Multi-ARB for up to 4 signals
EXBOX-K94	Record 512 Mbyte
EXBOX-K240	Dig. Std. GSM/EDGE
EXBOX-K241	Dig. Std. EDGE Evolution
EXBOX-K242	Dig. Std. 3GPP FDD

Option Key: ** ** ** ** ** ** ** ** ** ** ** ** ** ** ** **



EX-IQ-BOX Device 101211

Hardware Info

Part Number	1409.5505K04
Serial Number	101211
Firmware Version	00.00.0-36
FPGA Base Version	00.06.15
PPC Firmware Version	00.90.03 (Nov 26 2009 - 14:17:02)
FPGA DigIO Version	User Defined 00.00.000
Board Part Number	90002
Board Serial Number	10010
Board Revision	313
Breakout Board Type	EXBOX-B85
Breakout Board Serial Number	900001
Breakout Board Revision	3

Installed Options

Option	Description
EXBOX-B81	Breakout Board for DigRF(SM)
EXBOX-B85	Breakout Board for CPRI(TM)
EXBOX-K0	Demo Option
EXBOX-K10	CPRI(TM) RE Test
EXBOX-K11	CPRI(TM) REC Test

Option Key ** ** ** ** ** ** ** ** ** ** ** ** ** ** ** **

For detailed description on this dialog refer to "EX-IQ-BOX Device Manager" in the operating manual.

2. Select the R&S EX-IQ-BOX from "EX-IQ-BOX Device".
3. Enter the licence key provided with the option in the "Option-Key" field and confirm with "Enter".

   Note: Installing several options
   Just repeat step 3 to install more options on the same device or steps 2 and 3 to install options on other devices.

Checking for installed options

To check for installed options proceed as follows:

1. Open the "EX-IQ-BOX Device Manager" dialog.
2. Select the R&S EX-IQ-BOX from "EX-IQ-BOX Device".

   The installed options are displayed in the "Installed Options" table.

5 Application Examples

This chapter covers some application examples. The test setups show the R&S EX-IQ-BOX controlled by R&S DigIConf. Applications with User Defined Interface transmission protocols also support the direct control of the R&S EX-IQ-BOX by R&S Instruments. Standardized interface protocols always require the configuration by R&S DigIConf.

5.1 Baseband Receiver Chip Test

Example of the generation of a standards-compliant digital baseband signal for checking the quality of a receiver.

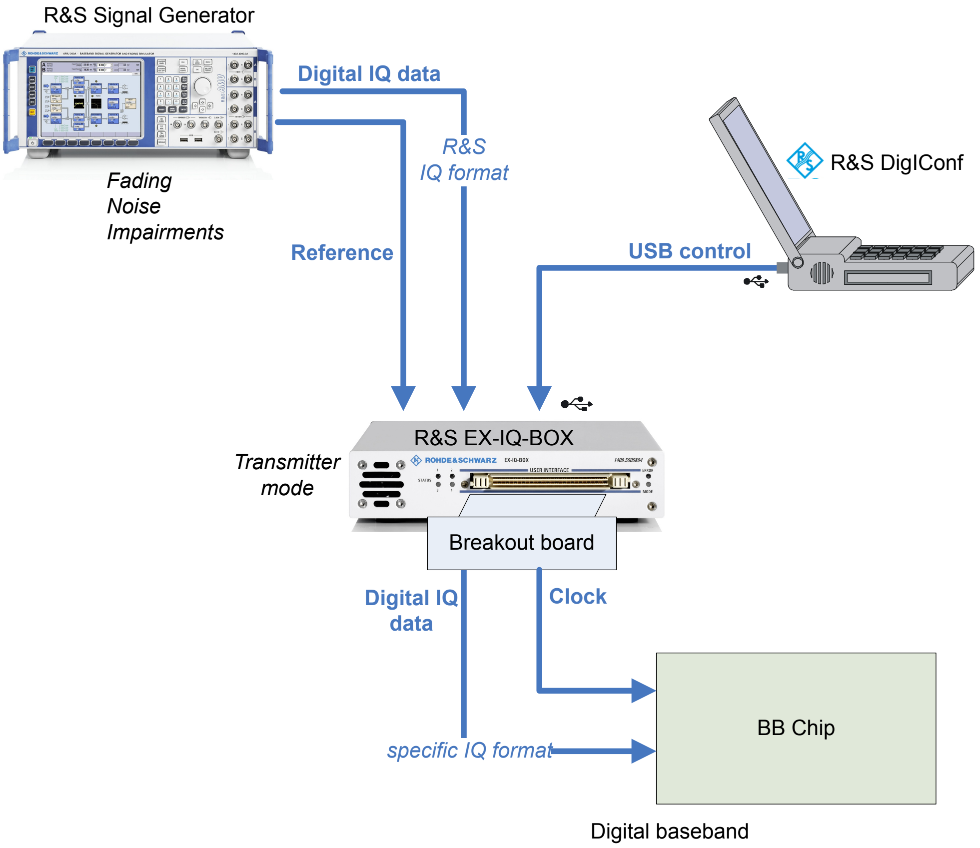


Fig. 5-1: Application example of a baseband receiver chip test

An R&S signal generator together with the R&S EX-IQ-BOX provides digital baseband signals for all important mobile radio and wireless digital standards such as EUTRA/LTE, 3GPP, HSPA, GSM/EDGE, WiMAX IEEE 802.16 and WLAN IEEE 802.11n. All signal generator functions are also available for generating digital baseband signals, plus all signal processing functions to yield effects such as fading, AWGN or I/Q impairments. This allows measurements on baseband receiver chips to be performed accurately and reproducibly. With the aid of bit and block error ratio measurements the quality of the receiver can be tested.

5.2 CPRI Test Setup

The following test setups show two typical CPRI test scenarios with the R&S EX-IQ-BOX. First, the R&S EX-IQ-BOX emulates the baseband module, and in the other example, it acts as the RF part.

5.2.1 Typical CPRI RE Test Setup

Example of a typical CPRI **RE** (**R**adio **E**quipment = RF unit) test scenario, where the R&S EX-IQ-BOX acts as a baseband module **REC** (**R**emote **E**quipment **C**ontrol).

The test setup requires the CPRI breakout board, option R&S EXBOX-B85, the CPRI RE Test, option R&S EXBOX-K10 and the configuration software R&S DigIConf. For details on available options, see chapter 3.2.2.1, "Standardized Protocols", on page 22.

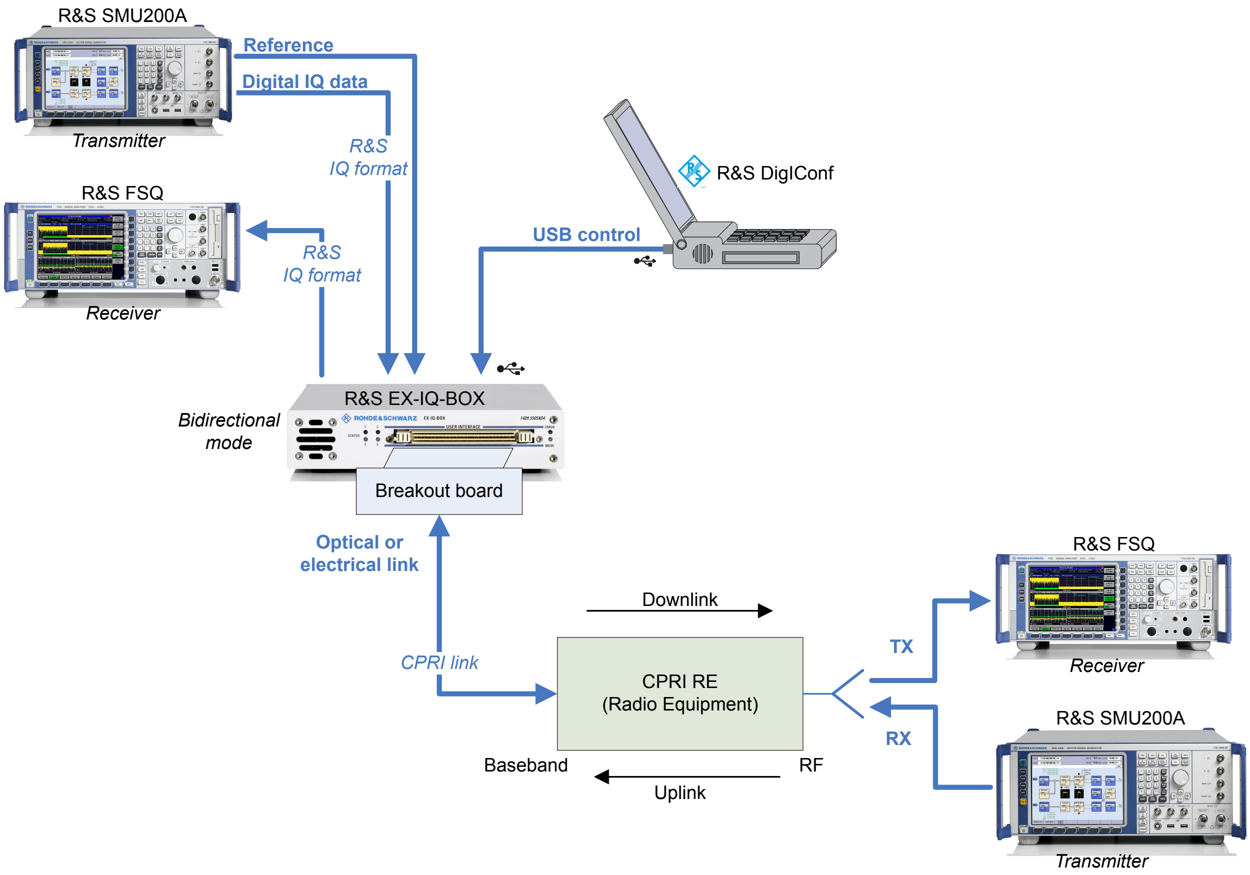


Fig. 5-2: Application example of a RE test setup with the digital interface protocol CPRI

The test setup covers the downlink and the uplink. It provides testing both directions either simultaneously, i.e. full duplex, or uplink and downlink seperately.

The downlink signal flow

The R&S baseband signal generator feeds a baseband signal (e.g. an LTE downlink) in the R&S specific I/Q format to the R&S EX-IQ-BOX. The R&S EX-IQ-BOX converts the R&S I/Q format into the CPRI protocol. The CPRI link transmits the I/Q baseband signal and control & management information from the R&S EX-IQ-BOX to the DUT, in this case the CPRI RE Device.

The CPRI RE device extracts the baseband signal from the CPRI link and executes an I/Q modulation to a certain carrier frequency RF. The resulting RF signal is sent to the R&S spectrum-analyzer, to perform various measurements, e.g. **ACP** (**A**djacent **C**hannel **P**ower) or **EVM** (**E**rror **V**ector **M**agnitude) evaluation.

The uplink signal flow

The R&S vector signal generator feeds an RF signal (e.g. an LTE uplink) via the antenna input into the CPRI RE device. The DUT converts the signal from RF to baseband and transmits the baseband signal by using the CPRI link.

The R&S EX-IQ-BOX extracts the I/Q baseband signal from the CPRI protocol and sends the signal in the R&S specific I/Q format to the R&S signal analyzer for demodulation.

All settings regarding the baseband signal (e.g. LTE) are directly controlled by the R&S signal generator and analyzer, respectively.

CPRI settings like I/Q mapping or link settings are controlled by the configurator software R&S DigIConf .

In addition to the I/Q data, **C&M** (**C**ontrol and **M**anagement) information is embedded in the CPRI protocol. These parameters are also set with the aid of R&S DigIConf.

An Ethernet connector provides fast C&M, and the R&S DigIConf inline text console can be used for slow C&M.

5.2.2 Typical CPRI REC Test Setup

Example of a typical CPRI **REC** (**R**adio **E**quipment **C**ontrol = baseband unit) test scenario, where the R&S EX-IQ-BOX acts as a RF module RE (Remote Equipment).

The test setup requires the CPRI breakout board, option R&S EXBOX-B85, the CPRI REC Test, option R&S EXBOX-K11 and the configuration software R&S DigIConf. For details on available options, see chapter 3.2.2.1, "Standardized Protocols", on page 22.

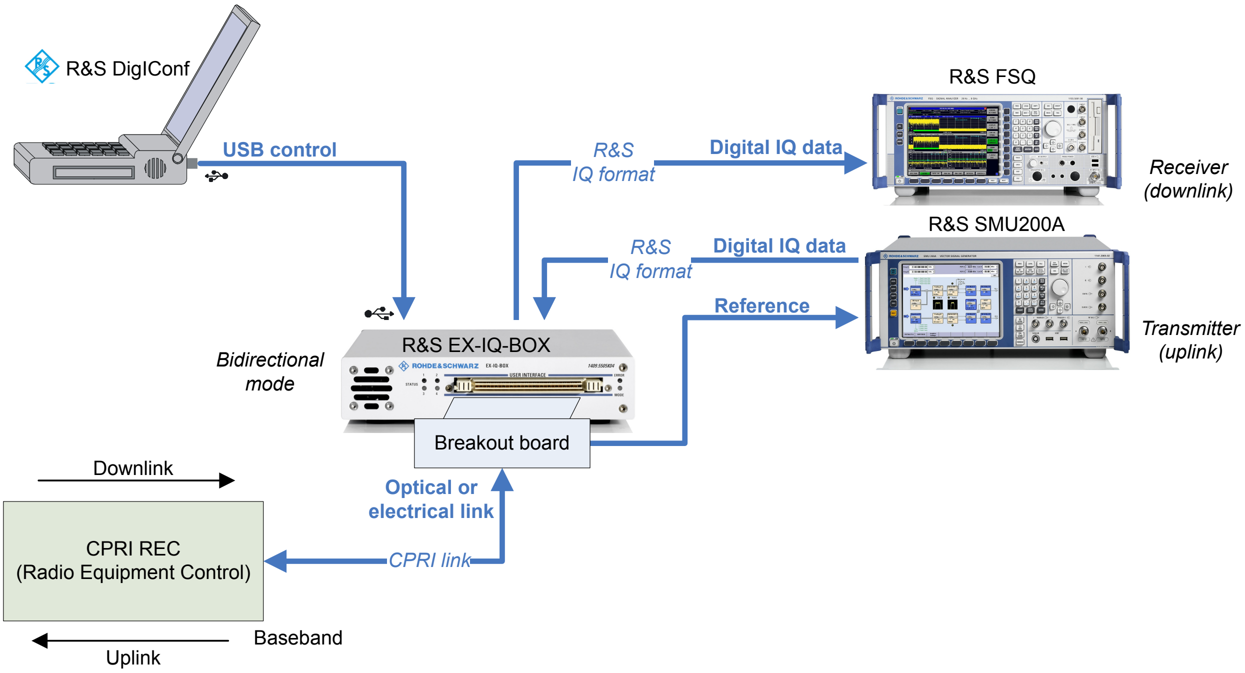


Fig. 5-3: Application example of a REC test setup with the digital interface protocol CPRI

The test setup covers the downlink and the uplink. It provides testing both directions either simultaneously, i.e. full duplex, or uplink and downlink separately.

The downlink signal flow

The DUT, in this case the CPRI REC device, generates a digital baseband signal (e.g. an LTE downlink) and transmits this signal over the CPRI link.

The R&S EX-IQ-BOX extracts the I/Q baseband signal from the CPRI protocol and sends the signal in the R&S specific I/Q format to the R&S signal analyzer for demodulation.

The R&S signal analyzer features various measuring methods, as e.g. **ACP** (**A**djacent **C**hannel **P**ower) or **EVM** (**E**rror **V**ector **M**agnitude) evaluation. Use this measurement methods to examine the validity and quality of the digital baseband signal, or to evaluate the influence of numerical imperfections, e.g. quantization effects depending on the I/Q resolution.

The uplink signal flow

The R&S signal generator feeds an UE uplink signal (e.g. an LTE uplink) in the R&S specific I/Q format to the R&S EX-IQ-BOX.

The R&S EX-IQ-BOX converts the R&S I/Q format into the CPRI protocol. The CPRI link transmits the I/Q baseband signal and control & management information from the R&S EX-IQ-BOX to the DUT, in this case the CPRI REC device.

The DUT must now be able to demodulate the UE uplink signal. Use the various functionalities of the R&S signal generator, e.g. add Channel Fading, AWGN (Additive White Gaussian Noise) and I/Q impairments in order to perform a very powerful and realistic receiver / demodulator measurement with this test scenario.

All settings regarding the baseband signal (e.g. LTE) are directly controlled by the R&S signal generator and analyzer, respectively.

CPRI settings like I/Q mapping or link settings are controlled by the configurator software R&S DigIConf.

In addition to the I/Q data, "C&M" (**C**ontrol and **M**anagement) information is embedded in the CPRI protocol. These parameters are also set with the aid of R&S DigIConf.

An Ethernet connector provides fast C&M, and a RS-232-C connector provides slow C&M in real time.

5.3 DigRF Test Setup

In this setup the R&S EX-IQ-BOX emulates a BB-IC which controls the RF-IC via the DigRF 3G / v4 interface. The setup is combined with an R&S signal generator and an R&S signal analyzer that provide signal input and analysis of the RF-IC.

The test setup example requires the DigRF breakout board, option R&S EXBOX-B81 and, depending on the used DigRF protocol, either the DigRF 3G RF-IC option R&S EXBOX-K13, or the DigRF v4 RF-IC option R&S EXBOX-K15. The parameters are set with the configuration software R&S DigIConf.

For details on available options, see chapter 3.2.2.1, "Standardized Protocols", on page 22.

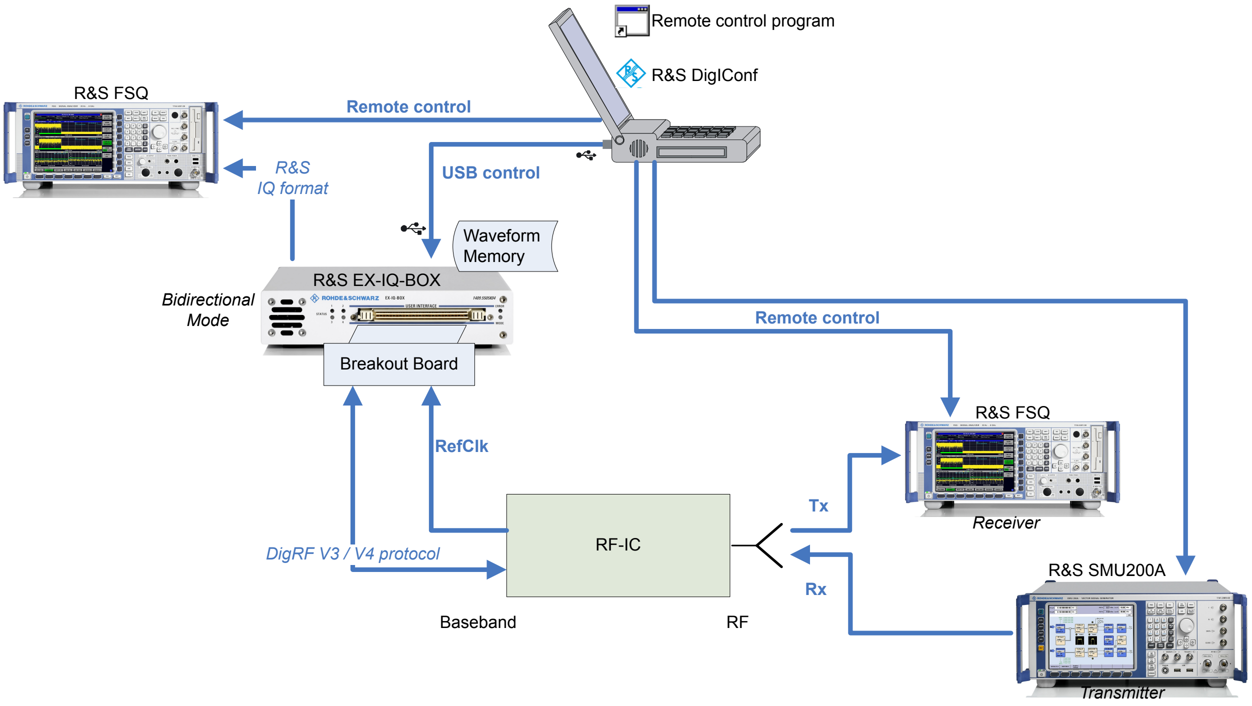


Fig. 5-4: Application example of a DigRF V3/4 test setup

The internal Waveform Memory of the R&S EX-IQ-BOX is used as I/Q data source. The respective standard-compliant waveform files can be generated with R&S WinIQSIM2 or another suitable external tool.

The R&S EX-IQ-BOX feeds the I/Q data into the Tx module of the RF-IC in standard-compliant DigRF packages. User-specific control information is also embedded in the DigRF transmission protocol. The returned data from DigRF 3G/v4 is then transmitted to the R&S signal analyzer via the R&S digital I/Q interface, where they can be evaluated accordingly.

The entire DigRF protocol can be controlled via direct commands or via a script in real-time.

The Rx module of the RF-IC is supplied by a standard-compliant signal from the R&S signal generator, and the output signal of the Tx module is measured and analyzed with an R&S signal analyzer.

In future extensions, the R&S EX-IQ-BOX will be able to emulate the RF-IC in order to test the BB-IC. Refer to the supplementary sheet at the beginning of this manual.

In this example, the complete measuring procedure is automated by a remote program that controls all R&S instruments, including the R&S EX-IQ-BOX.

5.4 In-Circuit Emulation for Wireless Designs

The following test setup example requires the Cadence Palladium Breakout Board, option R&S EXBOX-Z3, and the configuration software R&S DigIConf.

The following example shows a test setup for the emulation of a chip in a software model:

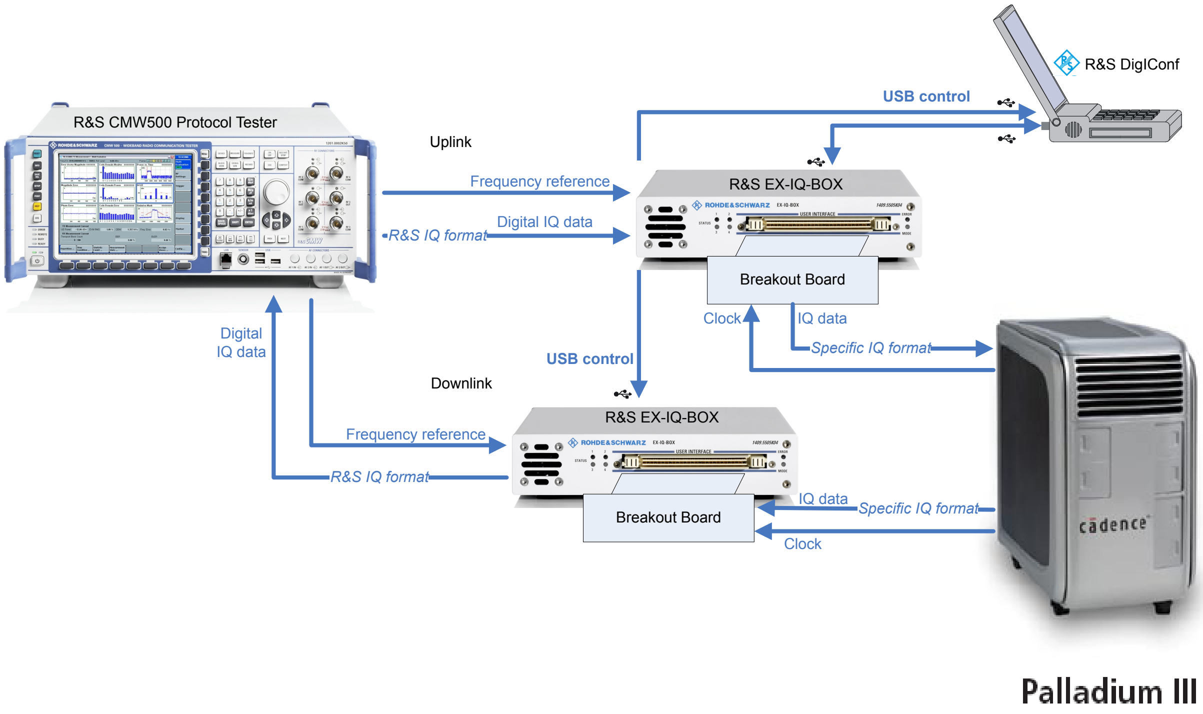


Fig. 5-5: Application example of an in-circuit emulation of wireless designs

This test setup shows an R&S CMW500, equipped for protocol testing which creates an I/Q signal. The signal is then converted by an R&S EX-IQ-BOX and fed to the emulator. A second R&S EX-IQ-BOX converts the incoming signal from the emulator and feeds it into the baseband section of the R&S potocol tester. Both R&S EX-IQ-BOX devices are controlled by R&S DigIConf. For detailed information on this application refer to the operating manual of the protocol tester, and the to http://www.rohde-schwarz.com/appnote/1CM75 on the internet.

6 R&S EX-IQ-BOX Configuration

The versatile functionality of the R&S EX-IQ-BOX and its options provide convenient adjustment for signal transmission between different digital interfaces and communication protocols. It supports both **user defined** protocols or **standardized** transmission protocols such as **CPRI** or **DigRF**.

The configuration software R&S DigIConf enables you to configure and control the R&S EX-IQ-BOX via PC. Some R&S instruments, as e.g. the R&S CMW500, also provide installing R&S DigIConf on the instrument directly. Check in the operating manual to see if your R&S instrument supports this mode of operation. Refer to chapter 3.1, "Basic Operating Modes", on page 14 for description in detail.

The R&S EX-IQ-BOX, model **1409.5505.02**, additionally supports direct control from an R&S instrument in **User Defined** mode. Due to the enhanced capabilities of the R&S EX-IQ-BOX **1409.5505K04**, this model is controlled by R&S DigIConf exclusively, since it supports all applications.

The following references lead you to the appropriate descriptions for using R&S DigIConf, and configuring the R&S EX-IQ-BOX for the respective applications:

- R&S DigIConf Configuration Software, comprises the graphical user interface and basic functionalities of R&S DigIConf, including configuration dialogs and basic information on remote control.
  Note: The latest software versions can be downloaded free charge from the R&S website:
  http://www.rohde-schwarz.com/product/EX-IQ-Box.html
- Configuration via R&S Instruments covers all specific characteristics of an R&S instrument in conjunction with an R&S EX-IQ-BOX1409.5505.02, separately described for every instrument family. E.g. the indication of the R&S EX-IQ-BOX in an instrument and access to the parameters of the R&S EX-IQ-BOX in an instrument´s dialog. This constellation applies to User Defined applications.

Separate chapters contain protocol settings of the specific operating modes:

- chapter 7.1, "User Defined", on page 98 covers the parameters and settings for serial or parallel transmission of I/Q signals, including clock modes, data rates and logical signal levels.
- chapter 7.2, "CPRI", on page 126 covers explanations and the description to this standardized protocol.
- chapter 7.3, "DigRF", on page 193 contains the description and settings of the DigRF 3G and v4 standardized protocol.

6.1 R&S DigIConf Configuration Software

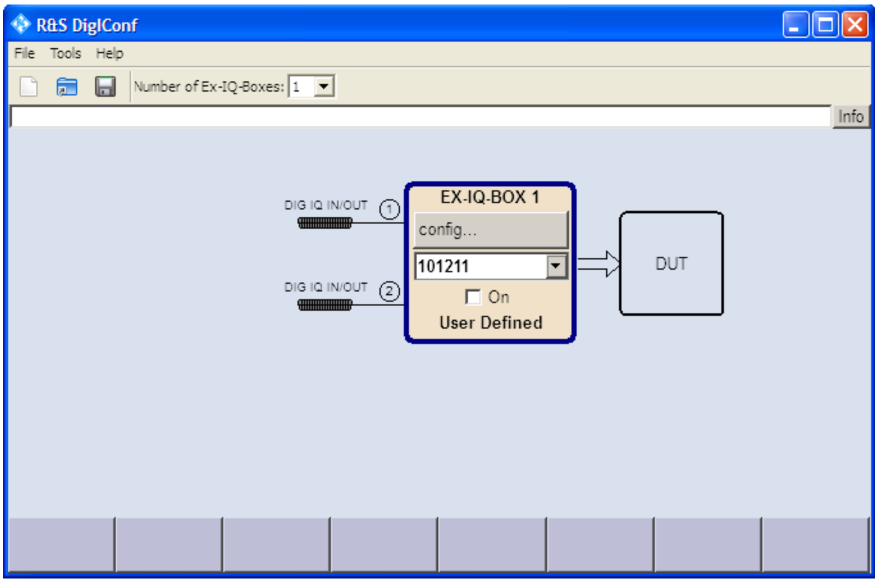
This chapter describes the graphical user interface of R&S DigIConf, including the layout of the application window, the display, controls and how to operate the configuration software R&S DigIConf. Additionally the chapter contains information on special features concerning the connection of the R&S EX-IQ-BOX to R&S instruments and the respective configuration dialogs.

6.1.1 Graphical User Interface - Overview

After starting the R&S DigIConf software the main application window opens.

The appearance of the application window is based on the Microsoft®Windows layout, covering

- a header with the name of the window and buttons for minimizing and closing,
- a **menubar** and a **toolbar** with icons of the most important functions,
- a display which includes an **infoline**, a **block diagram** and a **winbar**, and
- **dialogs** for configuration parameter settings.



Number of Ex-IQ-Boxes: 1

101211

☐ On

User Defined

The following description mainly refers to R&S DigIConf and to the R&S EX-IQ-BOX. For windows functionalities refer to Microsoft® Windows help system.

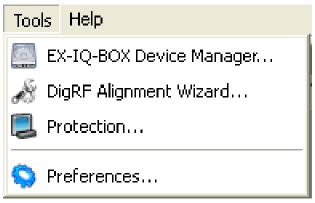
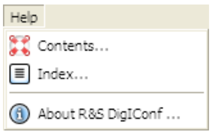
6.1.1.1 Menu Bar

The **menu bar** covers menus with functions for file management, tools for configuration and help for support. Some of the functions are visualized by icons and available in the toolbar.

For an overview of functions with associated icons, refer to chapter 6.1.1.2, "Toolbar", on page 56.

The menu functions are executed by a mouse click on the associated menu item. The following table briefly explains the menus and refers to the detailed description:

Table 6-1: Menu overview

Menu	Function	Find description under ...
	The File menu contains all functions that belong to file management, e.g. creating, saving or recalling settings data.	chapter 6.1.2.1, "File Menu", on page 58
	Open dialogs for accessing information on R&S EX-IQ-BOX devices and to set protection levels for test and service purposes.	chapter 6.1.2.2, "Tools Menu", on page 60
	The Help menu provides access to the complete description of the R&S EX-IQ-BOX, and index for search and informs about software version and support.	chapter 6.1.2.3, "Help Menu", on page 60

6.1.1.2 Toolbar

The toolbar of the main application window contains icons for quickly starting the main functions.

The functions are started by clicking the icon buttons with the left mouse button. Each icon features a corresponding item in the menu lists. For assignment on the icons to the corresponding functions see the table below:

Table 6-2: Icons and the corresponding functions

Icon	Function	Corresponding Menu item
🗋	Preset	File > New
📂	Load Settings	File > Open
💾	Save Settings	File > Save

File handling is described briefly in chapter 6.1.2.1, "File Menu", on page 58

6.1.1.3 Info

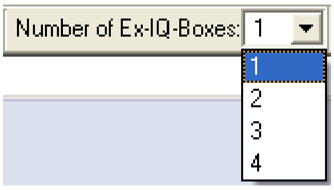
The info line reports and indicates the current state with status, error and warning messages. Detailed information on the messages is shown in the info window, called by the info button. For description in detail refer to chapter 6.1.3, "Info Line and Window", on page 61.

6.1.1.4 Block Diagram

The diagram is built up like the display of the R&S SMU family. Test system architecture and signal flow are shown in the block diagram. Each R&S EX-IQ-BOX is assigned to a block, which is shown always in a line with an instrument block and a DUT. The DUT is displayed as passive block.

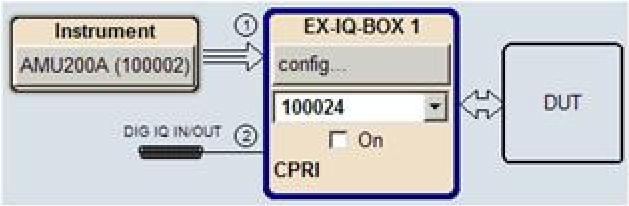
Block Diagram

R&S DigIConf may handle up to four R&S EX-IQ-BOX devices simultaneously. The number of R&S EX-IQ-BOXes to be configured is set in the entry field "Number of R&S EX-IQ-BOXes" located in the toolbar.



Number of Ex-IQ-Boxes: 1

The block diagram in the figure below represents a configuration with one R&S EX-IQ-BOX and one R&S instrument, i.e. in this case an R&S AMU200A.



The R&S EX-IQ-BOX transfers test signals to a DUT or from a DUT to an R&S instrument:

- in **transmitter** mode the signals are transferred from an R&S instrument in conjunction with the R&S EX-IQ-BOX to a DUT.
- in **receiver** mode incoming signals from a DUT are forwarded to an R&S instrument from the R&S EX-IQ-BOX.

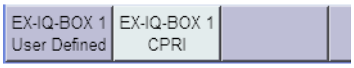
Input/Output symbols in the block diagram show the currently used inputs and outputs and the lines indicate the signal flow.

SCPI command:

`[:SOURce<hw>]:EBOX:COUNt` on page 306

6.1.1.5 Winbar

The labeled buttons in the winbar indicate active dialogs. When a button softkey is pressed, the associated dialog is displayed in the foreground or minimized in the winbar.



The button displayed in a lighter color indicates that the corresponding dialog is currently open. Up to eight dialogs may be open simultaneously. When the ninth dialog is opened, the dialog that was opened first is automatically closed.

6.1.1.6 Dialogs

The parameters are set in **dialogs**, which differ in details depending on their functions. Dialogs are designed in Microsoft®Windows format, covering the same functional elements, as e.g. entry fields, selection lists, checkboxes and buttons. A dialog is accessed either by means of an item in the menu list or via the function block in the diagram.

Each dialog consists of a window header and one or more sections with various fields for setting parameters. The header line contains the name of the dialog and the buttons for minimizing and closing the dialog. To operate the buttons, use the mouse. Several fields of associated but separately set parameters can be organized in an area, framed and labelled with the function common to all parameters. Also, some parameters can be partially structured in tabs.

R&S DigIConf mainly distinguishes between the **settings dialogs** for User Defined or standardized protocol settings and **configuration dialogs**, which comprise for example general settings of the R&S EX-IQ-BOX, options, connected instruments, default settings or setup tests.

- **Configuration dialogs** are described in chapter 6.1.6, "Configuration Dialogs", on page 66.
- For **settings dialogs** of your specific application, comprising signal and interface parameters refer to the respective section under chapter 7, "Protocol Settings", on page 97.

6.1.2 Menus

6.1.2.1 File Menu

The **File** menu contains all functions that belong to file management, e.g. creating, saving or recalling settings data.

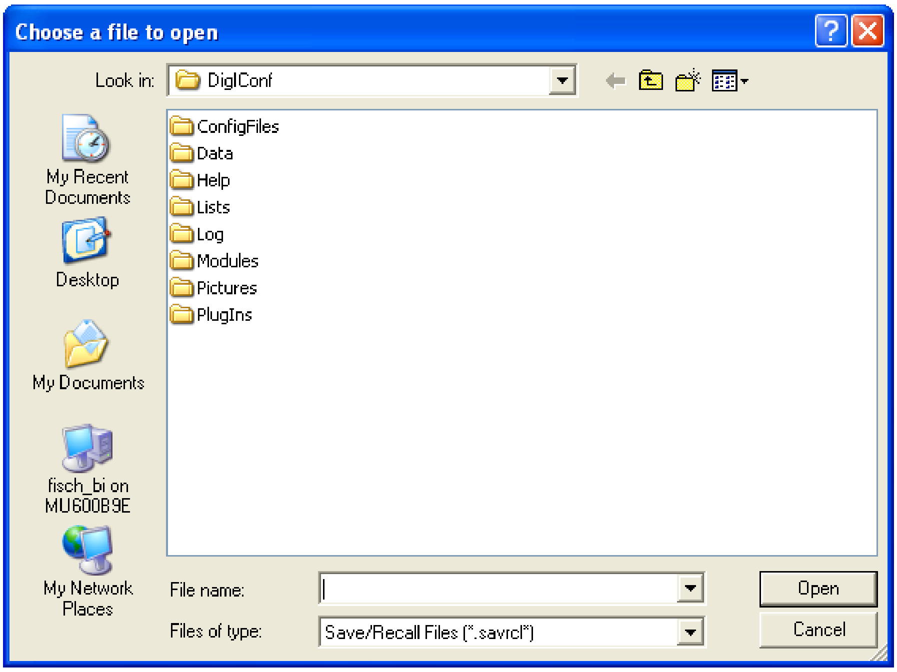
Operation of file management is very similar to operation of Windows user interfaces. Menus and dialogs are made up of known elements, such as selection lists, check boxes and entry fields.

File > New

Setup a new configuration. The function resets the current configuration.

File > Open...

Open a settings file previously stored with Save or Save as.



Look in: DiglConf

File name:

Files of type: Save/Recall Files (*.savrcl*)

The "Choose a file to open" dialog is similar to an MS Windows File dialog. Use this dialog in the same way to select a previously stored settings file.

R&S instruments or programs generally store settings files with the extension *.savrcl. Therefore the suffix is preset in the field **Files of type** and only files with this extension are listed.

File > Save

Store the current settings in a file. If it is a previously loaded file the settings are stored in the same file without confirmation. If it is a new configuration the settings are stored with "Save as".

File > Save as...

Store the current settings in a selected file. Assign a file name and choose the directory to save the settings file.

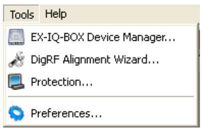
The extension of a settings file is *.savrcl and cannot be changed. By default settings files are stored in the R&S DiglConf application directory, for example %Program Files%\RohdeSchwarz\DiglConf\... .

File > Exit

Quits the R&S DiglConf.

The current settings of the R&S DiglConf session are saved and loaded by default when starting R&S DiglConf again.

6.1.2.2 Tools Menu



The **Tools** menu contains functions for R&S EX-IQ-BOX devices and protection.

Tools > EX-IQ-BOX Device Manager

Displays information about the connected R&S EX-IQ-BOX devices, e.g. serial or part number and a list of installed options. Fields and parameters of this dialog are described in chapter 6.1.6.1, "EX-IQ-BOX Device Manager", on page 66.

For installing options refer to Installing chapter 4.6, "Installation of R&S EX-IQ-BOX Options", on page 44.

Tools > Protection...

Opens the protection dialog, which is described under chapter 6.1.6.3, "Protection", on page 70.

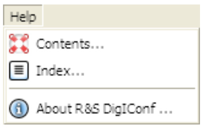
Tools > DigRF Alignment Wizard...

Starts the alignment wizard to perform an internal adjustment of the DigRF 3G TX1 output, see chapter 6.1.6.2, "Starting a Self Alignment", on page 69.

Tools > Preferences...

Opens the preferences dialog, covering the default settings directory and displays the SCPI server port. See chapter chapter 6.1.6.4, "Preferences", on page 71.

6.1.2.3 Help Menu



The **Help** menu provides access to the complete description of the R&S EX-IQ-BOX, an index for search and informs about software version and support.

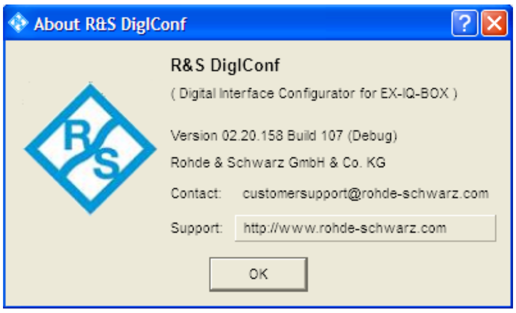
Help > Contents...

Opens the online help start page.

Help > Index...

Open the online help index. Search for specific words or phrases, or choose from a list of keywords.

Help > About R&S DigIConf ...



R&S DigIConf
(Digital Interface Configurator for EX-IQ-BOX)
Version 02.20.158 Build 107 (Debug)
Rohde & Schwarz GmbH & Co. KG
Contact: customersupport@rohde-schwarz.com
Support: http://www.rohde-schwarz.com

Retrieve information about software version and R&S support of R&S DigIConf.

6.1.3 Info Line and Window

6.1.3.1 Info Line

On top of the block diagram the info line reports and indicates the current state with status, error and warning messages. Status information and messages differ concerning their importance and display duration. Further information on all messages can be called in the info window.

Status information

Gives an overview of the main operating states and settings. States are indicated for information and do not necessiate any action by the user.

Messages

Mesages indicate errors. They are displayed in different colors depending on their importance. Errors are displayed in red, information and warnings in balack. Warnings indicate less significant errors.

Volatile messages

Brief messages report automatic settings in the R&S EX-IQ-BOX or on illegal entries that are not accepted by the instrument. They are displayed in the info line on a yellow background, always on top of status information or permanent messages. Volatile messages do not normally demand user actions and disappear automatically after a brief period of time. They are stored in the history, however.

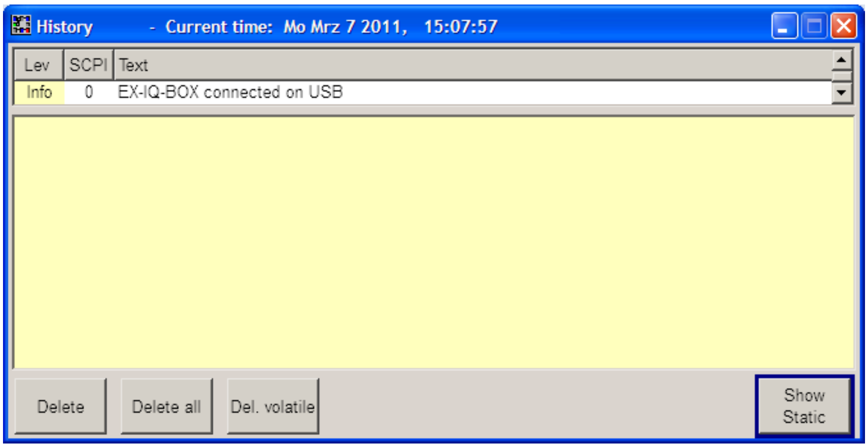
Permanent messages

Permanent messages are displayed if an error occurs that impairs further operation, e.g. a hardware fault. The error signalled by a permanent message must be eliminated before correct instrument operation can be ensured.

The message is displayed until the error is eliminated. It covers the status display in the info line. After error elimination, the message automatically disappears and is also recorded in the history.

6.1.3.2 Info Window

An information window comprising a description of current messages opens with the "Info" button.



Lev	SCPI	Text
Info	0	EX-IQ-BOX connected on USB

The upper section of the info window contains a list of all current permanent messages in the order of their occurrence, i.e. the most recent message is displayed first. In the lower section of the window, additional information on the highlighted message is displayed. A history of all messages that have occurred since startup can be called with the "Show History" softkey. The most recent message is displayed first.

The messages are color-coded according to their level. Device-specific messages are red, info and remote control error are black.

The level is also indicated in the "Lev" column. Column "SCPI" indicates the SCPI error code. Column "Text" displays the message in short form.

With the aid of the softkeys, error messages can be cleared and a history of all messages called.

Delete
Clears the highlighted message.

This button is available only if the history of the messages is displayed.

Delete all
Clears all messages.

This button is available only if the history of the messages is displayed.

Del. volatile
Clears all volatile messages.

This button is available only if the history of the messages is displayed.

Show History /Show Static
Calls the list of all messages that have occurred since instrument switch-on. The most recent messages are displayed at the top of the list. When the softkey is pressed again, the list of current messages is displayed.

6.1.4 Blocks

The block diagram shows the current configuration and signal flow and permits interactive operation via graphical elements. Signal processing can be completely operated from the block diagram.

Blocks of R&S EX-IQ-BOX devices contain a "Config" button, which pops up a list of associated menus to open configuration dialogs.

In the "On" check box of the R&S EX-IQ-BOX block, the respective function can be quickly activated or deactivated. After activation, the block is displayed in blue.

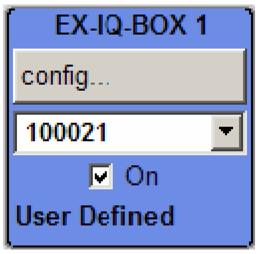
Status information is indicated in the last line of a block.

An **instrument** block contains a button, that indicates name and ID of the connected instrument. The button leads to a configuration dialog for setting network parameters.

The **DUT** is displayed as passive block, just representing the device under test.

6.1.4.1 R&S EX-IQ-BOX

The R&S EX-IQ-BOX is configured in settings dialogs which are opened in the respective function block. R&S DigIConf may handle up to four R&S EX-IQ-BOX devices, which are differentiated in the label of the block by a counter. Each device is set separately.



EX-IQ-BOX 1

100021

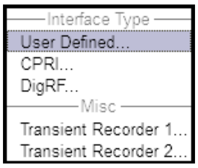
☑ On

User Defined

In this block, a R&S EX-IQ-BOX is configured and activated. User Defined and standardized protocols are listed in the menu, opened by clicking the "config..." button. The serial number of the R&S EX-IQ-BOX and the selected operating mode are displayed in the block.

Indicates the assigned counter (1 ... 4) of the R&S EX-IQ-BOX.

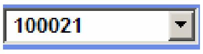
Opens a menu list for access to the settings dialogs of the interface protocols and to further functions, as e.g. "Transient Recorder", "Waveform Memory", "Multi Waveform Playback" or "Recording Memory". Select an item to open the respective configuration dialog.



A settings dialog can only be activated, if the corresponding option is installed and the respective breakout board is connected. Refer to chapter 6.1.6.1, "EX-IQ-BOX Device Manager", on page 66 for installed options.

The chapter 7.1, "User Defined", on page 98, chapter 7.2, "CPRI", on page 126 and chapter 7.3, "DigRF", on page 193 describe the parameters of the specific protocols.

See also chapter 6.1.6.6, "Transient Recorder", on page 73 for details on data monitoring using the R&S EX-IQ-BOX.



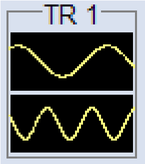
Lists the serial numbers of connected R&S EX-IQ-BOXes. Select one to assign it to the block. A device can be assigned only once, i.e. it is then grayed out in the lists of the other blocks.

If a device is assigned to a block, its serial number is disabled (grayed out) in the list of other blocks. Refer to chapter 6.1.6.1, "EX-IQ-BOX Device Manager", on page 66 for connected devices.

Activates signal input or output of the assigned R&S EX-IQ-BOX.

Indicates the interface protocol mode of the R&S EX-IQ-BOX.

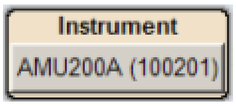
6.1.4.2 Smart Graphic Display



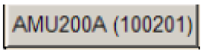
The signal can be graphically displayed in the block diagram, in form of a "smart graphic". A shown signal is actually recorded by one of the transient recordes. The display is activated in the settings dialog chapter 6.1.6.6, "Transient Recorder", on page 73, and can be used for checking purposes. R&S DigIConf provides two transient recorders pro R&S EX-IQ-BOX, which can both be activated for display.

To quickly open the transient recorder dialog, just double click the smart graphic.

6.1.4.3 Instrument



In the instrument block a connected R&S instrument is indicated. Clicking the button, a dialog opens to configure the network connection, described in chapter 6.1.6.5, "Instrument on the R&S EX-IQ-BOX", on page 72.



Displays the name and the device ID of the connected instrument.

6.1.5 Help System

R&S DigIConf is equipped with a context-sensitive help function offering quick context-sensitive reference to the information needed for operating. The comprehensive help system contains the complete user documentation including the contents of the quick start guide.

Each parameter offers a context-sensitive help page you can call at any time during the operation.

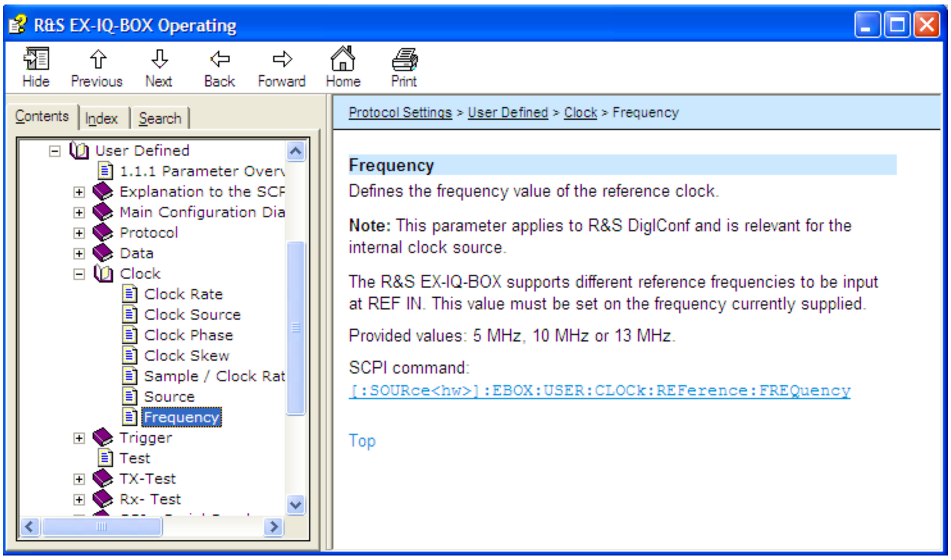
► Open a help page with the F1 function key.
F1 opens a browser window with the description of the highlighted parameter. You can move from this context-sensitive page to any page of the help system.
Note:
The Help (`*.chm`) file, included on the CD-ROM, also works in stand-alone mode.

Alternatively, you can open the help in the help menu or in the menu tree.

► Select the appropriate item in the help menu, or right-click in the application window.
Click "Menu" and select the appropriate help item.

A browser window opens, tiled into three panels. On top, several navigation are available scrolling through the help pages. On the left, a contents panel lists all topics, and the text panel aside describes the selected topic. The contents panel provides additional tabs with an index and a search function.

Links are highlighted in blue, and can be selected and called up using the mouse.



Frequency

Defines the frequency value of the reference clock.

Note: This parameter applies to R&S DiglConf and is relevant for the internal clock source.

The R&S EX-IQ-BOX supports different reference frequencies to be input at REF IN. This value must be set on the frequency currently supplied.

Provided values: 5 MHz, 10 MHz or 13 MHz.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:CLOCk:REFerence:FREQuency`

Fig. 6-1: R&S EX-IQ-BOX Configuration > help window

6.1.5.1 Navigation panel

Navigation softkeys on top of the help window provide browsing through the help pages.

- "Hide" / "Show"
  Display or hide the contents panel.
- "Previous" / "Next"

Scroll through the help pages. The sequence of the pages corresponds to their position in the dialogs.

- "Back" / "Forward"
  Switches to the previously opened help page and back again.
- Home
  Opens the first pge of the online help.
- Print
  Enables you to print the selected topic or all the topics in the selected heading.

6.1.5.2 Contents panel

The contents panel is divided into three tabs:

- "Contents"
  In the topics list you can select certain help pages individually. It is structured hierarchically. The highlighted topic indicates the currently displayed page.
- "Index"
  The index contains an alphabetical list of all terms which refer to functions of the application. The index is used to call up all pages which contain the selected entry. The index has an alphabetical structure. The associated help page can be opened by double click.
- "Search"
  The text search allows you to look for freely selectable terms in all help pages. A list of the pages containing the entered term is displayed as the search result.
  The content of the titles only for the complete help text can be searched for the entered term.

6.1.5.3 Text panel

Shows the help text and links to subtopics and the corresponding GPIB bus command. Internal links in the text open pages which directly relate to the described function.

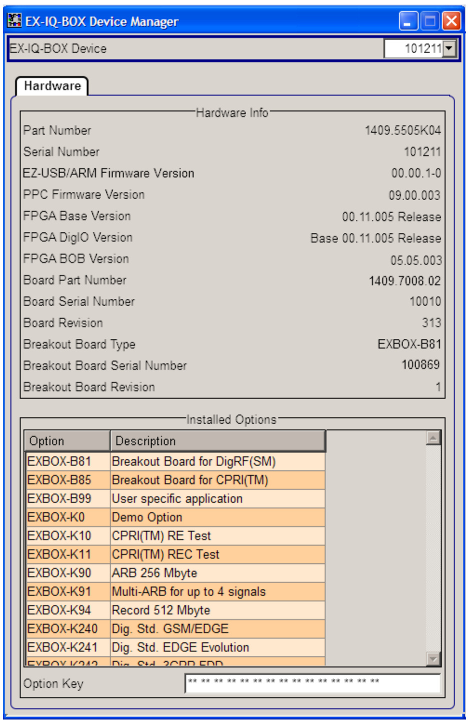
6.1.6 Configuration Dialogs

Select "Tools" > "Menu" and the corresponding menu item to access a configuration dialog.

6.1.6.1 EX-IQ-BOX Device Manager

This dialog displays information on the connected R&S EX-IQ-BOX, like, e.g. part number, serial number, firmware version, etc. and the installed options. Installing new options is done in this dialog.

The enhanced functionalities like standardized protocols or waveform memories are supported only by the R&S EX-IQ-BOX variant **1409.5505K04**. Hence, the "EX-IQ-BOX Device Manager" dialog varies in dependence of the variant.



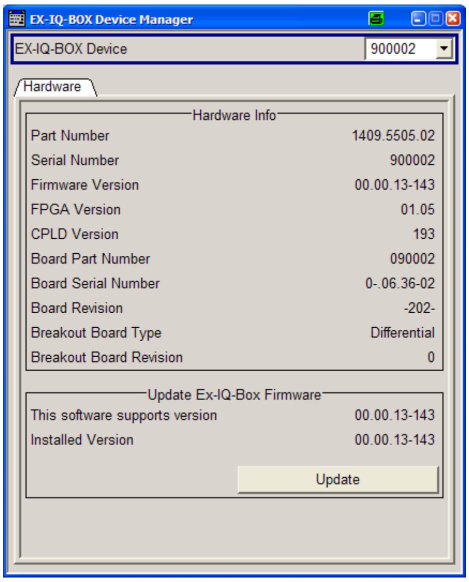
EX-IQ-BOX Device: 101211

Part Number	1409.5505K04
Serial Number	101211
EZ-USB/ARM Firmware Version	00.00.1-0
PPC Firmware Version	09.00.003
FPGA Base Version	00.11.005 Release
FPGA DiglO Version	Base 00.11.005 Release
FPGA BOB Version	05.05.003
Board Part Number	1409.7008.02
Board Serial Number	10010
Board Revision	313
Breakout Board Type	EXBOX-B81
Breakout Board Serial Number	100869
Breakout Board Revision	1

Option	Description
EXBOX-B81	Breakout Board for DigRF(SM)
EXBOX-B85	Breakout Board for CPRI(TM)
EXBOX-B99	User specific application
EXBOX-K0	Demo Option
EXBOX-K10	CPRI(TM) RE Test
EXBOX-K11	CPRI(TM) REC Test
EXBOX-K90	ARB 256 Mbyte
EXBOX-K91	Multi-ARB for up to 4 signals
EXBOX-K94	Record 512 Mbyte
EXBOX-K240	Dig. Std. GSM/EDGE
EXBOX-K241	Dig. Std. EDGE Evolution

Option Key: ** ** ** ** ** ** ** ** ** ** ** ** ** ** **

R&S EX-IQ-BOX 1409.5505K04



EX-IQ-BOX Device: 900002

Part Number	1409.5505.02
Serial Number	900002
Firmware Version	00.00.13-143
FPGA Version	01.05
CPLD Version	193
Board Part Number	090002
Board Serial Number	0-.06.36-02
Board Revision	-202-
Breakout Board Type	Differential
Breakout Board Revision	0
This software supports version	00.00.13-143
Installed Version	00.00.13-143

R&S EX-IQ-BOX 1409.5505.02

EX-IQ-BOX Device

The selection field "EX-IQ-BOX Device" lists each connected device.

The serial number of the device is used to identify a device. “Undefined” indicates that there is no R&S EX-IQ-BOX connected. For connection refer to chapter 4.5, "Connecting the R&S EX-IQ-BOX", on page 42.

SCPI command:

`[:SOURce<hw>]:EBOX:DEVice:CATalog` on page 295

`[:SOURce<hw>]:EBOX:DEVice:SELect` on page 299

Hardware Info

The hardware panel is related to the selectecd R&S EX-IQ-BOX and indicates various information, like part number, serial number, firmware version etc. and the installed options.

Hardware component	Information	Model-specific
"Part Number"	The part number of the R&S EX-IQ-BOX.	-
"Serial Number"	The serial number of the R&S EX-IQ-BOX.	-

Hardware component	Information	Model-specific
"EZ-USB/ARM Firmware Version"	The firmware version installed in the R&S EX-IQ-BOX.	-
"PPC Firmware Version"	The version of the built-in power PC.	R&S EX-IQ-BOX **1409.5505K04**
"FPGA (Base) Version"	The version of FPGA (**F**ield **P**rogrammable **G**ate **A**rray) basic design.	-
"FPGA DigIO Version"	The version of the digital interface standard.	R&S EX-IQ-BOX **1409.5505K04**
"FPGA BOB Version"	The version of the connected breakout board.	-
"CPLD Version"	The version of CPLD (Complex Programmable Logic Device).	R&S EX-IQ-BOX **1409.5505.02**
"Board Part Number"	The part number of the R&S EX-IQ-BOX´s internal board.	-
"Board Serial Number"	The serial number of the R&S EX-IQ-BOX´s internal board.	-
"Board Revision"	The revision number of the R&S EX-IQ-BOX´s internal board.	-
"Breakout Board Type"	The type of the connected breakout board.	-
"Breakout Board Serial Number"	The serial number of the connected breakout board.	R&S EX-IQ-BOX **1409.5505K04**
"Breakout Board Revision"	The revision number of the connected breakout board. The breakout board might be unplugged while the R&S EX-IQ-BOX is running. In this case, the R&S EX-IQ-BOX is deactivated, i.e. the protocol, if active, is also deactivated. The breakout board information is no longer indicated.	-

SCPI command:

`[:SOURce<hw>]:EBOX:DEVice:PART` on page 297
`[:SOURce<hw>]:EBOX:DEVice:CONTroller` on page 296
`[:SOURce]:EBOX:DEVice:SERial` on page 299
`[:SOURce<hw>]:EBOX:DEVice:PPCVersion` on page 297
`[:SOURce<hw>]:EBOX:DEVice:FPG:BASe` on page 296
`[:SOURce<hw>]:EBOX:DEVice:FPG:DIGio` on page 297
`[:SOURce<hw>]:EBOX:DEVice:FPG:BOB` on page 296
`[:SOURce<hw>]:EBOX:DEVice:CPLD` on page 296
`[:SOURce]:EBOX:DEVice:BOARd:PART` on page 297
`[:SOURce]:EBOX:DEVice:BOARd:SERial` on page 298
`[:SOURce]:EBOX:DEVice:BOARd:REVision` on page 298
`[:SOURce]:EBOX:DEVice:BOB:TYPe` on page 299
`[:SOURce]:EBOX:DEVice:BOB:SERial` on page 298
`[:SOURce]:EBOX:DEVice:BOB:REVision` on page 298

Installed Options

Lists all options the R&S EX-IQ-BOX is equipped with. The first column shows the R&S option type, and the second contains a short description.

Note: Only the R&S EX-IQ-BOX variant **1409.5505K04** supports the enlarged functionality of the additionally available options.

SCPI command:

`[:SOURce<hw>]:EBOX:OPT` on page 307

Response: `'EXBOX-B85`, `EXBOX-K10`, `EXBOX-K11`, `EXBOX-K90`, `EXBOXK242`, `...'`

License Key ← Installed Options

An R&S EX-IQ-BOX option is installed (just) by typing an license key.

For description on how to install a new option refer to chapter 4.6, "Installation of R&S EX-IQ-BOX Options", on page 44.

Update EX-IQ-BOX Firmware

This section is displayed in the device manager dialog of an R&S EX-IQ-BOX **1409.5505.02**. It indicates the installed as well as the currently available firmware version and provides an update.

FW versions	Information
"This software supports version"	Indicates the firmware available in the current software of the R&S DigIConf.
"Installed version"	Indicates the currently installed firmware version in the R&S EX-IQ-BOX.

SCPI command:

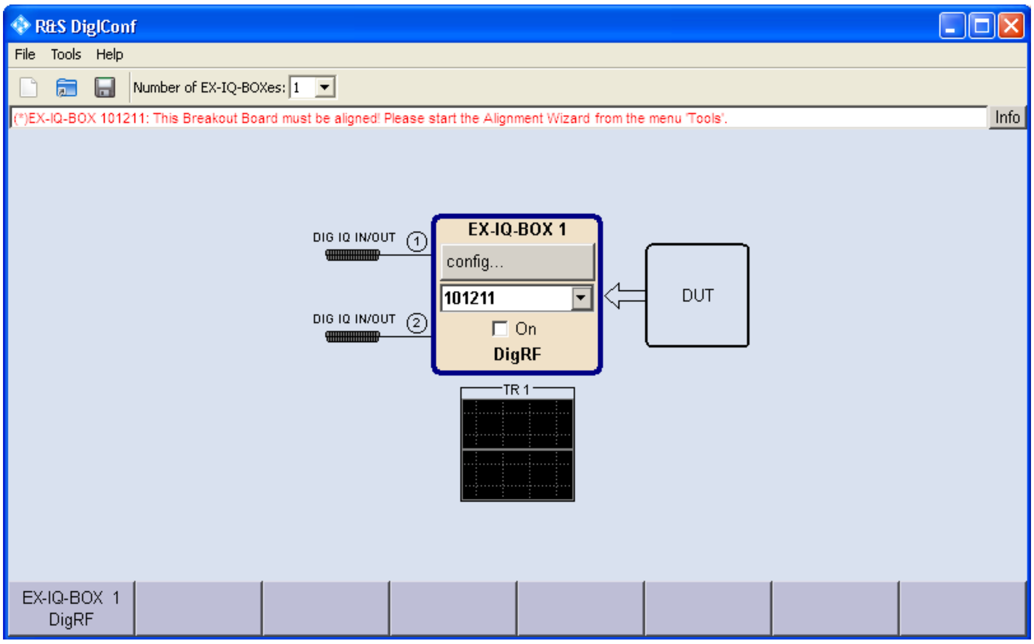
`[:SOURce]:EBOX:DEVice:FIRMware:SUPPorted` on page 299

Update

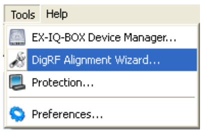
Executes an update of the firmware. R&S DigIConf starts the update and reports when it is completed.

6.1.6.2 Starting a Self Alignment

R&S DigIConf provides an alignment function for the DigRF TX1 output. When you connect a DigRF breakout board for the first time, R&S DigIConf prompts you to execute the alignment wizard. However, you can perform the alignment also at any later date.



(*)EX-IQ-BOX 101211: This Breakout Board must be aligned! Please start the Alignment Wizard from the menu 'Tools'.



Start DigRF Alignment Wizard

Performs an internal alignment on the DigRF 3G TX1 output.

Note: Before you start, make sure that the output of TX1 is not connected.

Welcome to the DigRF Alignment Wizard

Please select EX-IQ-BOX, disconnect all Tx1 connectors from DigRF Breakout Board and click "Next" button.

Select EX-IQ-BOX 101211

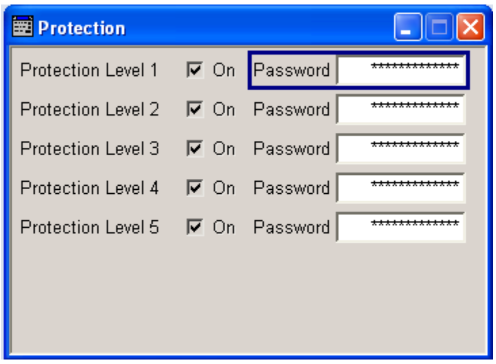
Follow the instructions of the wizard.

When finished, R&S DigIConf stores the correction values determined by the wizard in a `digrf_xxxxxx.clb` file in the application folder. `xxxxxx` represents the serial number of the breakout board, i.e. each breakout board has a separate file.

6.1.6.3 Protection

Protection

"Protection" enables activating or deactivating several protective levels to provide special functions like self test or specific tests for service purposes.



Protection Level 1 ☑ On Password **************

Protection Level 2 ☑ On Password **************

Protection Level 3 ☑ On Password **************

Protection Level 4 ☑ On Password **************

Protection Level 5 ☑ On Password **************

Protected functions are unlocked, when the correct password for the respective protection level is entered.

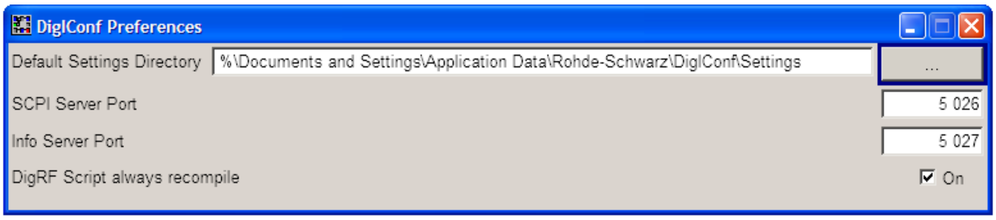
Unlock, for example, some self test routines, while you switch protective level 1 to unprotected. The password is 123456.

Note: Only personnel of R&S Service Departments are authorized to access level 2 and higher.
After Startup, all protection levels are activated.

SCPI command:
n.a.

6.1.6.4 Preferences

The preference dialog indicates the settings directory for default settings, and indicates the currently used server port.



Default Settings Directory %\Documents and Settings\Application Data\Rohde-Schwarz\DigIConf\Settings

SCPI Server Port 5 026

Info Server Port 5 027

DigRF Script always recompile ☑ On

Default Settings Directory
Select the directory that contains application-specific settings files.

Note:

- During installation, R&S DigIConf creates several directories, including the settings directory, which is scheduled for storing application settings. With this field you can individually select a directory with application-specific settings files.
- If you uninstall DigIconf, you can keep these files. The same applies if you update R&S DigIConf.

SCPI Server Port
Select the port address of the server for remote control.

Info Server Port
Sets the port address of the TCP/IP connection.

Provides information on TCP/IP connection on this port, such as parallel, locked, USB or LVDS.

DigRF Script always recompile
Compiles the currently loaded DigRF script every time you execute it. This switch is enabled by default.

Note: If you turn it off, a script is compiled only if the corresponding compiled file does not exist. This helps you to reduce measurement times, since the compilation step is not necessary.
But keep in mind that interim changes are not taken into account. In case of changes, you can compile the script directly in the editor.

6.1.6.5 Instrument on the R&S EX-IQ-BOX

This dialog covers information on the connected R&S instrument. In addition, R&S DigIConf provides the remote control of the instrument.

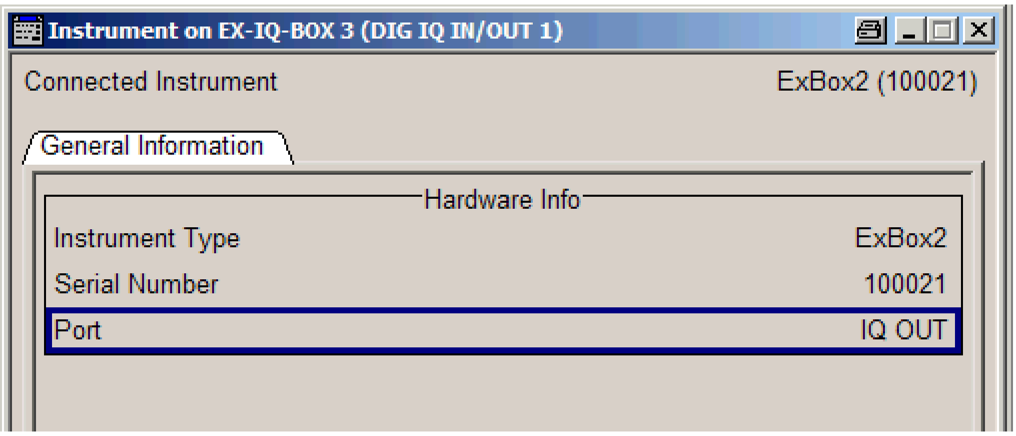
The instruments block and the configuration dialog are available, if an R&S instrument is connected.

R&S instruments can be remote controlled from an external PC via LAN (TCP/IP), GPIB or USB. This allows convenient operation of the instruments from R&S DigIConf, too. Settings are sent by R&S DigIConf into the instruments via SCPI commands, which are entered in the SCPI Interactive tab or the SCPI Scripting tab.

Refer to the operating manual of your R&S instrument for details to interfaces and programming for the remote control.

The dialog is accessed in the block of the connected instrument:

Click on the <instrument> button in the instrument block.



Instrument on EX-IQ-BOX 3 (DIG IQ IN/OUT 1)

Connected Instrument ExBox2 (100021)

Hardware Info

Instrument Type	ExBox2
Serial Number	100021
Port	IQ OUT

Connected Instrument

Indicates the name and serial number of the connected R&S instrument. These two parameters also appear as label on the <instrument> button of the instrument block.

The **General Information** tab, section **Hardware Information** displays hardware information of the connected instrument.

SCPI command:

`[:SOURce<hw>]:EBOX:INST<ch>:NAME` on page 308

Instrument Type

Displays the name of the connected instrument. The name is used for instrument identification within the program and is displayed in the <instrument> button of the instrument block.

SCPI command:

`[:SOURce<hw>]:EBOX:INST<ch>:TYPE` on page 309

Serial Number

The serial number of the connected R&S instrument. The ID is also is displayed in the <instrument> button of the instrument block.

SCPI command:

`[:SOURce<hw>]:EBOX:INST<ch>:SERial` on page 308

Port

The digital interface where the R&S instrument is connected.

SCPI command:

`[:SOURce<hw>]:EBOX:INST<ch>:PORT` on page 308

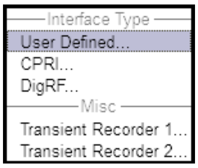
6.1.6.6 Transient Recorder

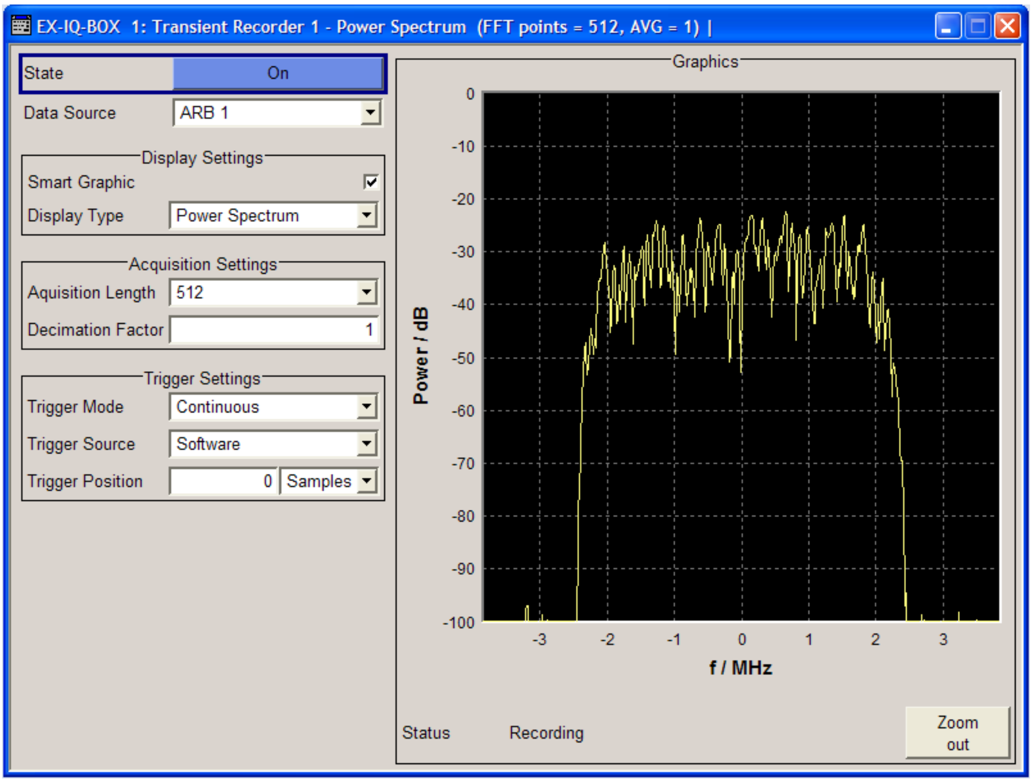
Two independent transient recorders provide monitoring the I/Q data flow through the R&S EX-IQ-BOX. You can record input signals, output signals and signals of the waveform memory. The graphical representation allows to quickly view and check the current signal characteristics.

The transient recorders are provided in the R&S EX-IQ-BOX 1409.5505K04.

The Transient Recorder configuration dialog is accessed in the "EX-IQ-BOX" block in the "Config..." menu.

► Click "Config..." and select "Transient Recorder <n>"





EX-IQ-BOX 1: Transient Recorder 1 - Power Spectrum (FFT points = 512, AVG = 1) |

State: On

Data Source: ARB 1

Display Settings

Smart Graphic: ☑

Display Type: Power Spectrum

Acquisition Settings

Aquisition Length: 512

Decimation Factor: 1

Trigger Settings

Trigger Mode: Continuous

Trigger Source: Software

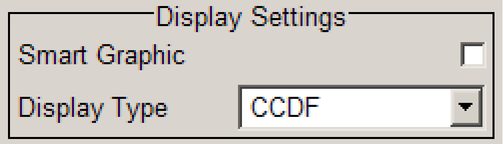
Trigger Position: 0 Samples

Status: Recording

Fig. 6-2: R&S DigIConf transient recorder

This dialog contains all parameters required for recording, as:

- "State" for activating
- "Data Source" to select the signal
- "Display Settings" to determine the type of display
  It enables to indicate a smart graphic in the main application window and offers different display types for graphical signal display.

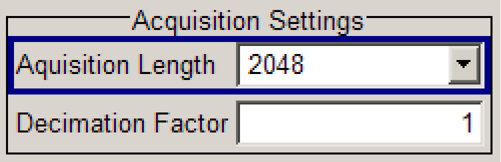


Display Settings

Smart Graphic: ☐

Display Type: CCDF

- "Acquisition Settings" for setting the capture length
  This section provides setting the length for recording or selecting a specific sample for recording.

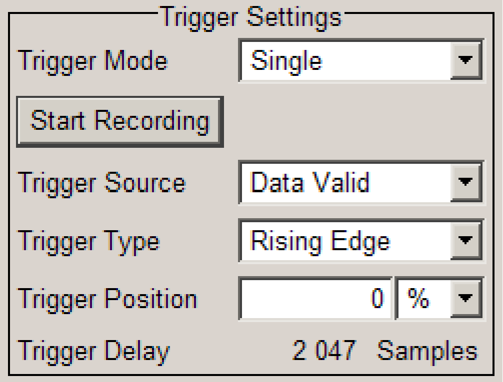


Acquisition Settings

Aquisition Length: 2048

Decimation Factor: 1

- "Trigger Settings" to configure the triggering mechanism for data acquisition
  The section contains the parameters for triggering the signal to be recorded.



Trigger Settings

Trigger Mode: Single

Trigger Source: Data Valid

Trigger Type: Rising Edge

Trigger Position: 0 %

Trigger Delay: 2 047 Samples

- The "Status" line indicates when recording is running.

State
Activates the selected transient recorder.

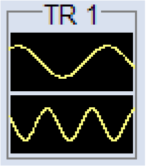
Note: Note that the R&S EX-IQ-BOX must be switched on for data recording.

After activation, the diagram selected with **Display Type** is displayed in the "Graphics" window.

Data Source
Selects the signal source of the I/Q data for recording.

Either signals directly fed in at the digital interfaces of the R&S EX-IQ-BOX, or signals generated from the waveform output memory can be recorded.

"DIG IQ IN 1"	Selects the signal fed in at the corresponding digital interface DIG I/Q IN/OUT 1.
"DIG IQ OUT 2"	Selects the signal assigned at the corresponding digital interface DIG I/Q IN/OUT 2 output.
"ARB 1 ... 4"	Records a signal played back from one of the waveform memories.
"USER INTERFACE"	Records the signal transmitted at the USER INTERFACE.
"Sine Testsignal"	Records the internally generated sine test signal.



Smart Graphic
Activates the display of a smart graphic.

Additionally to the graphics window in the dialog, R&S DigIConf shows the graphic in a smaller scale, i.e. as a **Smart graphic** in the main application window, directly below the corresponding "EX-IQ-BOX" block. It serves basic checks.

Note: Double click the smart graphic to open the transient recorder configuration dialog.

Display Type
Select the graphical signal display. Available diagram types to display the recorded data are **I/Q, Vector**, **CCDF** and **Power Spectrum** diagrams. The individual diagram types are described in chapter 6.1.6.7, "Graphical Signal Displays ", on page 77.

Acquisition Length

Select the number of samples to be captured by the transient recorder. The sample memory sizes 512, 1024 and 2048 MSamples are available.

Decimation Factor

Selects a certain sample to be recorded, i.e. only the nth sample is recorded.

Trigger Mode

Select the mode for triggering.

"Continuous"	Recording is automatically initiated and continues until the process is stopped manually. Recording is retriggered every 250ms. **Note:** Deactivate the recorder while switching off status.
"Single"	Records one signal flow until acquisition length is reached. Initiate a single trigger event by pressing the "Start Recording" button.

Start Recording

Manually initiate a trigger event to start recording the signal once.

Note: This button applies to "Single Trigger" mode.

Trigger Source

Sets the time for starting the recording. A trigger event can be initiated by the software itself or by hardware events.

Note: The control signals GP_0 ... GP_5 are part of the I/Q signal and transmitted via the digital I/Q interface of the R&S instrument.

"Software"	R&S DigIConf initiates the trigger event for recording. Recording starts automatically either within specified intervals, in continuous mode or by defined user events in single mode.
"Data valid"	The external control signal **Data Valid** initiates the recording of data.
"GP_0"	The "(Marker 0)" determines the beginning of recording.
"GP_1 "	(Reserve 0) triggers the recording.
"GP_2 "	(Trigger 0) triggers the recording.
"GP_3 "	(Trigger 1) triggers the recording.
"GP_4 "	(Marker 1) triggers the recording.
"GP_5 "	(Reserve 1) triggers the recording.

Trigger Type

Set the polarity of the signal to trigger data recording.

Note: "Trigger type" supports all hardware trigger sources like DATA VALID and GP_0..5. Trigger source "Software" does not use this parameter.

"Rising Edge"	The positive slope of the reference signal starts recording the I/Q data signal.
"Falling Edge"	The negative slope of the reference signal triggers recording.
"Low Level"	The low reference level of the signal triggers recording. Low level represents the logical 0.

"High Level"	Start recording as long as the reference signal level is high. High level corresponds to logical 1.

Trigger Position
The trigger position determines the position of the trigger event on the time-scale. The value is set in samples while a positive number <n> means the trigger event is at sample number <n>, a negative value means the trigger event was before the first sample.

Status
Indicates the current status of the transient recorder: "Stopped", or "Running".

6.1.6.7 Graphical Signal Displays

Different signal displays assist in evaluating and checking the I/Q data flow through the R&S EX-IQ-BOX.

I/Q Diagram

The I/Q diagram displays the inphase component (i[t]) and quadrature component (q[t]) of the I/Q signal over time. The diagram is displayed in a window with two separate coordinate systems. The coordinate systems have identical X and Y axes. The time in number of samples is plotted on the X axes, and the amplitude scaled to the peak envelope power (PEP) is plotted on the Y axes (minimum scaled amplitude = -1; maximum scaled amplitude = +1). The recording depth is 1 kSamples.

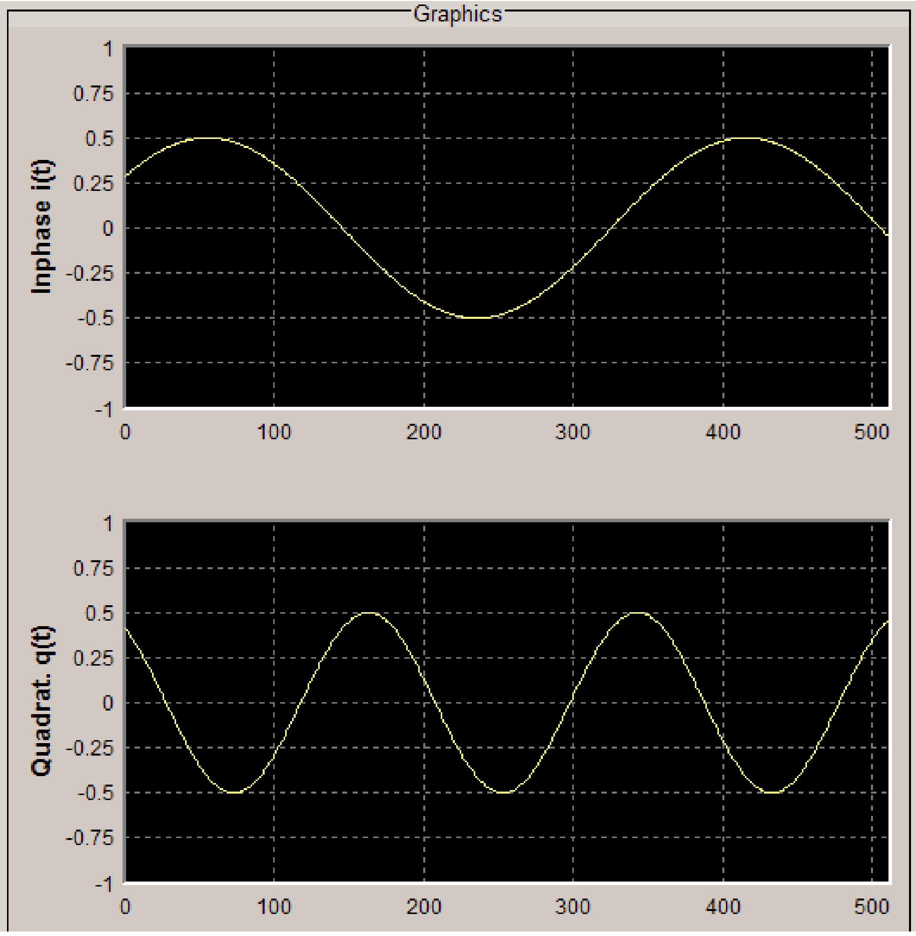


Fig. 6-3: R&S DigIConf signal graphics > I/Q diagram

Vector Diagram

The Q component is displayed over the I component in the vector diagram. Each point is determined by a vector. The amplitudes of the signal components scaled to the peak envelope power (PEP) are plotted on the X and Y axis (minimum scaled amplitude = -1; maximum scaled amplitude = +1).

This display shows the curves between the various states of modulation mapping. The recording depth is 1 kSamples.

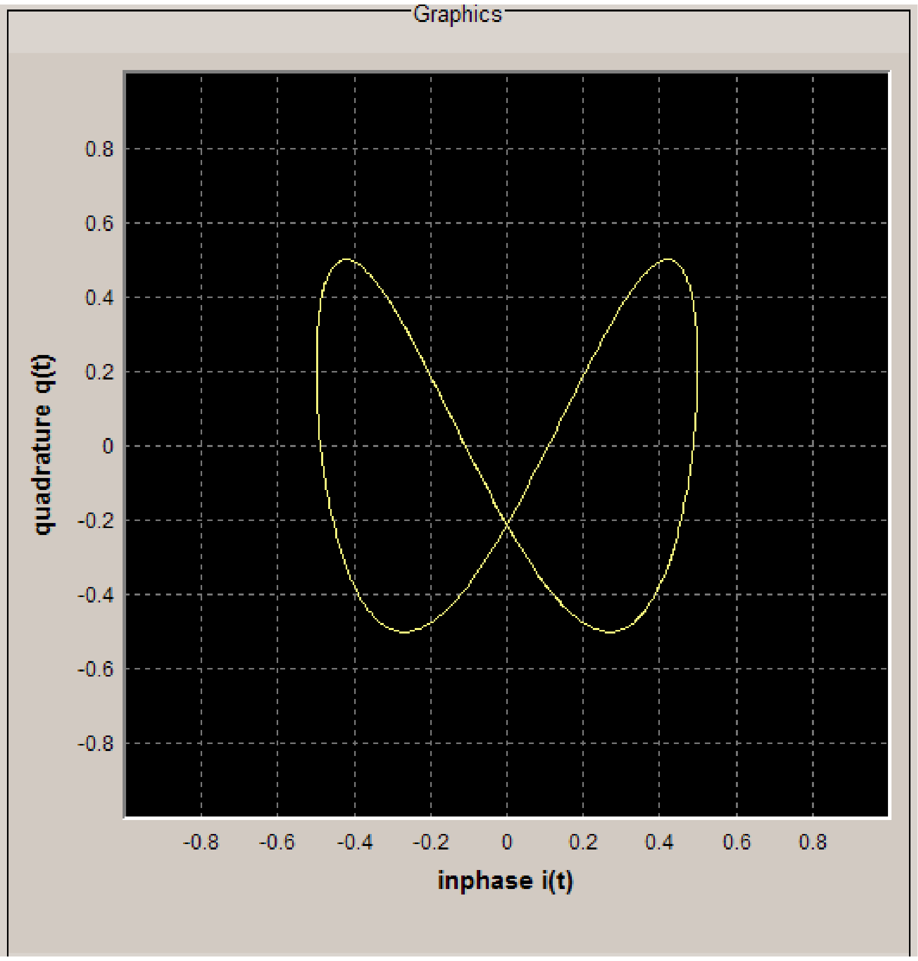


Fig. 6-4: R&S DigIConf signal graphics > Vector diagram

CCDF Display

The Complementary Cumulative Distribution Function shows the probability with which the output will exceed the average power. The level over the average power is plotted from 0 to 20 dB on the X axis; the average power corresponds to the origin. The probability of exceeding the average power is plotted between and 100% on the Y axis. The recording depth is 8 kSamples.

The point at which the CCDF curve intersects the X axis gives the crest factor of the signal.

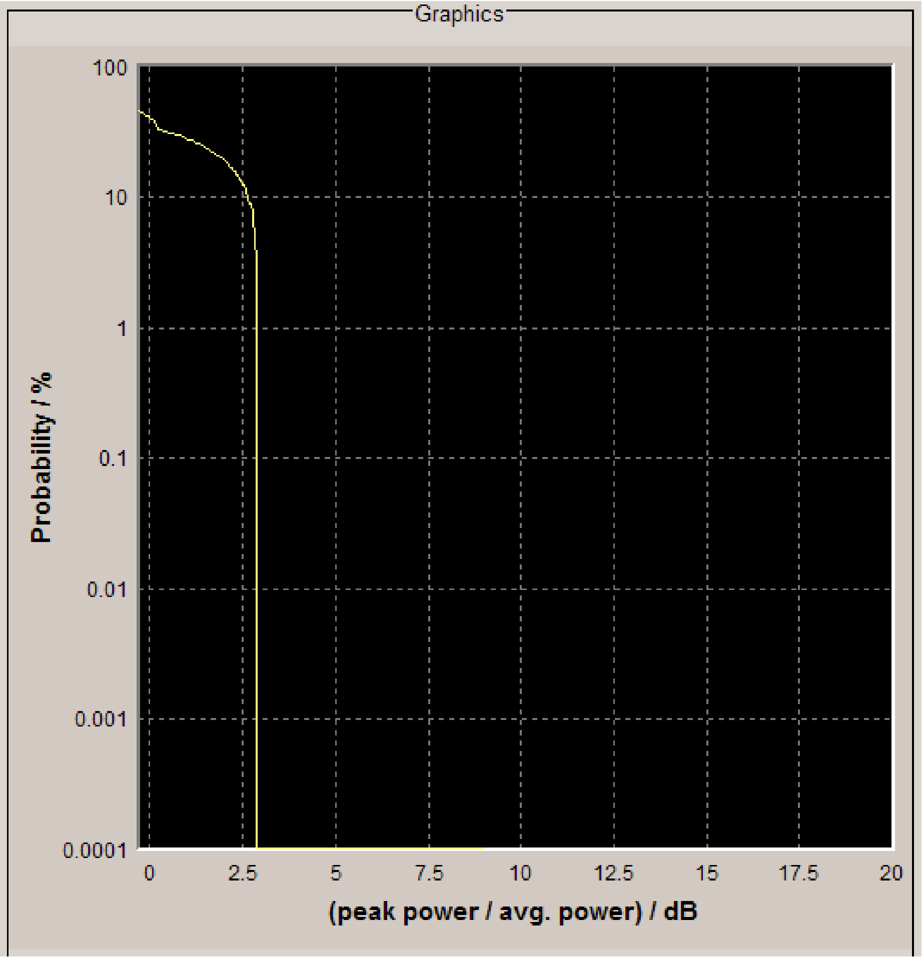


Fig. 6-5: R&S DigIConf signal graphics > CCDF display

Power Spectrum (FFT)

With the spectrum display, the signal spectrum is calculated from the I/Q signal by means of Fourier Transform (FFT). The power density over frequency is displayed. The power density is plotted on the Y axis, and frequency is plotted symmetrically on the X axis (-sampling rate/2 to +sampling rate/2). FFT Points indicates the number of I/Q value pairs which are used for calculating a (part-)FFT. AVG indicates number of subspectra used for averaging. The recording depth is 8 kSamples.

The spectrum display of the output signal is particularly suitable for checking multi carrier signals.

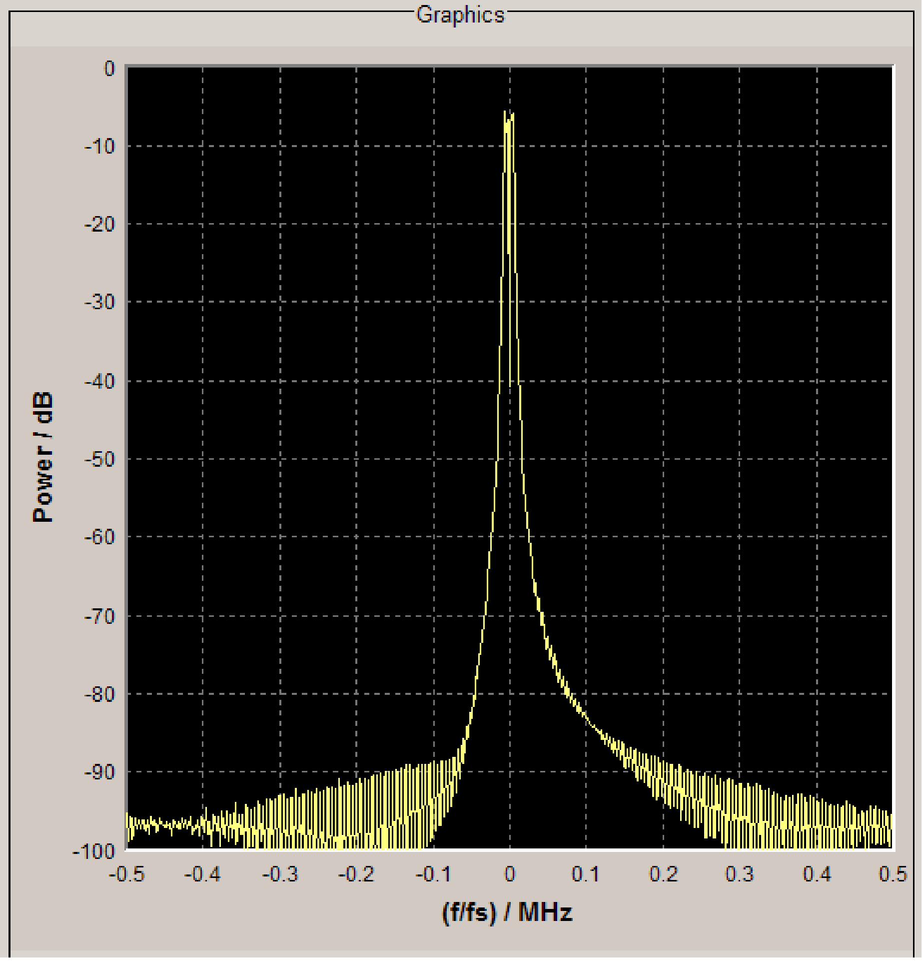


Fig. 6-6: R&S DigIConf signal graphics > Power spectrum

6.1.7 Connected R&S EX-IQ-BOX

This section describes how a connected R&S EX-IQ-BOX is indicated in R&S DigIConf.

6.1.7.1 Connection

For controlling the R&S EX-IQ-BOX with R&S DigIConf, the R&S EX-IQ-BOX must be connected to the PC via USB. The connection of the R&S EX-IQ-BOX to the PC and the instrument is described in detail in chapter 4.5, "Connecting the R&S EX-IQ-BOX", on page 42.

6.1.7.2 Indicating the R&S EX-IQ-BOX in R&S DigIConf

By the connection of an R&S EX-IQ-BOX, R&S DigIConf recognizes the device automatically and shows the following message in the **Info line**.

EX-IQ-BOX connected on USB

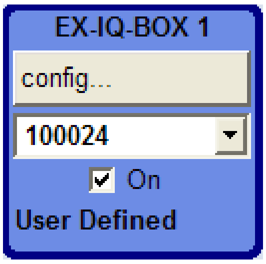
► Select a serial number from the list to assign the R&S EX-IQ-BOX to the block.

Undefined
100024

A device can be assigned only once, i.e. it is then grayed out in the lists of the other blocks. If no R&S EX-IQ-BOX is connected or an assigned R&S EX-IQ-BOX is disconnected, "Undefined" is indicated automatically.

R&S DigIConf shows a connected R&S EX-IQ-BOX as follows:

- the "EX-IQ-BOX" function block shows the serial number

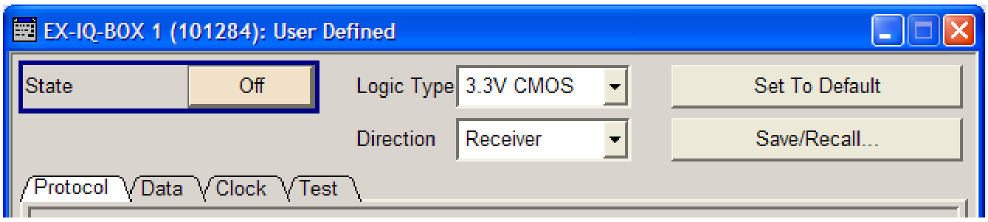


EX-IQ-BOX 1
config...
100024
☑ On
User Defined

Fig. 6-7: R&S DigIConf > serial number of the R&S DigIConf in the function block

R&S DigIConf shows the serial numbers of all connected R&S EX-IQ-BOXes in the device list of each function block.

- the header of all "settings dialogs" indicates the serial number

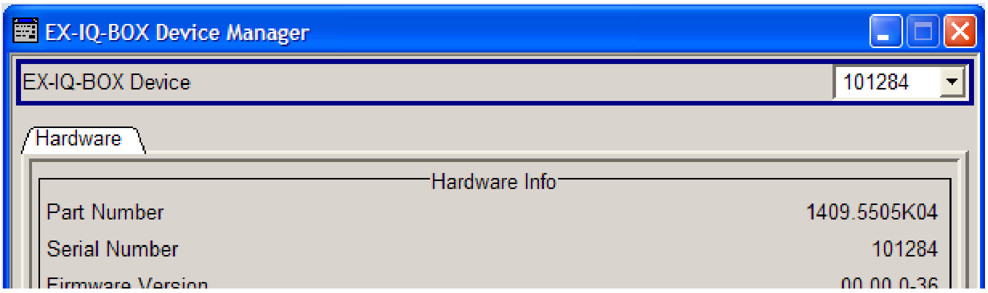


EX-IQ-BOX 1 (101284): User Defined

State: Off
Logic Type: 3.3V CMOS
Direction: Receiver

Fig. 6-8: R&S EX-IQ-BOX serial number in the header of dialogs

- the "EX-IQ-BOX Device Manager"



EX-IQ-BOX Device Manager

EX-IQ-BOX Device: 101284

Hardware Info

Part Number	1409.5505K04
Serial Number	101284
Firmware Version	00.00.0-36

Fig. 6-9: R&S EX-IQ-BOX hardware information in the device manager

This dialog provides detailed information on the hard- and firmware, see chapter 6.1.6.1, "EX-IQ-BOX Device Manager", on page 66

6.1.7.3 Transmitting I/Q Data

The I/Q data transmission between the R&S instruments and DUT via the R&S EX-IQ-BOX starts by switching on in the protocol settings dialogs or by ticking the checkbox of the R&S EX-IQ-BOX function block.

Data transmission requires that the respective option is installed and the corresponding breakout board is connected.

6.1.8 Connected R&S Instruments

A test setup usually operates with one or more R&S instruments for generating signals or evaluating results. This section explains how R&S DigIConf indicates a connected R&S instrument.

6.1.8.1 Connection

The connection to an R&S instrument is established via the digital I/Q interface DIG IQ IN/OUT.

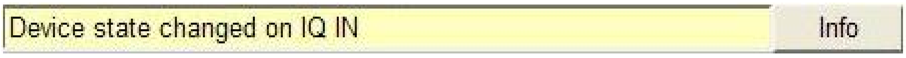
An R&S instrument has to be equipped with an option for digital baseband input or output, respectively. Refer to the corresponding internet site of your instrument for information on the available options.

Additionally, the R&S EX-IQ-BOX controlled by R&S DigIConf, i.e. it must be connected to the controlling PC via USB.

The connection of the R&S EX-IQ-BOX to the PC and the instrument is described in detail in chapter 4.5, "Connecting the R&S EX-IQ-BOX", on page 42.

6.1.8.2 Indicating the R&S Instrument in R&S DigIConf

By the connection, R&S DigIConf recognizes the R&S instrument automatically and shows the following message in the **Info line**.



Device state changed on IQ IN

The button in the instruments block is labeled with the name and the device ID of the instrument.

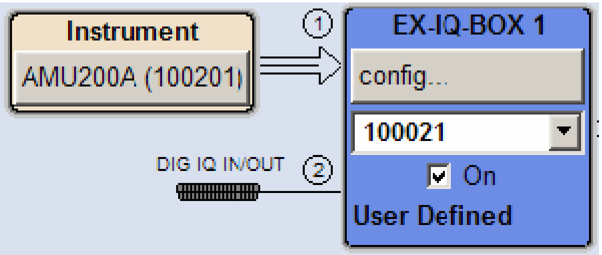


Fig. 6-10: R&S DigIConf > R&S instrument function block

R&S DigIConf indicates a connected R&S instrument as follows:

- it shows an "Instrument" function block with a softkey, labeled with product name and device ID (serial number).
- "Input/Output" symbols show the currently used inputs and outputs
- "Arrows" indicate the signal flow.

► Click "<instrument>" to open the "Instrument on EX-IQ-BOX <n> (<connector>)" dialog box.

Connected Instrument AMU200A (100201)

Fig. 6-11: R&S DigIConf > Instrument on EX-IQ-BOX... dialog box

R&S DigIConf displays the procuct name and device ID of the connected R&S instrument in the header of this dialog box, described in chapter 6.1.6.5, "Instrument on the R&S EX-IQ-BOX", on page 72.

Indication of an R&S EX-IQ-BOX in the R&S Instrument

After establishing the data connection, the R&S EX-IQ-BOX is also indicated in the R&S instrument. In R&S signal generators, the ID (serial number) is shown in the "Connected Device" field of the digital IQ input/output dialogs. Analyzers indicate the respective R&S EX-IQ-BOX information in the "EXBoxStatus" field.

6.1.9 Automation of R&S DigIConf

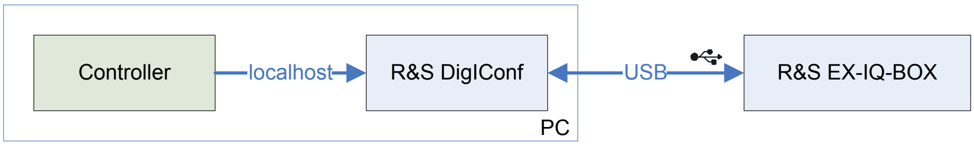
In addition to the usual control of the R&S EX-IQ-BOX using the R&S DigIConf interface, the entire system can be remotely controlled.

It is particularly useful for repeating measurement sequences reproducible, e.g. to achieve higher configuration speeds or to perform complex test setups.

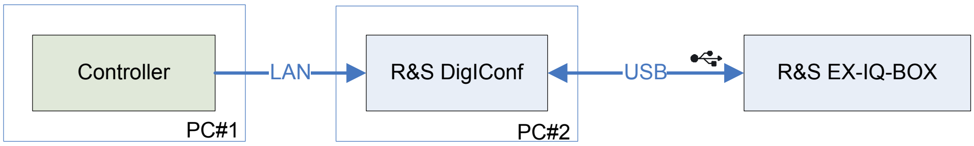
In remote mode, the software is remotely controlled by a controller. Each PC with the required remote control software installed can act as a controller. You only need a LAN connection to the PC with R&S DigIConf.

Possible remote control configurations are:

- Controller and R&S DigIConf installed on the same PC



- Controller and R&S DigIConf running on separate PCs:



Refer to chapter 8.1.3, "Starting a Remote Control Session", on page 271 for information on how to get started and how to establish a remote control connection between the controller and the software.

The remote control mode controls R&S DigIConf with commands following the **SCPI** (**S**tandard **C**ommands for **P**rogrammable **I**nstruments) standard.

Find a detailed description of the SCPI commands available for R&S DigIConf in chapter 9, "Remote Control Commands", on page 292. The remote control commands related to the transmission protocols are described in detail after each functional unit.

For background information on the SCPI command structure and basic information on operating the R&S DigIConf software via remote control, refer to chapter 8, "Remote Control Basics", on page 269.

6.2 Configuration via R&S Instruments

This chapter describes how you configure the R&S EX-IQ-BOX directly in a R&S instrument. It explains connection, indication and data transmission separately for each instrument family.

- chapter 6.2.1, "R&S Signal Generators", on page 86 contains general information on the connection and operation with the R&S signal generators, the block diagram and the configuration dialogs.
- chapter 6.2.2, "R&S Signal Analyzers", on page 91 contains general information on connection and operation with R&S signal analyzers and shows the display and configuration dialogs.
- chapter 6.2.3, "R&S Protocol Tester", on page 96 always control the R&S EX-IQ-BOX via R&S DigIConf. Therefore, this chapter contains references to the relevant information.

Direct configuration via R&S Instruments applies to the previous model of the R&S EX-IQ-BOX **1409.5502.02** and User Defined applications.

The R&S EX-IQ-BOX **1409.5505K04** is always controlled by R&S DigIConf.

Some R&S instruments, as e.g. the R&S CMW500 may also directly control the R&S EX-IQ-BOX, but in this case, operation is only possible with R&S DigIConf. Check in the operating manual to see if your instrument supports this mode of operation. How to operate R&S DigIConf in general refer to chapter 6.1, "R&S DigIConf Configuration Software", on page 54.

The protocol settings are described in chapter 7.1, "User Defined", on page 98, where you also find links to the corresponding remote commands, described in chapter 9.3, "User Defined - Remote Control Commands", on page 313.

6.2.1 R&S Signal Generators

The information in this section applies to R&S SMx and R&S AMU Signal Generators.

The R&S EX-IQ-BOX **1409.5502.02** can be controlled directly by an R&S signal generator only in a "User Defined" application. Test cases of standardized protocols require R&S DigIConf.

An R&S instrument must be equipped with the option for digital baseband input or output, respectively. The R&S EX-IQ-BOX is then connected at the digital interface **Baseband Digital IN** or **Out** of the R&S instrument.

You find a short overview on the instruments and the appropriate options in chapter 3.2.5, "R&S Instruments Working with the R&S EX-IQ-BOX", on page 25. Refer to the R&S website for latest information.

The configuration is performed in the signal generator´s configuration dialogs. Accessing the dialogs is described in chapter 6.2.1.3, "Dialogs", on page 89 and the settings in chapter 7.1, "User Defined", on page 98.

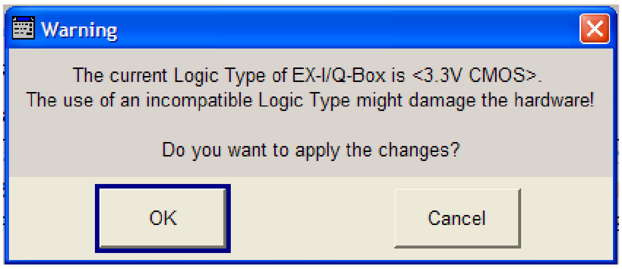
NOTICE

Risk of hardware damage

Digital, electrical signals base on various logical technologies, such as TTL or CMOS with several voltage levels. Therefore, the signal settings in the R&S EX-IQ-BOX must correspond to the signal, in both, the logical standard as well as the voltage value.

Any deviations may damage the DUT or the R&S EX-IQ-BOX.

A change of the logic type during the operation is performed only when you confirm the following warning message:



The current Logic Type of EX-I/Q-Box is <3.3V CMOS>.
The use of an incompatible Logic Type might damage the hardware!

Do you want to apply the changes?

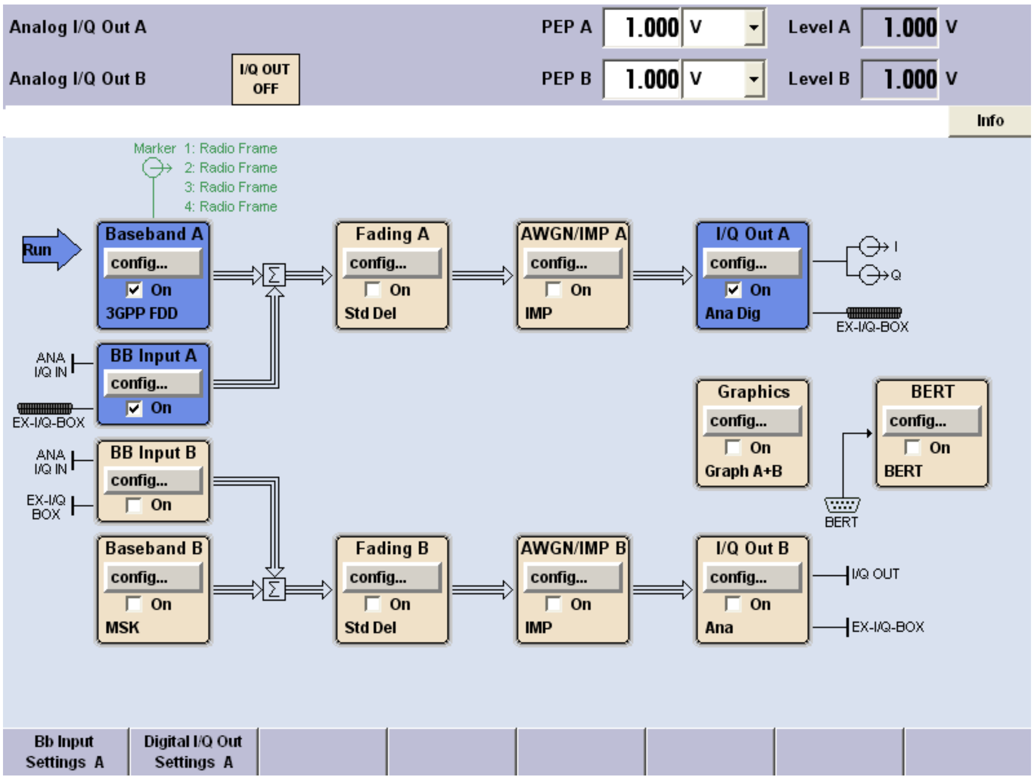
- Check the voltage values of your test setup.
- Select "OK" if the correct logic type is selected.
- Select "Cancel" if an incompatible logic type is selected. Adjust your setup accordingly and set correct logic type in the main configuration dialog for User Defined protocols, see "Logic Type" on page 101 .

6.2.1.1 Connection

► Establish the USB and LVDS connection between the R&S EX-IQ-BOX and the R&S signal generator, as described in chapter 4.5, "Connecting the R&S EX-IQ-BOX", on page 42.
The R&S EX-IQ-BOX can be connected or disconnected while the R&S instrument is in operating mode.

6.2.1.2 Indication of the R&S EX-IQ-BOX in an R&S Signal Generator

The graphical user interfaces (GUIs) of the signal generators R&S AMU200A, R&S SMU200A and R&S SMJ100A display the architecture and the signal flow in a block diagram. If an R&S EX-IQ-BOX is connected, the R&S instrument recognizes this device automatically, and marks the connection in the block diagram accordingly.



Analog I/Q Out A PEP A 1.000 V Level A 1.000 V

Analog I/Q Out B PEP B 1.000 V Level B 1.000 V

Fig. 6-12: Display of the R&S AMU 200A Baseband Signal Generator and Fading Simulator

The shown diagrams represent the block diagram of an R&S AMU200A baseband signal generator. RS SMx signal generators with RF signal path show the same baseband input block, but the digital I/Q signal output is assigned to the AWGN/IMP block. They do not have a separate output block as the AMU.

Once the R&S EX-IQ-BOX is connected via USB, the generator detects it and displays the following:

- "Info Line"
  The signal generator establishes the connection and reports it in the info line.

EX_IQ_BOX connected to USB; establish connection

Fig. 6-13: R&S signal generator > establish R&S EX-IQ-BOX connection

- "Symbol in the block diagram"
  The generator shows a symbol labeled with "EX-IQ-BOX" in the block diagram.

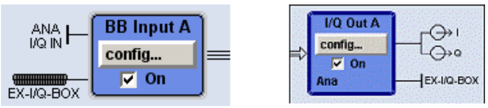
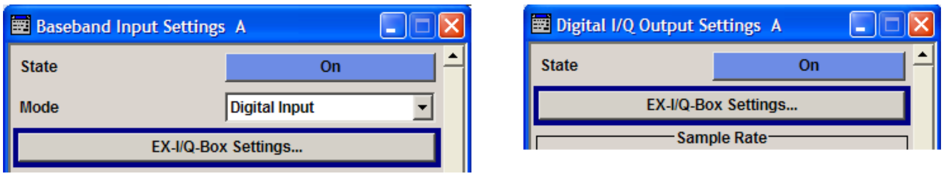


Fig. 6-14: Indication of an R&S EX-IQ-BOX in a generator block diagram at the example of the R&S AMU200A

- "Baseband Input Settings" or "Digital I/Q Output Settings" dialogs
  - The button "EX-I/Q-BOX Settings..." appears, providing access to the R&S EX-IQ-BOX settings dialogs.


Baseband Input Settings A

State On

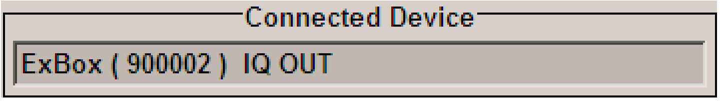
Mode Digital Input

Digital I/Q Output Settings A

State On

Fig. 6-15: R&S EX-IQ-BOX button in a signal generators digital input / output settings dialogs

– The ID (serial number) of the connected R&S EX-IQ-BOX is shown in the "Connected Device" information field.


Connected Device

ExBox (900002) IQ OUT

If you unplug the R&S EX-IQ-BOX, the generator changes its display accordingly:

- Symbol in the block diagram
  The instrument automatically closes the associated active R&S EX-IQ-BOX dialogs and shows the common symbol "DIG I/Q IN" or "DIG I/Q OUT".

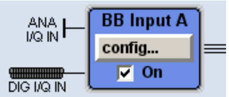


Fig. 6-16: R&S signal generator standard symbol of the digital interface.

6.2.1.3 Dialogs

The R&S EX-IQ-BOX settings are accessed via the main settings dialogs "Baseband Input Settings" or "Digital I/Q Output Settings" of the associated function block.

- The setting parameters for the R&S EX-IQ-BOX are identical for baseband input and output, but there is a separate dialog for each direction, indicated in the header.
- In the remote control signal direction is determined in the command syntax.
- The parameters are described in chapter 7.1, "User Defined", on page 98 and the remote control commands in chapter 9.3, "User Defined - Remote Control Commands", on page 313 .

1. To access the settings dialog, click "Config..." of the corresponding block and select the associated settings entry in the menu list.

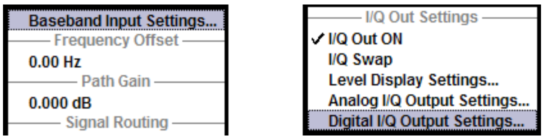
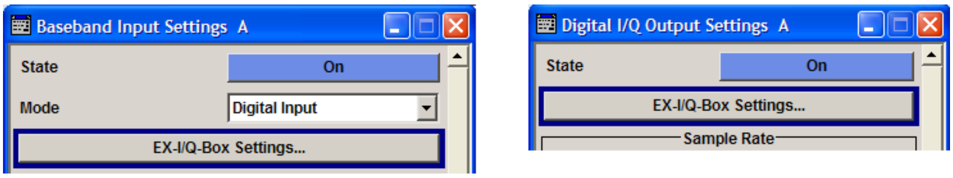


Fig. 6-17: Digital input / output menus of signal generators

Either the dialog "Baseband Input Settings" or "Digital I/Q Output Settings" opens.



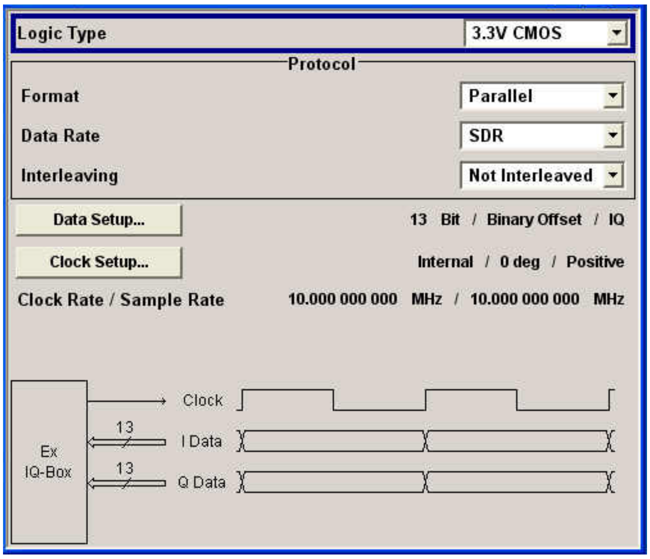
State On

Mode Digital Input

State On

Fig. 6-18: R&S EX-IQ-BOX button in a signal generators digital input / output settings dialogs

2. Click the "EX-I/Q-Box Settings..." button to open the main settings dialog of the R&S EX-IQ-BOX.



Logic Type 3.3V CMOS

Format Parallel

Data Rate SDR

Interleaving Not Interleaved

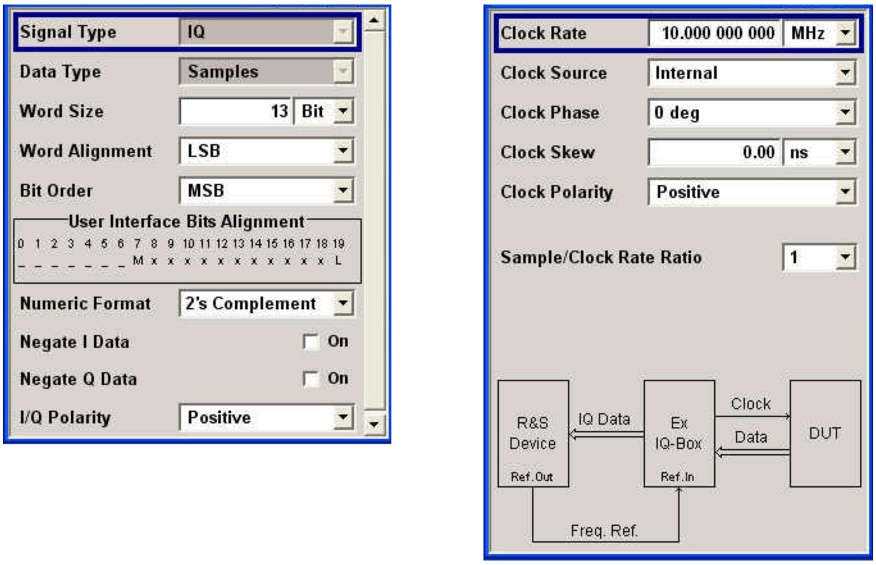
13 Bit / Binary Offset / IQ

Internal / 0 deg / Positive

Clock Rate / Sample Rate 10.000 000 000 MHz / 10.000 000 000 MHz

Fig. 6-19: Main settings dialog of the R&S EX-IQ-BOX in R&S signal generators

The main configuration dialog provides "Logic Type" and "Protocol" parameters. Corresponding to the current settings the I/Q data and clock signals are displayed graphically in the lower section of the dialog.
The buttons "Data Setup" and "Clock Setup" provide access to the respective subdialogs.



Signal Type IQ
Data Type Samples
Word Size 13 Bit
Word Alignment LSB
Bit Order MSB

User Interface Bits Alignment
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
_ _ _ _ _ _ _ M x x x x x x x x x x x L

Numeric Format 2's Complement
Negate I Data ☐ On
Negate Q Data ☐ On
I/Q Polarity Positive

Clock Rate 10.000 000 000 MHz
Clock Source Internal
Clock Phase 0 deg
Clock Skew 0.00 ns
Clock Polarity Positive
Sample/Clock Rate Ratio 1

Fig. 6-20: R&S EX-IQ-BOX Data Setup and Clock Setup dialogs

The "Data Setup" dialog enables to define the mode for data transmission. The currently set bits alignment at the user interface is indicated graphically.
The "Clock Setup" dialog contains all clock settings required for User Defined protocols. The lower area indicates clock and data signal direction in a block diagram

6.2.1.4 I/Q Data Transmission

Signal transmission starts when you turn on the "Status" in the **Baseband Input / Digital I/Q Output** settings dialogs.

6.2.2 R&S Signal Analyzers

The information in this section applies to R&S FSx and R&S FMU Signal Analyzers.

The R&S EX-IQ-BOX "1409.5502.02" can be controlled directly by an R&S signal analyzer in a "User Defined" application. Test cases of standardized protocols require R&S DiglConf.

An R&S signal analyzer must be equipped with the digital baseband interface option R&S FSQ-B17. The R&S EX-IQ-BOX is then connected to this digital interface.

The R&S EX-IQ-BOX is connected either only to the R&S signal analyzer, or additionally to a PC.

The configuration is performed in the signal analyzer´s configuration dialogs. Accessing the dialogs is described in chapter 6.2.2.3, "Dialogs", on page 94 and the settings in chapter 7.1, "User Defined", on page 98.

NOTICE

Risk of hardware damage

Digital, electrical signals base on various logical technologies, such as TTL or CMOS with several voltage levels. Therefore, the signal settings in the R&S EX-IQ-BOX must correspond to the signal, in both, the logical standard as well as the voltage value.

Any deviations may damage the DUT or the R&S EX-IQ-BOX.

6.2.2.1 Connection

► Establish the USB and LVDS connection between the R&S EX-IQ-BOX and the R&S signal analyzer, as described in chapter 4.5, "Connecting the R&S EX-IQ-BOX", on page 42.
The R&S EX-IQ-BOX can be connected or disconnected while the R&S signal analyzer is in operating mode.

6.2.2.2 Indication of the R&S EX-IQ-BOX in an R&S Analyzer

The graphical user interfaces (GUIs) of the signal analyzers R&S FSQ, R&S FSG and R&S FMU36 display measurement results in diagram and several hotkeys located at the right and lower edges of the display. If an R&S EX-IQ-BOX is connected, provided, the appropriate option R&S FSQ-B17 is installed, the R&S signal analyzer recognizes this device automatically.

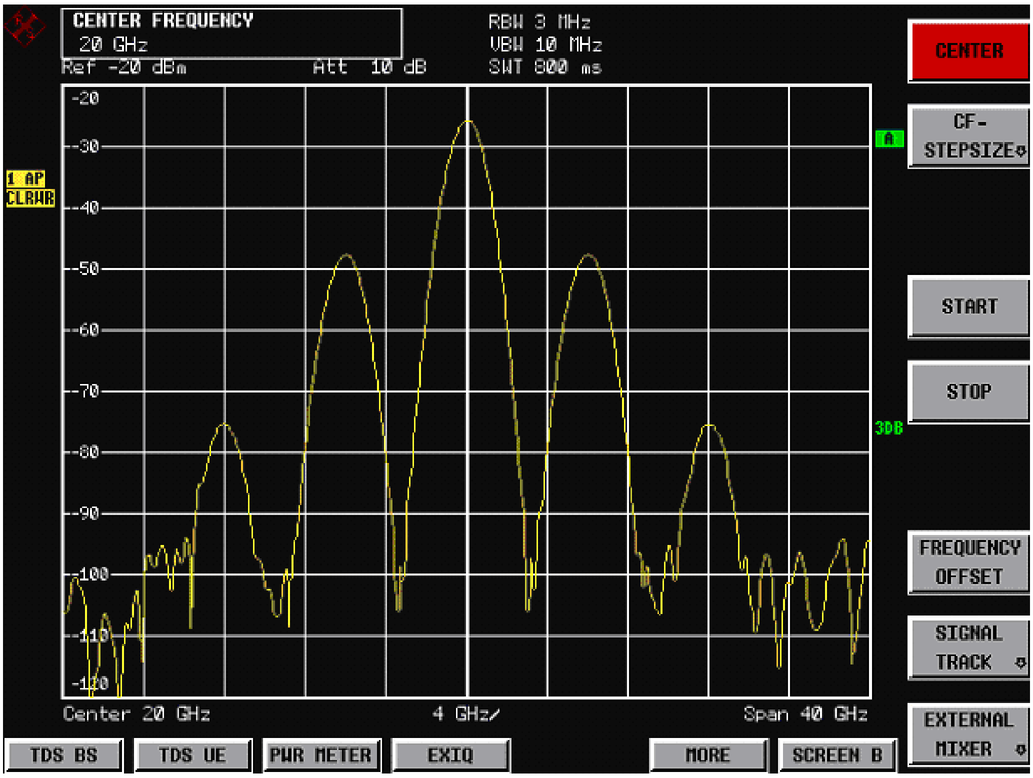
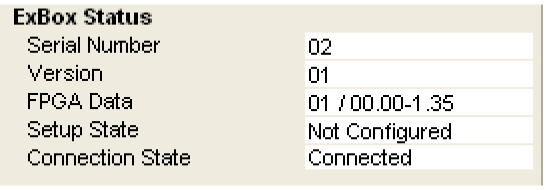

CENTER FREQUENCY
20 GHz
Ref -20 dBm Att 10 dB
RBW 3 MHz
VBW 10 MHz
SWT 800 ms
Center 20 GHz 4 GHz/ Span 40 GHz

Fig. 6-21: Display of the R&S FSQ Signal Analyzer with R&S FSQ-B17 option

Once the R&S EX-IQ-BOX is connected via USB, the signal analyzer detects it, establishes the connection and displays the following:

- "EXIQ" hotkey
  The R&S signal analyzer indicates a hotkey labeled "EXIQ".
- "ExBox Status" parameters
  The R&S signal analyzer updates the status fields and displays information on the connected R&S EX-IQ-BOX.

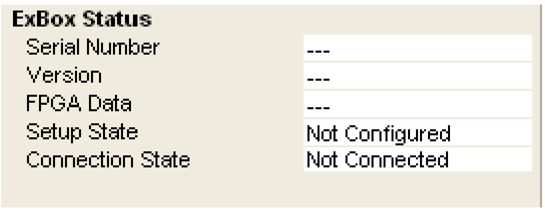

ExBox Status

Serial Number	02
Version	01
FPGA Data	01 / 00.00-1.35
Setup State	Not Configured
Connection State	Connected

Fig. 6-22: ExBox Status information in an R&S signal analyzer

If you unplug the R&S EX-IQ-BOX, the signal analyzer changes its display accordingly:

- "EXIQ" hotkey
  The hotkey dissapears.
- "ExBox Status" parameters
  The analyzer clears the **ExBox Status** information



ExBox Status

Serial Number	---
Version	---
FPGA Data	---
Setup State	Not Configured
Connection State	Not Connected

Fig. 6-23: ExBox Status > Not connected

Unplugging the I/Q data connector while the digital interface is active, may cause unexpected results.

First disable the digital interface before you unplug the I/Q interface connector.

Refer also to the manual of your R&S signal analyzer for description.

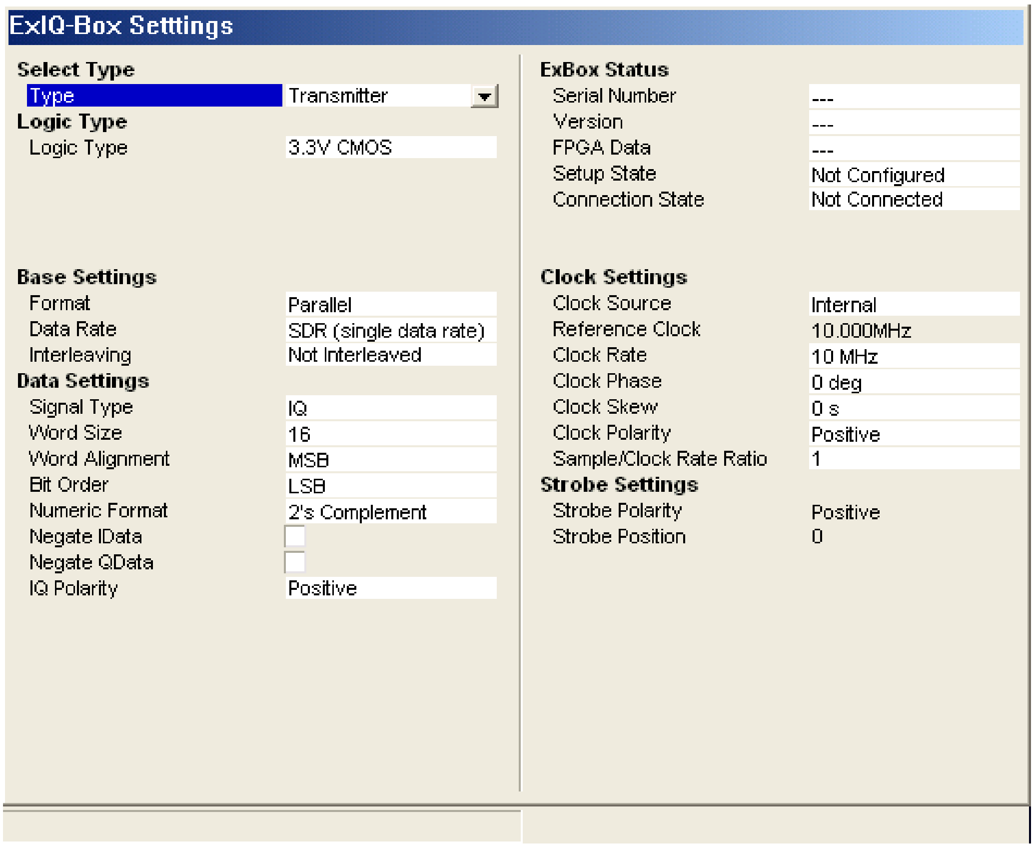
6.2.2.3 Dialogs

The R&S EX-IQ-BOX settings are accessed by pressing the "EXIQ" hotkey.

The configuration dialog "ExIQ-Box Settings" opens.

The "ExIQ-Box Settings" dialog is valid for baseband input and output.

The parameters are described in chapter 7.1, "User Defined", on page 98 and the remote control commands in chapter 9.3, "User Defined - Remote Control Commands", on page 313 .



ExIQ-Box Setttings

Select Type

Type	Transmitter

Logic Type

Logic Type	3.3V CMOS

Base Settings

Format	Parallel
Data Rate	SDR (single data rate)
Interleaving	Not Interleaved

Data Settings

Signal Type	IQ
Word Size	16
Word Alignment	MSB
Bit Order	LSB
Numeric Format	2's Complement
Negate IData	☐
Negate QData	☐
IQ Polarity	Positive

ExBox Status

Serial Number	---
Version	---
FPGA Data	---
Setup State	Not Configured
Connection State	Not Connected

Clock Settings

Clock Source	Internal
Reference Clock	10.000MHz
Clock Rate	10 MHz
Clock Phase	0 deg
Clock Skew	0 s
Clock Polarity	Positive
Sample/Clock Rate Ratio	1

Strobe Settings

Strobe Polarity	Positive
Strobe Position	0

Fig. 6-24: Settings dialog of the R&S EX-IQ-BOX in R&S signal analyzers

The "ExIQ-Box Settings" dialog provides all parameters for User Defined protocols, structured in several sections, as "Select Type" for direction, "Logic Type" and "Base Settings", "Data Settings", "Clock Settings" and "Strobe Settings". Section **ExBox Status** informs on the connected R&S EX-IQ-BOX.

Select Type

Select the direction path, i.e. "Receiver" or "Transmitter" for data transmission.

To toggle between the different types, press the "TX SETTINGS" or "RX SETTINGS" softkey. This parameter corresponds to "Direction" in R&S DigIConf.

Exit

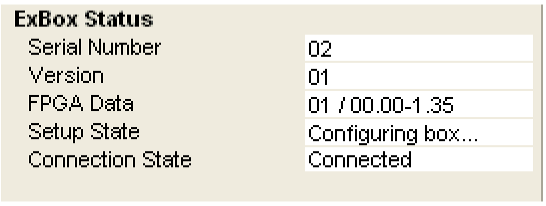
Press the "EXIT" to leave the configuration dialog.

Store

All parameters of the R&S EX-IQ-BOX are stored and available again after switching the analyzer off and on.

It is also possible to save the settings with the "Save/Recall" Manager.

The setup of the new data may take up to 15 seconds, especially if you have changed the logic type. During the configuration the analyzer indicates in the "Setup State" field that the configuration is in progress. During configuration, you can not perform any settings.

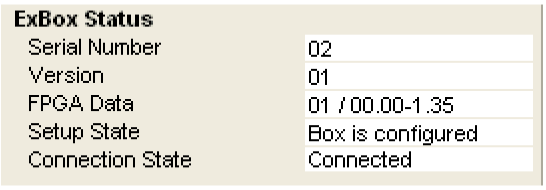


ExBox Status

Serial Number	02
Version	01
FPGA Data	01 / 00.00-1.35
Setup State	Configuring box...
Connection State	Connected

Fig. 6-25: ExBox Status > configuring box ...

It also indicates if the configuration is completed.



ExBox Status

Serial Number	02
Version	01
FPGA Data	01 / 00.00-1.35
Setup State	Box is configured
Connection State	Connected

Fig. 6-26: ExBox Status > box is configured

6.2.2.4 I/Q Data Transmission

Signal transmission starts by pressing the "SEND TO" hotkey.

Send to
Start signal transmission. The direction path of signal transmissioin is determined in the "Select Type" field in chapter 6.2.2.3, "Dialogs", on page 94.

SCPI command:
`[:SOURce]:RECeiver:SENDto` on page 317
`SOURce:TRANsmitter:SENDto` on page 317

6.2.3 R&S Protocol Tester

The parameters are set by using the R&S DigIConf software.

Some R&S instruments, as e.g. the R&S CMW500 may have installed the configuration software directly. Check in the operating manual to see if your instrument supports this mode of operation. How to operate R&S DigIConf refer to chapter 6.1, "R&S DigIConf Configuration Software", on page 54. The parameters are described in chapter 7, "Protocol Settings", on page 97.

7 Protocol Settings

"Protocol Settings" describes the parameters and settings of the respective transmission protocols. It contains all parameters that you have in the GUI dialogs, and provides the corresponding remote control command linked to the command description. Depending on the protocol type, you can find additional information, such as information on the transmission protocol or on operating elements of the breakout boards, or special features to the remote commands.

With the exception of a few specific test setups, the parameters of the R&S EX-IQ-BOX are set by a PC via the configuration software R&S DigIConf.

Important note to the command syntax in User defined applications

The previous version of the R&S EX-IQ-BOX, model 1409.5505.02 only supports test setups with User Defined protocols. As a special feature, it can be controlled directly by an instrument. In this mode, the remote-control commands differ in the notation, depending on the device that controls the R&S EX-IQ-BOX.

The commands listed in the **User Defined GUI description** always refer to R&S DigIConf, since it is used in almost all applications.

If you run an R&S EX-IQ-BOX, model 1409.5505.02 directly with an R&S instrument, you can find the appropriate command syntax by following the link of the SCPI command. See also chapter 9.3.1, "Explanation to the Device Specific SCPI Syntax", on page 314 for more details.

"Protocol Settings" contains:

- chapter 7.1, "User Defined", on page 98 describes the parameters of user defined applications, i.e. settings for serial or parallel transmission of I/Q signals to a DUT, including variable clock modes, various data rates as well as different logical signal levels. This section applies to applications using the breakout boards included in delivery.
- chapter 7.2, "CPRI", on page 126 contains a general overview of the standard interface and explains the configuration dialogs and parameters, performed with the configuration software R&S DigIConf. Besides the "Downlink" / **Uplink** settings, CPRI additionally enables you to set "Control&Management" parameters, "Vendor Data" management, "Waveform Playback" and "Recording" memory.
- chapter 7.3, "DigRF", on page 193 contains an overview of the standardized interface DigRF, versions 3G and v4, and all the important information required for measurements with these standards. It includes frame structure, scripts, and signaling systems, as well as the configuration dialogs and parameters, set with the configuration software R&S DigIConf.
  DigRF measurements are performed via scripts. Therefore, the necessary tools, such as script editor and compiler, and syntax of the used script language are described.

7.1 User Defined

In modern communication systems it is communicated increasingly via digital baseband interfaces, so called I/Q links. Therefore some standardized interfaces were developed, like CPRI or DigRF 3G and DigRF v4. These standardized interfaces are covered by special purpose options, which are additionally available for the R&S EX-IQ-BOX.

But also without any additional option, the R&S EX-IQ-BOX covers a large number of different digital I/Q interfaces by using user-specific breakout boards. This general operating mode is called **User Defined** and provides a maximum of flexibility and configuration possibilities.

Devices like ADC's and DAC's, modulators and demodulators, submodules of mobile base stations or IC's of mobile equipment are tested with this operating mode, including early prototypes like FPGA implementations and also real time tests with mature ASIC samples.

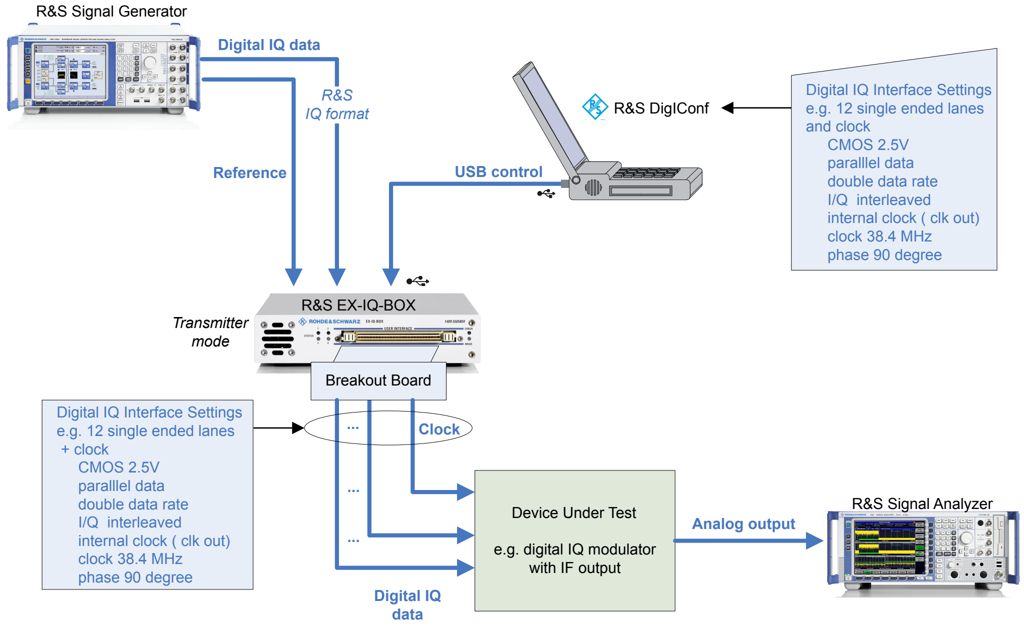


Fig. 7-1: Test scenario of a User Defined application

7.1.1 Parameter Overview

Beside the main controls, like switching on the R&S EX-IQ-BOX output, transmission direction and save/recall of settings, the interface is controlled by parameters, which are grouped by function:

Parameter Group	Purpose	Examples
Protocol	Fundamental protocol type settings	Parallel/serial interface, double data rate, I/Q interleaving
Data	Data representation	Resolution, alignment, bit order, numeric format

Parameter Group	Purpose	Examples
Clock	Interface clock settings	Clock rate, phase shift, skew, frequency reference
Trigger	Synchronization	Trigger source, delay
Test	Diagnostics on the interface to the DUT	TX Test, RX Test, Test signal sources

The parameters of these groups provide a large number of possible interface settings. This way the R&S EX-IQ-BOX can convert the R&S specific I/Q input/output to any digital I/Q interface of the DUT.

Additionally to the interfaces parameters, R&S DigIConf provides a test function, to check the signals between the R&S EX-IQ-BOX and the DUT. The R&S EX-IQ-BOX sends a known test signal to the DUT, or, vice versa, the R&S EX-IQ-BOX receives a signal from the DUT. This way, the I/Q interface to or from the DUT can be verified by performing bit error rate tests.

7.1.2 Main Configuration Dialog

The main configuration dialog covers main controls and parameters for user-defined applications. It sets the logical signal type, transmission path, and contains controls for storing or loading settings and for activation. The main controls are always indicated, independently fom the active subdialog.

Grouped by function, the subdialogs "Protocol", "Clock", "Data" and "Trigger" contain the respective parameters.

R&S DigIConf shows the current settings for signal transmission also graphically, and thus offers a convenient control of the configuration. I/Q data stream and clock signal to or from the R&S EX-IQ-BOX are shown schematically, and are adjusted by changes simultaneously. The "Data" tab additionally shows the bit alignment graphically, and the "Clock" tab the signal flow of the clock signal, corresponding to the currently selected scenario.

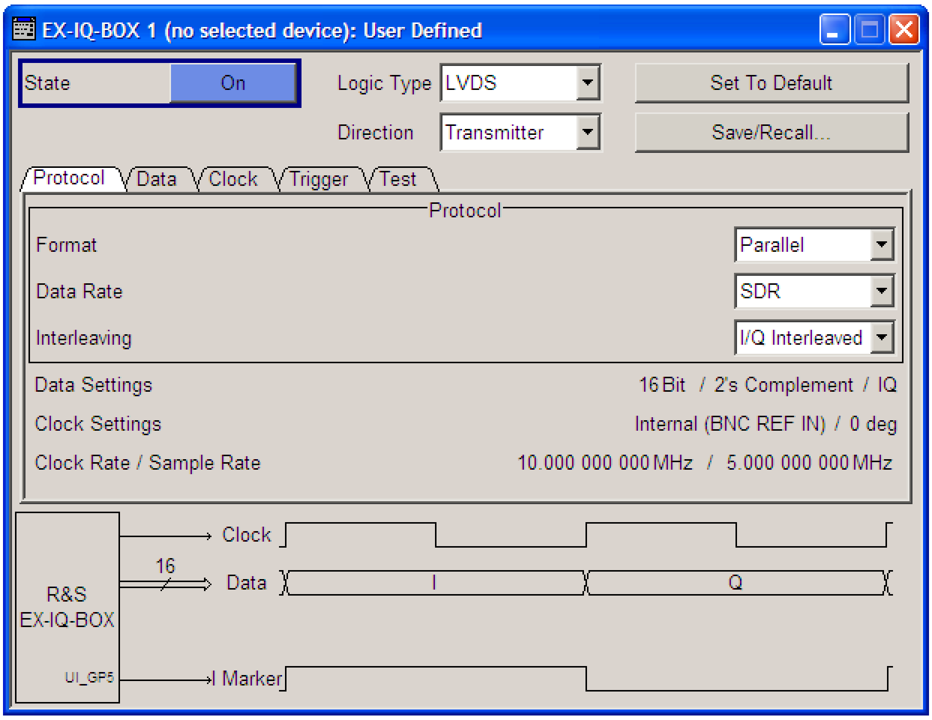
The start window of "User Defined" indicates the "Protocol" tab which, besides of the protocol parameters, also indicates the "Clock" and "Data" settings.

Device-specific dialog representation as well as command syntax

The dialogs in R&S signal generators are slightly different than in R&S DigIConf, e.g. they do not need an input field for the transmission direction, since the connection of the R&S EX-IQ-BOX determines the transmisssion path automatically. Clock and data parameters are also provided in separate tabs.

The commands in the following description relate to R&S DigIConf. If you run an R&S EX-IQ-BOX, model 1409.5505.02 directly with an R&S instrument, follow the link of the SCPI command. There you will find a set of remote commands in order to get the appropriate syntax for your application.

The following figures and description comprise the User Defined configuration dialogs representative also for applications without R&S DigIConf.



State On

Logic Type LVDS

Direction Transmitter

Format Parallel

Data Rate SDR

Interleaving I/Q Interleaved

Data Settings 16 Bit / 2's Complement / IQ

Clock Settings Internal (BNC REF IN) / 0 deg

Clock Rate / Sample Rate 10.000 000 000 MHz / 5.000 000 000 MHz

Fig. 7-2: R&S DigIConf > User Defined dialog

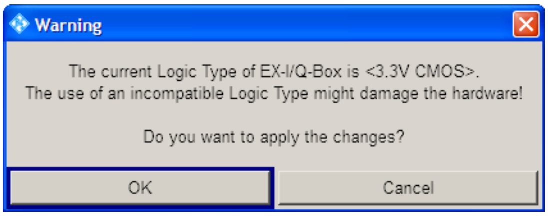
NOTICE

Risk of hardware damage

Digital, electrical signals base on various logical technologies, such as TTL or CMOS with several voltage levels. Therefore, the signal settings in the R&S EX-IQ-BOX must correspond to the signal, in both, the logical standard as well as the voltage value.

Any deviations may damage the DUT or the R&S EX-IQ-BOX.

A change of the logic type during the operation is performed only when you confirm the following warning message:



The current Logic Type of EX-I/Q-Box is <3.3V CMOS>.
The use of an incompatible Logic Type might damage the hardware!

Do you want to apply the changes?

Fig. 7-3: User > Logic type warning

- Check the voltage values of your test setup.
- Select "OK" if the correct logic type is selected.
- Select "Cancel" if an incompatible logic type is selected. Adjust your setup accordingly and set correct logic type in Logic Type.

State

Activate signal transmission.

This function applies to R&S DigIConf, since R&S signal generators and analyzers start signal transmission directly in the instrument.

Note: Data transmission requires that the respective breakout board is connected.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:STATe` on page 317

Logic Type

Selects the digital signaling system used for transmitting the baseband signal from or to the DUT.

Note: SCPI notation varies

The SCPI notation varies, when you remotely control the R&S EX-IQ-BOX on R&S EX-IQ-BOX or R&S signal generators and R&S signal analyzers.

Follow the command link below for description of the command and its syntax in detail.

"LVDS"	The signal is transmitted by using the signaling system LVDS (**L**ow **V**oltage **D**ifferential **S**ignaling).
"LVTTL"	The signal is transmitted by using LVTTL technology (**L**ow **V**oltage **T**ransistor **T**ransistor **L**ogic) with a voltage level of 3.3 V.
"x.x V CMOS"	The signal is transmitted by using the CMOS Technology (**C**omplementary **M**etal **O**xid **S**emiconductor). x.x represents the voltage level provided in the list.

"x.x V SSI""(only supported by R&S instruments)"	The signal is transmitted by using the SSI Technology (**S**erial **S**ynchronuos **I**nterface). **Note:** SSI signal are only supported by R&S signal generators and R&S signal analyzers. Due to the very specific application, it is listed here for completeness, but not described explicitly. Voltage levels are 1.5 V and 1.8 V.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:LOGic[:TYPE]` on page 316

Direction
Selects the direction of signal transmission from the DUT to R&S EX-IQ-BOX or vice versa.

Note:
Setting the transmission path and starting depend on the activating device

- **R&S DigIConf**
  Signal direction is selected in the "Direction" field of the R&S EX-IQ-BOX "User Defined" settings dialog. Select "Transmitter/Receiver" in the drop down list.
  The transmission is activated by switching On the "State" button.
- **R&S signal analyzers**
  Signal direction is selected in the "Select Type" field of the "EXIQ-Box Settings" dialog. Select "Transmitter/Receiver" in the drop down list, as described in chapter 6.1.1.6, "Dialogs", on page 58.
  To toggle between the different types, press the "TX SETTINGS" or "RX SETTINGS" softkey to select the type from the combo box.
- **R&S signal generators**
  The direction of signal transmission is distinguished as input and output settings dialogs "EX-IQ-BOX BBIN" and "EX-IQ-BOX BBOUT". Therefore, "Direction" is not required in control by for R&S signal generators.
  The transmission is activated by switching on the "State" button.

"Transmitter"	The connected R&S EX-IQ-BOX receives data from an R&S instrument and transmits this data to the DUT. In conjunction with analyzers the setup of the box must be initiated by the user. To do this the user must press "SEND TO" hotkey or send the following remote command to the analyzer:
"Receiver"	The connected R&S EX-IQ-BOX receives data from the DUT and transmits this data to an R&S instrument.

SCPI command:
R&S DigIConf, R&S signal generators:
`[:SOURce<hw>]:EBOX:USER:DIRection` on page 315
R&S signal analyzers:
`SOURce:TRANsmitter:SENDto` on page 317
`[:SOURce]:RECeiver:SENDto` on page 317

Set To Default
Executes a default application setup.

The function, provided by R&S DigIConf presets all parameters and switching states, also those of inactive operating modes. The default application settings provide a reproducible initial basis for all other settings.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:PRESet` on page 317

Save/Recall

Store the current application settings in the specified path, or load the selected file. Save provides to store the current application settings of R&S DigIConf in a file. Recall opens previously stored settings files.

Note: A settings file is always stored, or loaded with the extension `*.iqbox`. This file type cannot be changed.

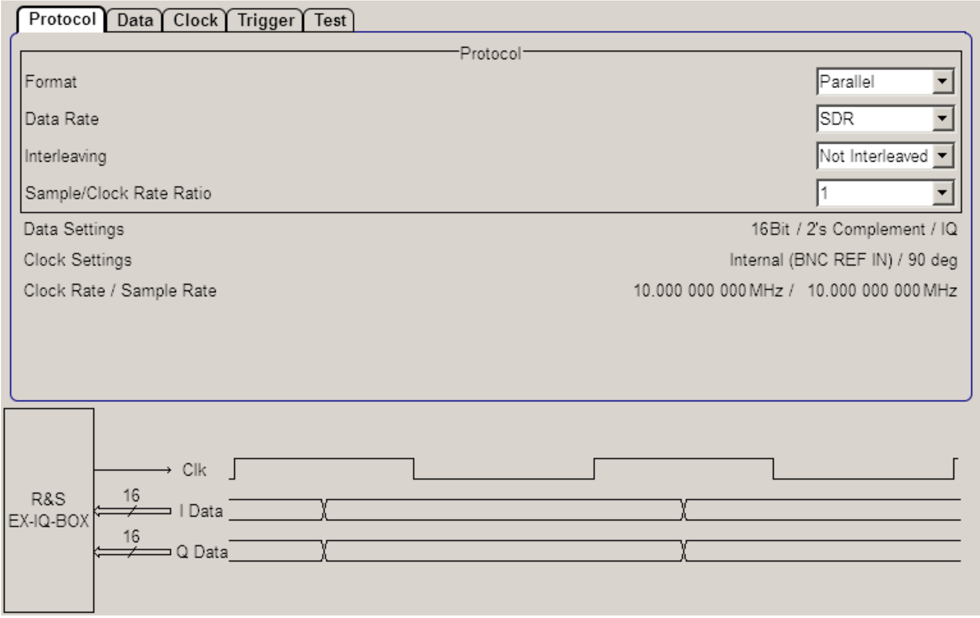
SCPI command:

`[:SOURce<hw>]:EBOX:USER:SETTing:STORe` on page 319

`[:SOURce<hw>]:EBOX:USER:SETTing:LOAD` on page 318

7.1.3 Protocol

The "Protocol" tab contains the interface parameters for signal transmission from the DUT to the R&S EX-IQ-BOX and vice versa. To the overview R&S DigIConf also shows the "Clock" and "Data" settings and the signal flow in a diagram.



Format Parallel

Data Rate SDR

Interleaving Not Interleaved

Sample/Clock Rate Ratio 1

Data Settings 16Bit / 2's Complement / IQ

Clock Settings Internal (BNC REF IN) / 90 deg

Clock Rate / Sample Rate 10.000 000 000 MHz / 10.000 000 000 MHz

Fig. 7-4: User defined > Protocol dialog

Format

Sets the transmission protocol of the R&S EX-IQ-BOX for receiving or sending a baseband signal from or to an external device (DUT) via the user interface of the R&S EX-IQ-BOX.

"Serial"

Tranmsits each sample serially, i.e. bitwise from the DUT to the R&S EX-IQ-BOX or vice versa.

Example:

The following graph shows an incoming serial I/Q signal from the DUT:

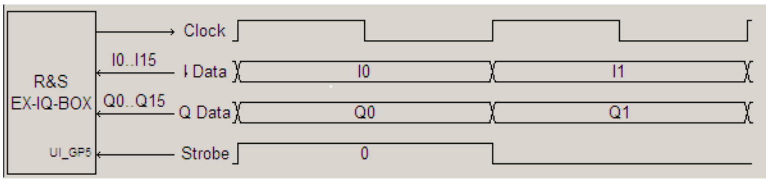


Fig. 7-5: User defined > I/Q IN serial signal flow

Direction = Receiver
Format = Serial

In serial mode, I data and Q data are sent via the input and output pins IO and QO, respectively.

"Parallel"

Transmits each sample parallel, i.e. wordwise from the DUT to the R&S EX-IQ-BOX or vice versa.

Example:

Parallel signal output to the DUT

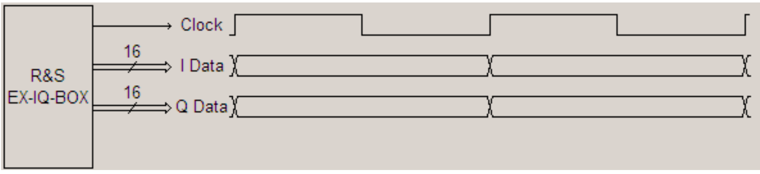


Fig. 7-6: User defined > I/Q OUT parallel signal flow

Direction = Transmitter
Format = Parallel

The input and output pin assignment depends on the bits alignment and the bit order settings. The "Data" dialog shows the current assignment.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:FORMat` on page 320

Data Rate

Sets the data rate mode of the R&S EX-IQ-BOX for receiving/sending a baseband signal from/to an external device (DUT).

"SDR"

Tranmsits the baseband signal in single data rate mode from the DUT to the R&S EX-IQ-BOX or vice versa. The rising edge of the clock signal triggers data transmission.

Example:

- Parallel signal output in single data rate

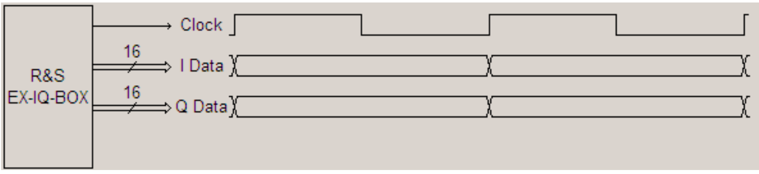


Fig. 7-7: User defined > Signal flow: I/Q OUT parallel, single data rate

Direction = Transmitter
Format = Parallel
Data Rate = SDR

- Serial signal input in single data rate:

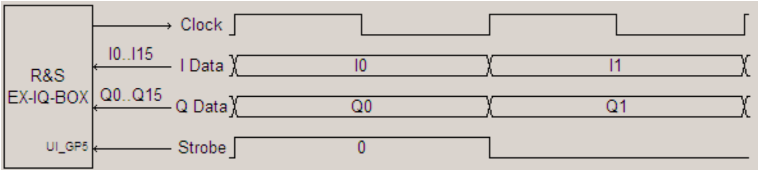


Fig. 7-8: User defined > Signal flow: I/Q OUT serial, single data rate

Direction = Receiver
Format = Serial
Data Rate = SDR

"DDR" Transmits the baseband signal in double data rate mode from the DUT to the R&S EX-IQ-BOX or vice versa. The rising edge and the falling edge of the clock signal trigger data transmission (double speed transfer).
The signal transmission is also shown in the graph.

Example:

- Parallel signal input in double data rate:

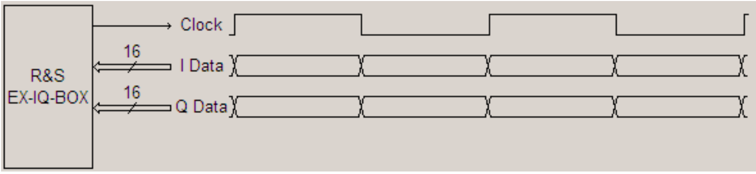


Fig. 7-9: User defined > Signal flow: I/Q IN parallel, double data rate

Direction = Receiver
Format = Parallel
Data Rate = DDR

- Serial signal input in double data rate:

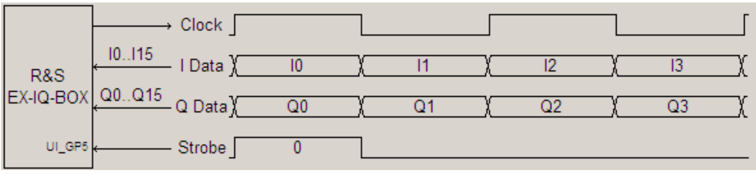


Fig. 7-10: User defined > Signal flow: I/Q IN serial, double data rate

Direction = Receiver
Format = Serial
Data Rate = DDR

SCPI command:
`[:SOURce<hw>]:EBOX:USER:DRATe` on page 320

Interleaving
Activates interleaving and selects the interleaving mode.

Depending on the interleaving settings, the baseband signal is either sent simultaneously or in I/Q or Q/I order from the external device (DUT) to the R&S EX-IQ-BOX or vice versa.

"Not Interleaved"

Transmits the baseband signal on the I and Q data lines as indicated in the graph below.

Example:

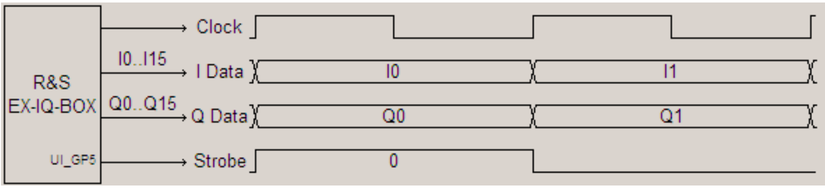


Fig. 7-11: User defined > Signal flow: I/Q OUT serial, not interleaved

Direction = Transmitter
Format = Serial
Data Rate = DDR
Interleaving = Not interleaved

"I/Q Interleaved"

Transmits the baseband signal on the I data line starting with I data.

Example:

- Serial signal output in single data rate.

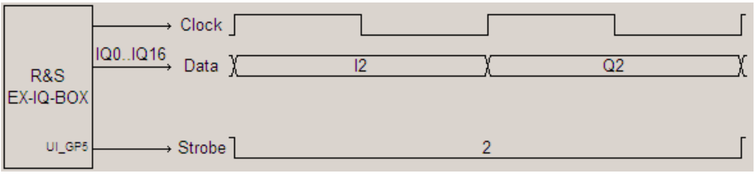


Fig. 7-12: User defined > Signal flow: I/Q OUT serial, single data rate, I/Q interleaved

Direction = Transmitter
Format = Serial
Data Rate = SDR
Interleaving = I/Q interleaved

The strobe signal (UI_GP5) takes 2 clock cycles. The first clock cycle triggers the I data, and the second cycle triggers the Q data.

- Serial signal output in double data rate.

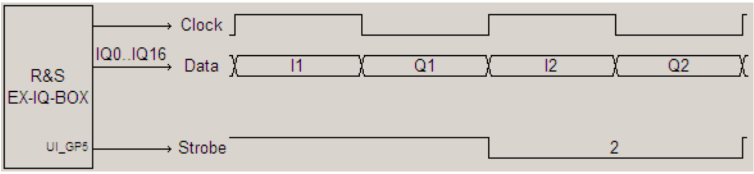


Fig. 7-13: User defined > Signal flow: I/Q OUT serial, double data rate, I/Q interleaved

Direction = Transmitter
Format = Serial
Data Rate = DDR
Interleaving = I/Q interleaved

The strobe signal UI_GP5 lasts 1 clock cycle. The rising edge triggers the I data, the falling edge the Q data.

- Parallel signal output in single data rate.

Fig. 7-14: User defined > Signal flow: I/Q OUT parallel, single data rate, I/Q interleaved

Direction = Transmitter
Format = Parallel
Data Rate = SDR
Interleaving = I/Q interleaved

The I marker output at the Reserved1 pin UI_GP5 of the user interface marks the I data.

- Parallel signal output in double data rate.

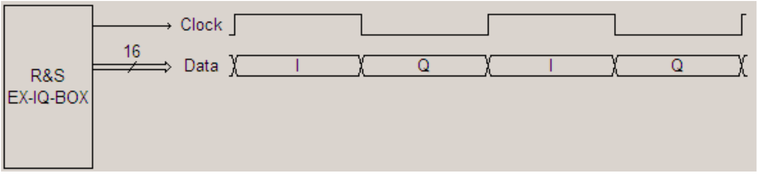


Fig. 7-15: User defined > Signal flow: I/Q OUT parallel, double data rate, I/Q interleaved

Direction = Transmitter
Format = Parallel
Data Rate = DDR
Interleaving = I/Q interleaved

The rising edge of the clock signal triggers the I data, the falling edge the Q data.

"Q/I Interleaved"	Transmit the baseband signal on the I data line starting with Q data. With interchanged order of the I and Q data the I/Q signal is transferred similarly as described above.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:ILEaving` on page 321

Sample / Clock Rate Ratio

Sets the sample to clock rate ratio in parallel signal transmisssion mode. This parameter characterizes the ratio of the sample rate to the clock rate depending on the parameter settings for "Word Size", "Interleaving" and "Data Rate". See also "Clock Rate" on page 117.

Note:
SCPI notation varies

- In the remote control, determine the clock rate ratio value for the R&S DiglConf and R&S signal generators with `SCRxDy`. `x` represents the value, `D` substitues the decimal point, and `y` is the decimal place.
- In contrast, just enter the value `x.x` when using an R&S signal analyzer.

Follow the command link below for description of the command and its syntax in detail.

"SCR"	1, 4/5, 2/5, 1/5, 1/10, 1/20
"SCR < 1:"	Dummy samples are added. The signal output SCR_VALID at the UI_GP_P1 pin of the user interface marks the validity of the data.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:SCRatio` on page 326

Data Settings

Displays the data parameters "Word Size", "Numeric Format" and "Signal Type". For the description of these parameters, see chapter 7.1.4, "Data", on page 110, including " Word Size" on page 111, "Numeric Format" on page 114, and " Signal Type" on page 110.

Clock Settings

Indicates the current values of the Clock Source and the Clock Phase. For the description of these settings in detail, see "Clock Source" on page 118 and "Clock Phase" on page 120.

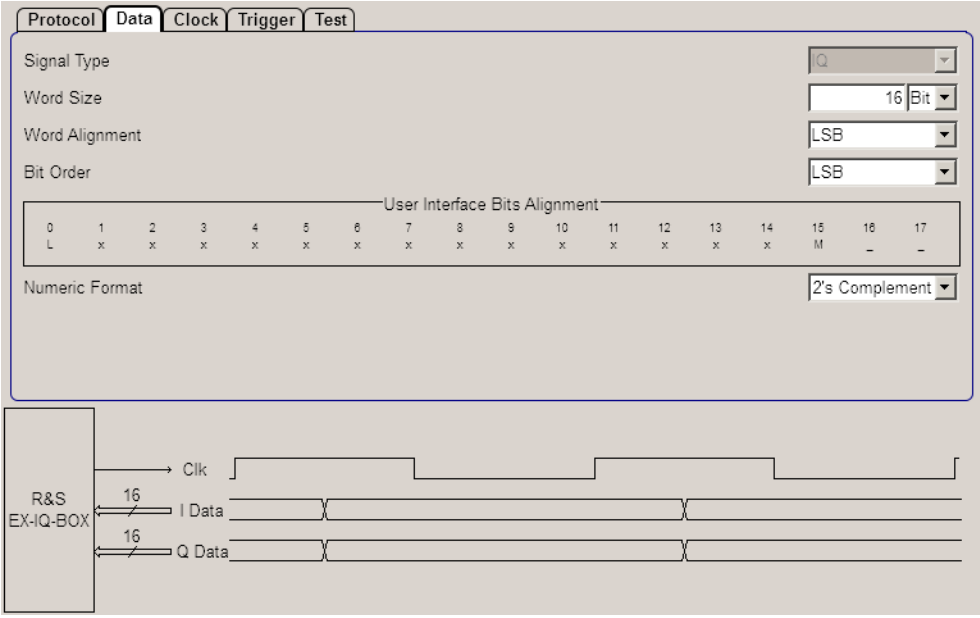
Clock Rate / Sample Rate

Displays the clock parameters "Clock Rate" and the calculated "Sample Rate". "Clock Rate" on page 117 explains these parameters in detail.

7.1.4 Data

The "Data" tab contains the parameters for data transmission. In parallel data transmission, R&S DigIConf shows the bits alignment at the user interface graphically, corresponding to the settings. If you transmit serially, you can additionally configure the serial strobe. In the lower pane, the signal flow is displayed as in all views.

Analyzers do not indicate data transmission graphically.



Signal Type IQ

Word Size 16 Bit

Word Alignment LSB

Bit Order LSB

User Interface Bits Alignment

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
L	x	x	x	x	x	x	x	x	x	x	x	x	x	x	M	_	_

Numeric Format 2's Complement

Fig. 7-16: User defined > Data dialog of parallel transmission

Signal Type

Selects the signal mode of the transmission. The digital I and Q signals are either transmitted separately or the I and Q samples are assembled to a carrier signal and shifted to an intermediate frequency (IF).

Note: Currently the signal type is firmly set to "IQ" and read only. IQ transmits the digital I and Q signal components separately. Signal type "IF" is intended for future use.

"IQ"	Transmits the digital I and Q signals separately.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:DATA:STYPe` on page 332

Word Size

Sets the word size resolution of a sample. If the word size is set to a value n, the I word and the Q word use these n bits. The R&S EX-IQ-BOX supports word sizes from 4 to 18 bits.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:DATA:SIZE` on page 331

Word Alignment

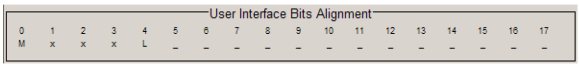
Sets the alignment of the data bits on the data lines. Either the MSB or the LSB is mapped firmly to one data line. Depending on the word size the equivalent bit moves to the appropriate data line.

Note:

- This parameter applies to parallel data transmission.
- Graphics in the dialog of the generators and in R&S DigIConf show the presently set word alignment in the "User Interface Bits Alignment" section.

"MSB" The MSB (**M**ost **S**ignificant **B**it) is mapped firmly to the same data line and the data line of the LSB varies in dependency of the word size.

Example:

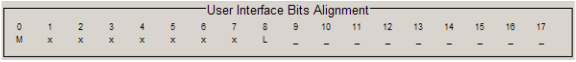
- 

User Interface Bits Alignment

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
M	x	x	x	L	_	_	_	_	_	_	_	_	_	_	_	_	_

Fig. 7-17: User defined > Word alignment MSB: I/Q parallel transmission, 5 bit, bit order MSB

word size = 5
word alignment = MSB
bit order = MSB

- 

User Interface Bits Alignment

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
M	x	x	x	x	x	x	x	L	_	_	_	_	_	_	_	_	_

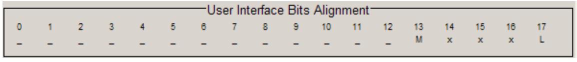
Fig. 7-18: User defined > Word alignment: I/Q parallel transmission, 9 bit, bit order MSB

word size = 9
word alignment = MSB
bit order = MSB

"LSB"

The LSB (Last Significant Bit) is mapped firmly to the same data line and the data line of the MSB varies in dependency of the word size.

Example:

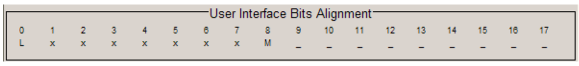
- 

User Interface Bits Alignment

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
_	_	_	_	_	_	_	_	_	_	_	_	_	M	x	x	x	L

Fig. 7-19: User defined > Word alignment LSB: I/Q parallel transmission, 5 bit, bit order MSB

word size = 5
word alignment = LSB
bit order = MSB

- 

User Interface Bits Alignment

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
L	x	x	x	x	x	x	x	M	_	_	_	_	_	_	_	_	_

Fig. 7-20: User defined > Word alignment LSB: I/Q parallel transmission, 9 bit, bit order LSB

word size = 9
word alignment = LSB
bit order = LSB

SCPI command:
`[:SOURce<hw>]:EBOX:USER:DATA:ALIGnment` on page 328

Bit Order

Sets the order of the data bits. In "Parallel mode", either the LSB or the MSB is transmitted on the first used data line. In "Serial mode" either the LSB or the MSB is transmitted as first bit.

"MSB"

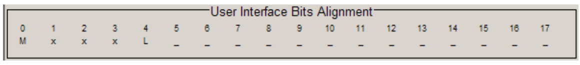
Transmits the MSB (**M**ost **S**ignificant **B**it) first.

Parallel transmission

The MSB is transmitted on the first used data line, depending on the word size and alignment.

Note: Graphics in the dialog of the generators and in R&S DigIConf shows the presently set bit sequence.

Example:

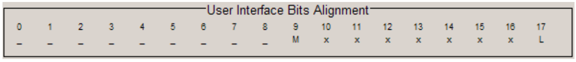
- 

  User Interface Bits Alignment

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
M	x	x	x	L	_	_	_	_	_	_	_	_	_	_	_	_	_

  Fig. 7-21: User defined > Bit order MSB: I/Q parallel transmission, alignment MSB, 5 bit

  word size = 5
  word alignment = MSB
  bit order = MSB

- 

  User Interface Bits Alignment

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
_	_	_	_	_	_	_	_	_	M	x	x	x	x	x	x	x	L

  Fig. 7-22: User defined > Bit order MSB: I/Q parallel transmission, alignment LSB, 9 bit

  word size = 9
  word alignment = LSB
  bit order = MSB

Serial transmission:

The MSB is transmitted first.

Example:

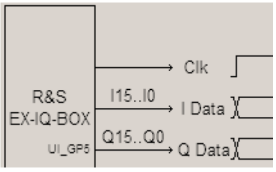


Fig. 7-23: User defined > Bit order MSB: I/Q serial transmission, 16 bit

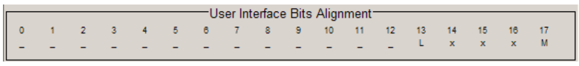
word size = 16 Bit
bit order = MSB

"LSB" Transmits the LSB (**L**ast **S**ignificant **B**it) first.

Parallel transmission:

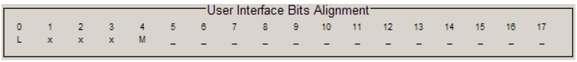
The LSB is transmitted on the first data line.

Example:

- 
  User Interface Bits Alignment

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
_	_	_	_	_	_	_	_	_	_	_	_	_	L	x	x	x	M

  Fig. 7-24: User defined > Bit order LSB: I/Q parallel transmission, alignment MSB, 5 bit

  word size = 5
  word alignment = MSB
  bit order = LSB
- 
  User Interface Bits Alignment

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
L	x	x	x	M	_	_	_	_	_	_	_	_	_	_	_	_	_

  Fig. 7-25: User defined > Bit order LSB: I/Q parallel transmission, alignment LSB, 9 bit

  word size = 9
  word alignment = LSB
  bit order = LSB

Serial transmission:

The LSB is transmitted first.

Example:

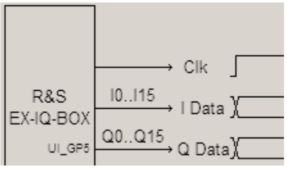


Fig. 7-26: User defined > Bit order LSB: I/Q serial transmission, 16 bit

word size = 16 Bit
bit order = LSB

SCPI command:

`[:SOURce<hw>]:EBOX:USER:DATA:BORDer` on page 329

Numeric Format

Select a numeric representation for data transmission.

Allowed number range for word size n Bit:

$-2^{n-1} \leq n \leq +2^{n+1}$

Table 7-1: User defined > Numeric format coding

z		2´s Complement					Binary Offset			
-8		1	0	0	0		0	0	0	0
-7		1	0	0	1		0	0	0	1
-6		1	0	1	0		0	0	1	0
-5		1	0	1	1		0	0	1	1

z		2´s Complement					Binary Offset			
-4		1	1	0	0		0	1	0	0
-3		1	1	0	1		0	1	0	1
-2		1	1	1	0		0	1	1	0
-1		1	1	1	1		0	1	1	1
0		0	0	0	0		1	0	0	0
1		0	0	0	1		1	0	0	1
2		0	0	1	0		1	0	1	0
3		0	0	1	1		1	0	1	1
4		0	1	0	0		1	1	0	0
5		0	1	0	1		1	1	0	1
6		0	1	1	0		1	1	1	0
7		0	1	1	1		1	1	1	1

"2´s Complement"

The value of the transmitted data is formatted in two´s-complement.
The most significant bit has a value of -2^{n-1}, the bits of lesser significance follow as:
$+2^{n-2}$ ... $+2^{0}$

"Binary Offset"

The value of the transmitted data is formatted in binary offset.
A binary offset of -2^{n-1} is added such that the final values are always positive.

Example:

$n = 4 \rightarrow -8 \le z < 8$

SCPI command:
`[:SOURce<hw>]:EBOX:USER:DATA:NFORmat` on page 329

Strobe Polarity

Determine the polarity of the strobe marker signal. During a serial data transmission every data sample is marked by the strobe marker signal.

The strobe marker is output at the UI_GP5 of the user interface.

Note: This parameter applies to serial data transmission.
"Clock Phase" or "Clock Skew" settings **do not affect** the strobe marker signal.

"Positive"

Example:

Sets the strobe polarity to high level.

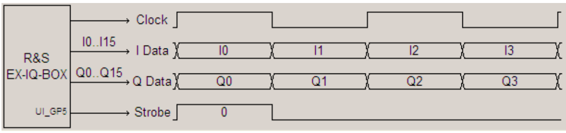


Fig. 7-27: User defined > Strobe polarity positive: I/Q OUT serial

word size = 4
bit order = LSB
numeric format = 2's complement
strobe polarity = positive

"Negative"

Sets the strobe polarity to low level.

Example:

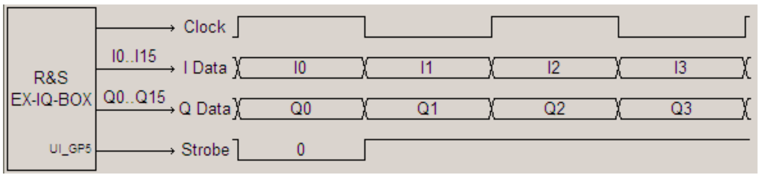


Fig. 7-28: User defined > Strobe polarity negative: I/Q OUT serial

word size = 4
bit order = LSB
numeric format = 2's complement
strobe polarity = negative

SCPI command:

`[:SOURce<hw>]:EBOX:USER:DATA:SPOLarity` on page 331

Strobe Position

Sets the sample position of the strobe marker output.

Note:

- This parameter applies to serial data transmission.
- Value range: 0 to word size -1.
- The graphic in the clock dialog of the generators and in R&S DigIConf shows the presently set sample position.
- The strobe marker is output at the UI_GP5 of the user interface.

Example:

Strobe Position = 2, Strobe Polarity = Positive.

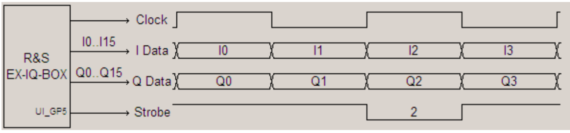


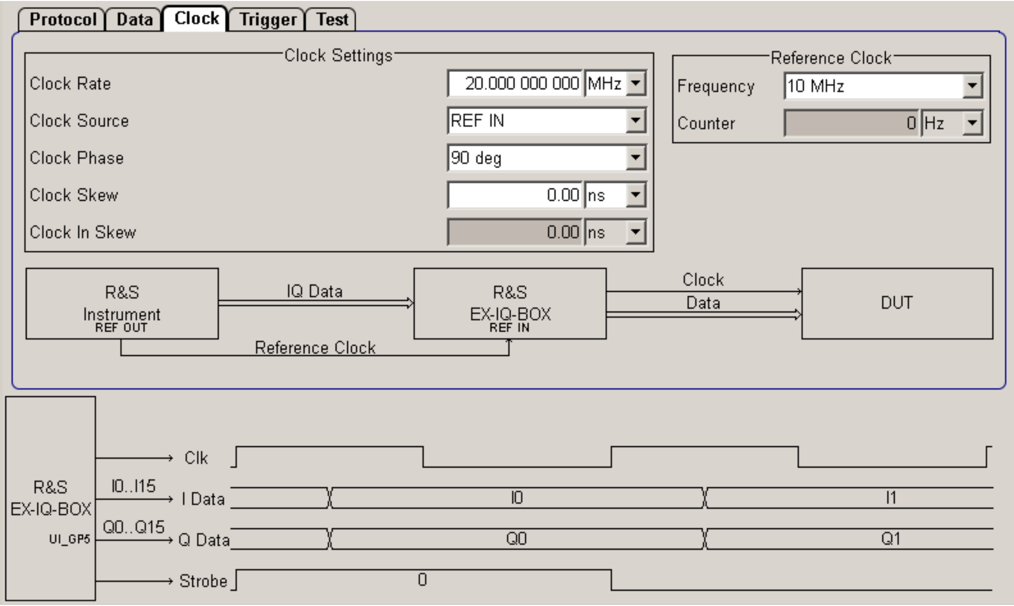
Fig. 7-29: User defined > Strobe position 2: I/Q OUT serial, negative polarity

word size = 16
bit order = LSB
strobe polarity = negative
strobe position = 2

SCPI command:
`[:SOURce<hw>]:EBOX:USER:DATA:SPOSition` on page 332

7.1.5 Clock

The "Clock" tab provides the frequency settings for synchronizing the test setup with either external or internal clock source.



Clock Settings
Clock Rate 20.000 000 000 MHz
Clock Source REF IN
Clock Phase 90 deg
Clock Skew 0.00 ns
Clock In Skew 0.00 ns

Reference Clock
Frequency 10 MHz
Counter 0 Hz

Fig. 7-30: User defined > Clock dialog

The graphic in the clock dialog of the generators and in R&S DigIConf indicates the data flow, the clock signal and the reference frequency signal. A signal diagram displays schematically the current type of data transmission.

Clock Rate

Sets the clock rate (frequency) for signal transmission between the R&S EX-IQ-BOX and the external device (DUT). Depending on the logic type and the clock source the clock rate range varies, as shown below.

$$f_{CLK} = \frac{f_s \cdot WS \cdot INT}{DDR \cdot SCR}$$

Fig. 7-31: User defined > Clock rate

f_{clk} = clock rate
f_s = sample rate
WS = Word size
INT = Interleaving mode
DDR = double rata rate
SCR = sample/clock rate ratio

Table 7-2: User defined > Value range of f_{CLK}

	Value Range	
f_S	1 kHz ... 100 MHz	
f_{CLK}	**LVTTL:** 1 (25) kHz - 100 MHz*)	**LVDS:** 1 (25) kHz - 400 MHz*)
WS	4 ... 18 (serial mode)	1 (parallel mode)
INT	1 (non interleaved)	2 (I/Q and Q/I interleaved)
DDR	1 (SDR)	2 (DDR)
SCR	1, 4/5, 2/5, 1/5, 1/10, 1/20	
*)1 kHz applies to the REF IN clock source, i. the reference signal is fed in from the R&S instrument, 25 kHz applies to the external reference from the user interface.		

Note: The value range of the clock rate depends on "Protocol, Logic Type" and "Signal Type" settings.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:CLOCk:RATE` on page 324

Clock Source

Selects the clock source for data transmission. Either the R&S instrument or the external device (DUT) can provide the reference, irrespective of the transmission direction.

The following clock scenarios are possible:

- Signal "input" synchronized by an "external" clock source.
  Data and data clock are fed by the DUT.

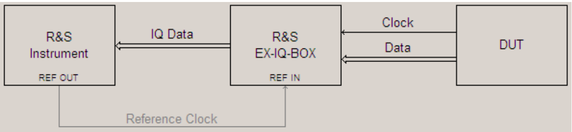


Fig. 7-32: User defined > I/Q IN synchronized by external clock

clock source = External (user interface)

- Signal "input" synchronized by the "internal" reference clock signal.
  The R&S EX-IQ-BOX receives the clock signal from the R&S instrument and forwards it to the DUT in order to synchronize the incoming data from the DUT.

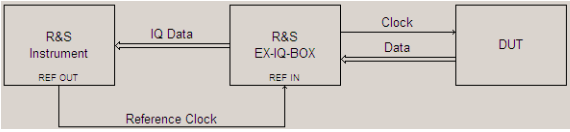


Fig. 7-33: User defined > I/Q IN synchronized by internal clock

clock source = Internal (BNC REF IN)

- Signal "output" synchronized by an "external" reference clock signal.
  The R&S EX-IQ-BOX receives the I/Q data from the R&S instrument and forwards it to the DUT, synchronized by the reference frequency of the DUT.

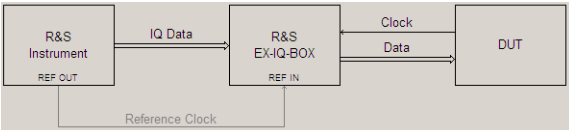


Fig. 7-34: User defined > I/Q OUT synchronized by external clock

clock source = External (User Interface)

- Signal "output" synchronized by the "internal" reference clock signal.
  The R&S instrument provides the I/Q data and the reference clock passed to the DUT by the R&S EX-IQ-BOX.

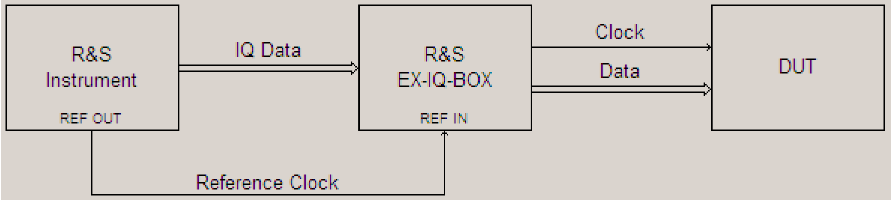


Fig. 7-35: User defined > I/Q OUT synchronized by internal clock

clock source = Internal (BNC REF IN)

"REF IN"	To synchronize data transmission, the R&S EX-IQ-BOX obtains the reference frequency from a connected R&S instrument, i.e. a signal generator or signal analyzer. The R&S instrument supplies the clock at the REF IN (BNC) connector. Select the supplied reference frequency in Frequency. **Note:** When using the reference frequency of an R&S instrument, the reference output of the R&S instrument must be connected to the REF IN of the R&S EX-IQ-BOX (see chapter 4.3.2, "Rear Panel View", on page 32). The connection can be kept during the entire operation even if an external clock reference is used.
"Internal"	The R&S EX-IQ-BOX synchronizes data transmission with a internally generated reference frequency of 10 MHz. The frequency is indicated Frequency.

"User Interface"	The R&S EX-IQ-BOX receives an external reference signal from the DUT via the user interface.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:CLOCk:SOURce` on page 326

Clock Phase

Sets a phase shift of the active clock edge in 90° steps related to the data bits.

The phase shift is graphically displayed in main settings dialog.

Adjustable values: 0° | 90° | 180° | 270°

Example:

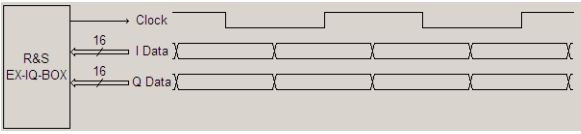


Fig. 7-36: User defined > Clock phase

Clock source = internal
clock phase = 90°

Note: SCPI notation varies

In the remote control you determine the clock phase value for the R&S signal analyzers with `Pxx`. In contrast, just enter the value `xx` without `P` when using R&S EX-IQ-BOX or an R&S signal generator. `xx` represents the value in degree.

Follow the command link below for description of the command and its syntax in detail.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:CLOCk:PHASe` on page 323

Clock Skew

Sets a time shift of the active clock edge related to the data bits. This feature is used to compensate an external clock skew which is caused by differences of the clock and data line lengths.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:CLOCk:SKEW:OUT` on page 325

Clock In Skew

Sets a time shift of the active clock edge related to the data bits. This feature is used to compensate an internal clock skew which is caused by differences of the clock and data line lengths.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:CLOCk:SKEW:IN` on page 325

Frequency

Sets / indicates the reference frequency.

The R&S EX-IQ-BOX supports different reference frequencies to be input at REF IN. This value must be set on the frequency currently supplied.

The parameter is grayed out, when an external, or the internal reference clock of the R&S EX-IQ-BOX is used.

"5 | 10 | 13"	Provided reference frequencies in MHz.

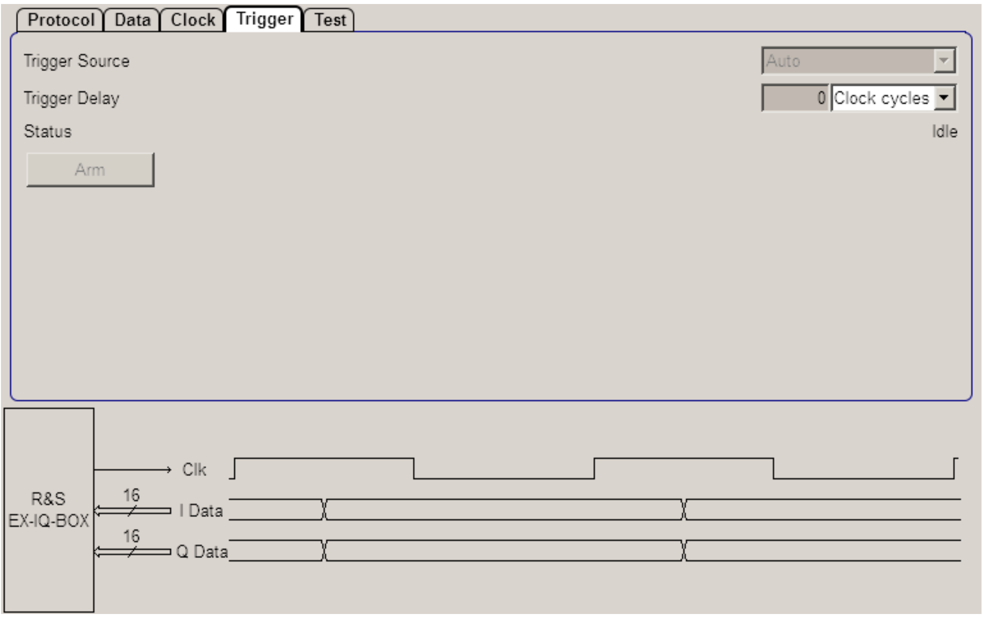
SCPI command:
`[:SOURce<hw>]:EBOX:USER:CLOCk:REFerence:FREQuency` on page 324

Freq. Counter
The function counts and indicates the actually reference frequency, fed by an R&S instrument, or the DUT.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:CLOCk:REFerence:VALue` on page 325

7.1.6 Trigger

In the "Trigger" tab you can configure and activate a trigger signal, when the R&S EX-IQ-BOX is working in transmitter mode.



Trigger Source: Auto
Trigger Delay: 0 Clock cycles
Status: Idle

Fig. 7-37: User defined > Trigger dialog

Trigger Source
Select the trigger source. The trigger signal starts the signal output at the user interface.

"Auto"	Outputs the signal immediately.
"Sync"	Synchronizes signal output with an incoming trigger signal, i.e. the DUT triggers data output to the R&S EX-IQ-BOX. The trigger signal is applied at the SYNC IN pin of the user interface.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:TRIGger:SOURce` on page 338

Trigger Delay

Specify a time delay after the trigger event. Trigger delay is defined clock cycles.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:TRIGger:DELay` on page 338

Status

Indicates the current trigger status.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:TRIGger:STATe` on page 338

Arm

Stops the current signal output. It continues either automatically or synchronized, according to the used trigger source.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:TRIGger:ARM` on page 337

7.1.7 Test

The "Test" tab provides functions for testing the user interface between the R&S EX-IQ-BOX and the DUT.

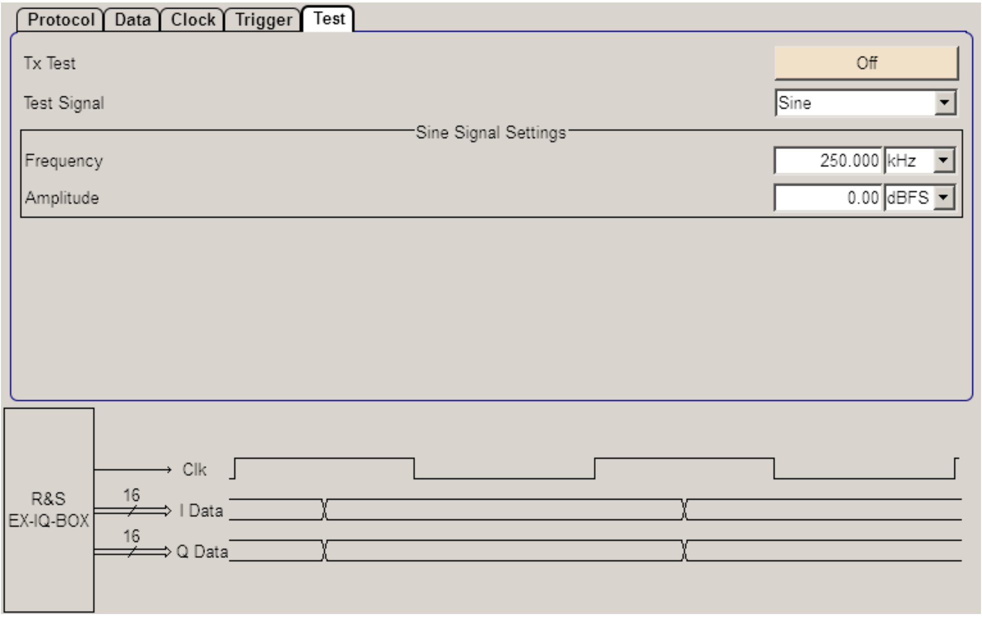
Prior to any measurement of an I/Q signal, we recommend that you to check the function of the data interface.

The R&S EX-IQ-BOX provides both, a test signal generator and a measurement receiver that supports BER measurement.

The test dialog changes depending on the transmissioni path. If the R&S EX-IQ-BOX is working as transmitter, the test dialog shows the control elements for the test signal generator. In receiver mode, the dialog provides the control elements for the test receiver. Refer for description to chapter 7.1.8, "TX-Test", on page 122, and to chapter 7.1.9, "Rx-Test", on page 125, respectively.

7.1.8 TX-Test

This section describes the parameters for testing in transmitter mode.



Tx Test: Off

Test Signal: Sine

Sine Signal Settings

Frequency: 250.000 kHz

Amplitude: 0.00 dBFS

Fig. 7-38: User defined > Test dialog of transmitter mode

Tx Test

Switches the test generator on or off.

While the test generator is switched on, the test signal replaces the I/Q data source coming from "DIG IQ IN".

SCPI command:

`[:SOURce<hw>]:EBOX:USER:TEST:TX:STATe` on page 337

Test Signal

Selects a test signal of the test generator. The R&S EX-IQ-BOX provides three different signals for testing.

"PRBS"

Generates a PRBS 16 (**P**seudo **R**andom **B**inary **S**equence) sequence. The output of this sequence complies to the "Protocol", "Data" and "Clock" settings of the R&S EX-IQ-BOX.
E.g. if the word size of the I / Q sample is 7 bits, the R&S EX-IQ-BOX sends the PRBS 16 sequence in 7-bit parts.
The I and Q values always contain the same copy of one test sample.
The PRBS 16 sequence is defined by the generator polynomial G(x) = $1 + x^2 + x^3 + x^5 + x^{16}$.

Example:

The functional implementation of this PRBS generator is also defined by the following linear feedback shift register (LFSR):

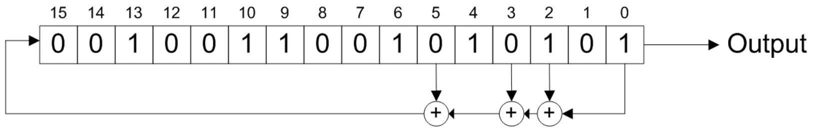


Fig. 7-39: User defined > Test PRBS linear feedback shift register (LFSR)

"Counter"

Generates a counter test signal. The counter size is based on the word size, set in the "Data" tab. Each output sample increases the counter by 1.

"Sine"

A complex sine signal is generated, following the formula below,

$$s(n) = e^{j2\pi\frac{f}{f_s}n} = cos\left[2\pi\frac{f}{f_s}n\right] + j\,sin\left[2\pi\frac{f}{f_s}n\right]$$

Fig. 7-40: User defined > sine signal formula

n = discrete time index
f = frequency of the test sine signal
f_s = sampling frequency, based on the "protocol", "data" and "clock" settings.

with the real component,

$$I(n) = cos\left[2\pi\frac{f}{f_s}n\right]$$

Fig. 7-41: User defined > sine signal I component formula (real)

and the imaginary component:

$$Q(n) = j\,sin\left[2\pi\frac{f}{f_s}n\right]$$

Fig. 7-42: User defined > sine signal Q component formula (imaginary)

SCPI command:
`[:SOURce<hw>]:EBOX:USER:TEST:TX:SIGNal` on page 335

Frequency

Sets the frequency of the sine test signal. The frequency is limited to "0.4 f_s", and the sampling frequency "f_s" depends on the clock settings, the double data rate setting and the interleaving mode.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:TEST:TX:SINE:FREQuency` on page 336

Amplitude

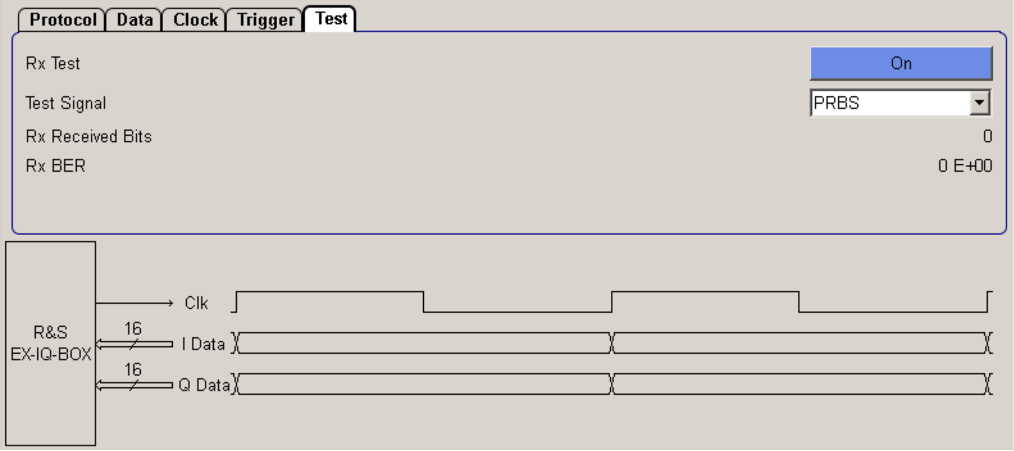
Sets the amplitude of the sine test signal in terms of dBFS. The maximum amplitude is full scale (0 dBFS).

SCPI command:

`[:SOURce<hw>]:EBOX:USER:TEST:TX:SINE:AMPLitude` on page 336

7.1.9 Rx- Test

This section provides the parameters for testing in receiver mode.



Rx Test: On

Test Signal: PRBS

Rx Received Bits: 0

Rx BER: 0 E+00

Fig. 7-43: User defined > Test dialog of receiver mode

Rx Test

Activates the test receiver.

The R&S EX-IQ-BOX expects a test signal at the user interface. First, the test receiver synchronizes to the last received data word, and then generates a test sequence and compares each generated sample with the corresponding received sample.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:TEST:RX:STATe` on page 334

Test Signal

Selects the incoming test signal to be analyzed. The test receiver analyzes both PRBS 16 or counter test signals.

SCPI command:

`[:SOURce<hw>]:EBOX:USER:TEST:RX:SIGNal` on page 334

Rx Received Bits
Indicates the number of received bits. This functions consecutively counts the number of received bits, compares them with the sent data and determines the error rate.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:TEST:RX:WORDs` on page 334

Rx BER
Indicates the bit error rate. The function consecutively counts the number of discrepancies that occur during the test. The BER result is the ratio, which is calculated by dividing the number of error bits by the total number of bits.

SCPI command:
`[:SOURce<hw>]:EBOX:USER:TEST:RX:BER` on page 333

7.2 CPRI

This CPRI documentation contains a general overview of the standard interface. The main part explains the configuration dialogs and parameters in detail, provided by the configuration software R&S DigIConf. Find the appropriate information in chapter 7.2.6, "Main Configuration Dialog", on page 145, chapter 7.2.7, "Hardware", on page 148, chapter 7.2.8, "Downlink and Uplink", on page 154, chapter 7.2.9, "Control & Management", on page 174, chapter 7.2.10, "Vendor Data", on page 179, and chapter 7.2.11, "Test & Diagnostics", on page 181.

You also find a panel chapter 7.2.12, "ARB", on page 186 in the CPRI configuration dialog. If the R&S EX-IQ-BOX is equipped with a special option for waveform memory, it supports playback of waveform signals. I.e. the R&S EX-IQ-BOX can work as a signal source without any generator connected.

In addition, an application example of a CPRI RE (**R**adio **E**quipment) test application exemplifies the necessary equipment, test construction and essential settings. Refer to chapter 7.2.5, "Start with CPRI - Setup Example", on page 137 for information on this application example.

CPRI parameter settings are set by means of the configurator software R&S DigIConf. See chapter 6.1, "R&S DigIConf Configuration Software", on page 54 for description of R&S DigIConf in detail.

The CPRI transmission protocol option, as well as the options for waveform memory, multi waveform playback and recording memory require the R&S EX-IQ-BOX **1409.5505K04** and the configuration software R&S DigIConf. The R&S EX-IQ-BOX **1409.5502.02** provides only **User Defined** protocols.

7.2.1 Introduction

CPRI^{TM} (**C**ommon **P**ublic **R**adio **I**nterface) is a publicly available digital communication protocol standardized by an industry cooperation. The CPRI transmission protocol defines the interface of base stations between the REC (**R**adio **E**quipment **C**ontrol) in the standard, to local or remote radio units, known as RE (**R**adio **E**quipment). For further information on CPRI Interface Specification refer to http://www.cpri.info/spec.html.

In the figure below, the REC and RE are shown for clarification. When connecting a REC and a RE with one or several CPRI interfaces, the resulting entity is a Node B in a Radio Access Network.

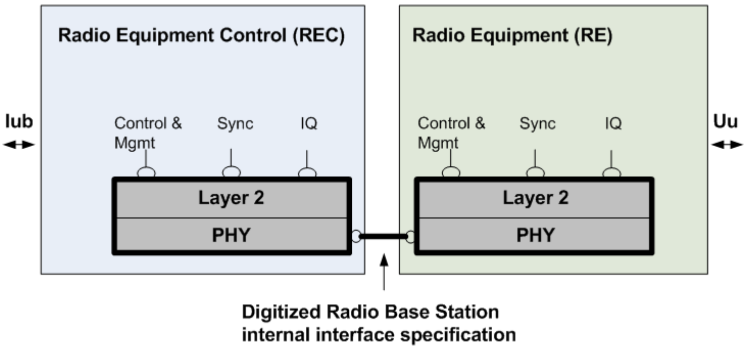


Fig. 7-44: CPRI internal interface specification

R&S provides this standardized protocol by the special purpose option R&S EXBOX-B85 for the R&S EX-IQ-BOX.

The associated option is available under R&S part number 1409.7208.02, including a breakout board and an option key code for authentification. For information on how to install the option refer to chapter 4.6, "Installation of R&S EX-IQ-BOX Options", on page 44.

The enclosed CPRI breakout board is directly connected to the R&S EX-IQ-BOX at the Z-Dok user interface. The connection to the device under test (DUT) is done from the breakout board, which supports small form factor pluggable (SFP) modules for the optical CPRI link. The interface is configured by the configuration software R&S DigIConf.

For information on connection of a test setup example, refer to chapter 7.2.5, "Start with CPRI - Setup Example", on page 137.

With the option R&S EXBOX-B85 you can perform tests directly in the CPRI interface between the baseband module and the RF module of a base station, i.e. between the REC and the RE. While one of the modules is simulated, the other, either the REC or the RE can be tested independently.

All state-of-the-art standards such as 3GPP FDD, incl. HSDPA, HSUPA and HSPA+, LTE, WiMAX and CDMA2000 are supported. The test solution covers individual uplink or downlink operation as well as full duplex operation. Depending on the configuration, up to 24 signal streams with settable sample rates can be processed; line bit rates of up to 3072.0 Mbps are achieved. Control and management information can be inserted, even in real-time.

In combination with R&S signal generators and R&S spectrum analyzers, the R&S EX-IQ-BOX utilizes the enhanced functions of the signal generators, like e.g. generation of digital communication signals, fading and AWGN simulation, and the signal analysis features of the spectrum analyzers, like e.g. EVM measurements for digital standards, or ACP measurement in the RF section.

The application example shows a CPRI RE test scenario, with the R&S EX-IQ-BOX emulating the baseband module REC.

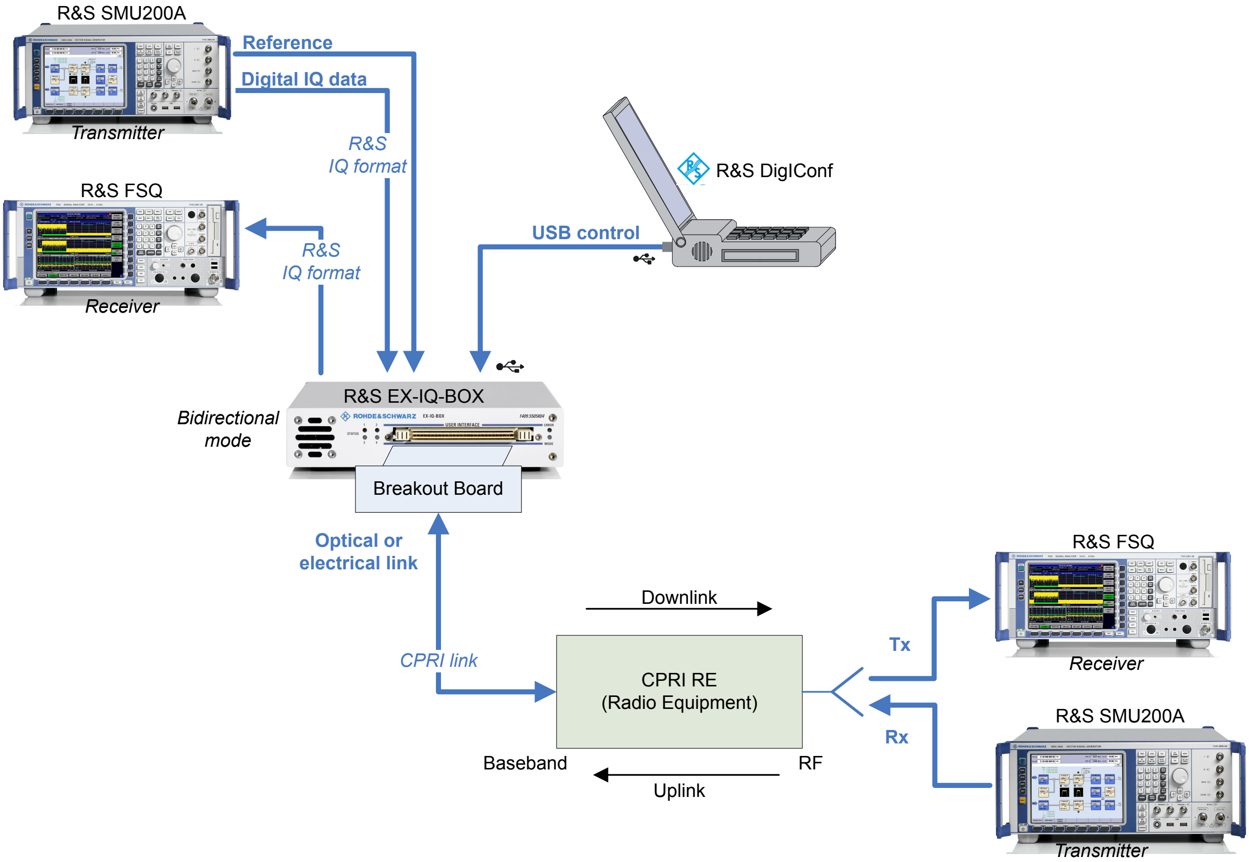


Fig. 7-45: CPRI RE test scenario, with the R&S EX-IQ-BOX emulating the baseband module REC

The test setup comprises the downlink and the uplink. Both directions can be tested either simultaneously, i.e. full duplex, or only uplink or downlink individually.

The following application example shows a CPRI **REC** test scenario, with the R&S EX-IQ-BOX emulating the RF module **RE**.

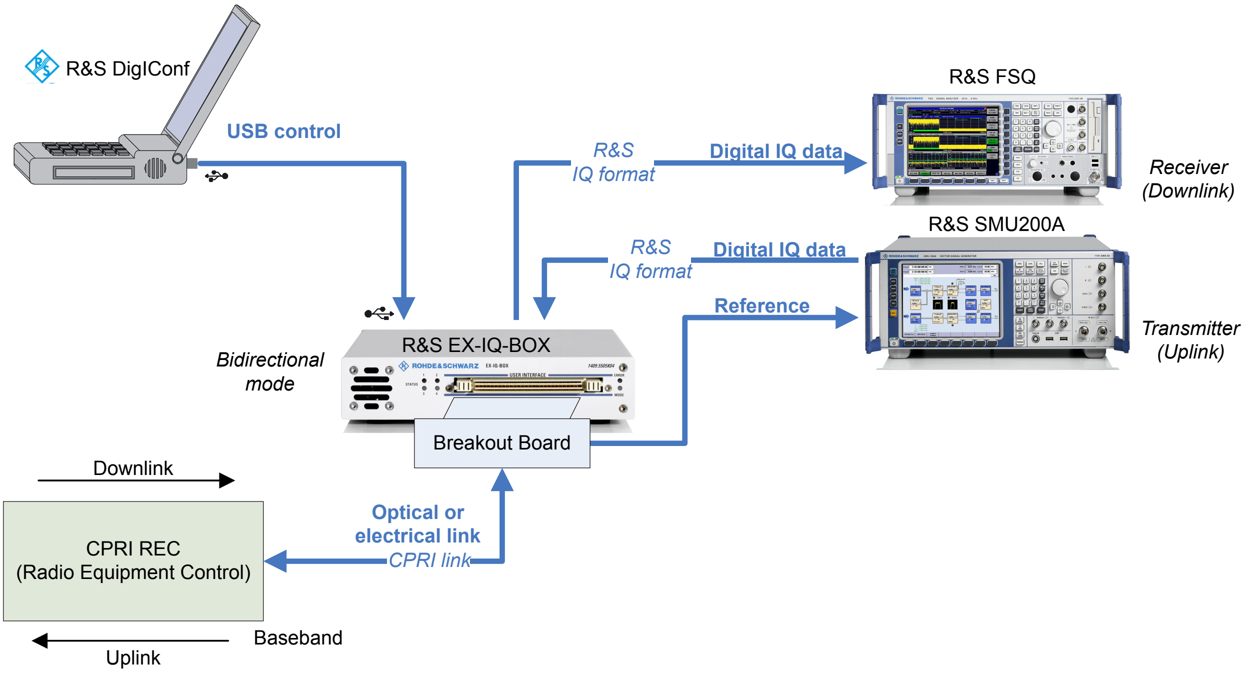
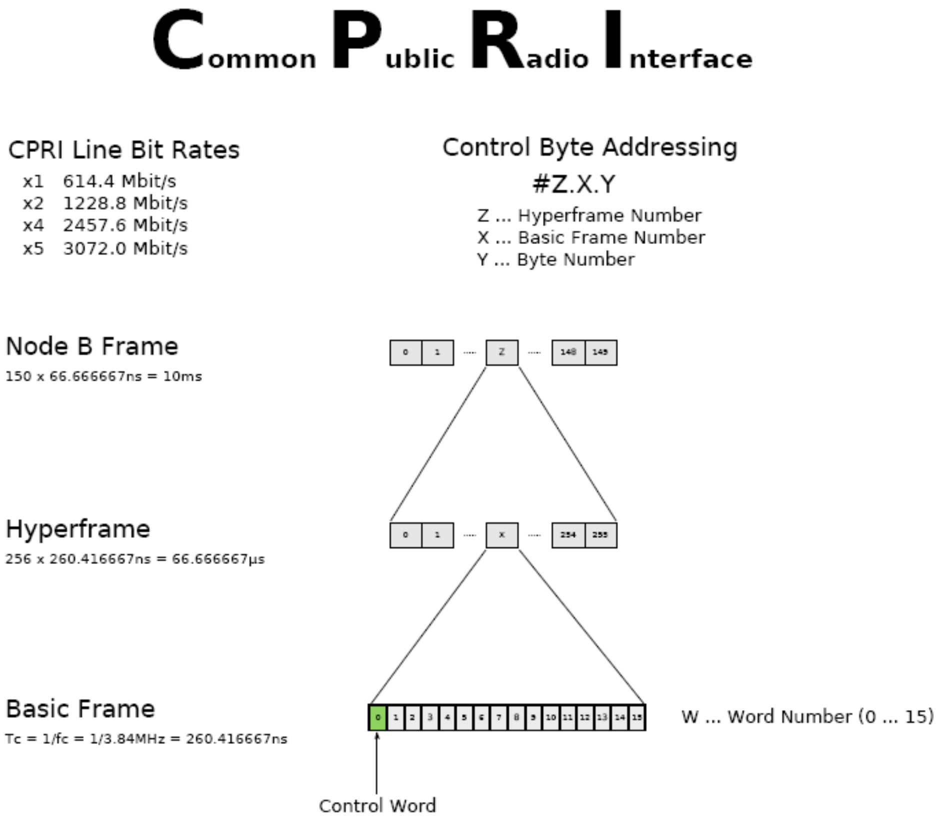


Fig. 7-46: CPRI REC test scenario, with the R&S EX-IQ-BOX emulating the RF module RE

Also in this test setup, DL and UL either can be tested simultaneously, i.e. full duplex, or Uplink/Downlink individually.

7.2.2 CPRI Transmission Protocol - Overview

In the digital link, the I/Q baseband data and control information are transmitted together in one link. The I/Q data and controlling data are embedded in the transmission protocol with the aid of the multiplex procedure. The overview shows, how the protocol is built up.



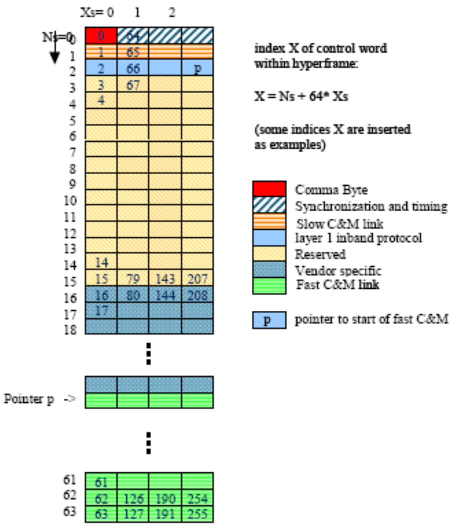


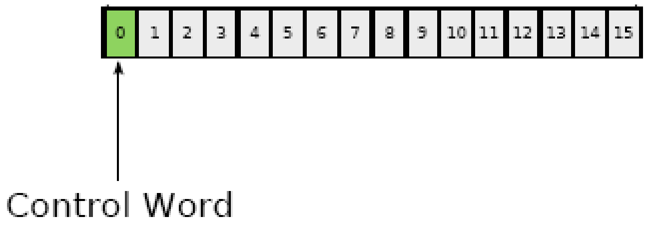
Fig. 7-47: Frame structure of the CPRI transmission protocol

7.2.2.1 Short Description of the CPRI Frame Structure

This segment briefly describes some basic features and the structure of CPRI, as shown in chapter 7.2.2, "CPRI Transmission Protocol - Overview", on page 129.

16 words, that are numbered from W0 to W15 form the **CPRI basic frame.**

Word W=0 always comes first in transmission and contains the controlling information, i.e. it is the **CPRI control word**. The remaining 15 words contain user data.



The length of the control word varies depending on the CPRI line bit rate.

256 basic frames form the **CPRI hyper frame**. Each hyper frame contains 256 control words, which in turn form one **control block.**

The control block of one hyper frame is arranged in 64 rows with 4 columns each.

Based on 3G and LTE, CPRI summarizes 150 hyper frames to a **Node B frame.**

One row within the hyper frame is a **subchannel**.

The organization of the control words in **subchannels** is illustrated in the figure below:

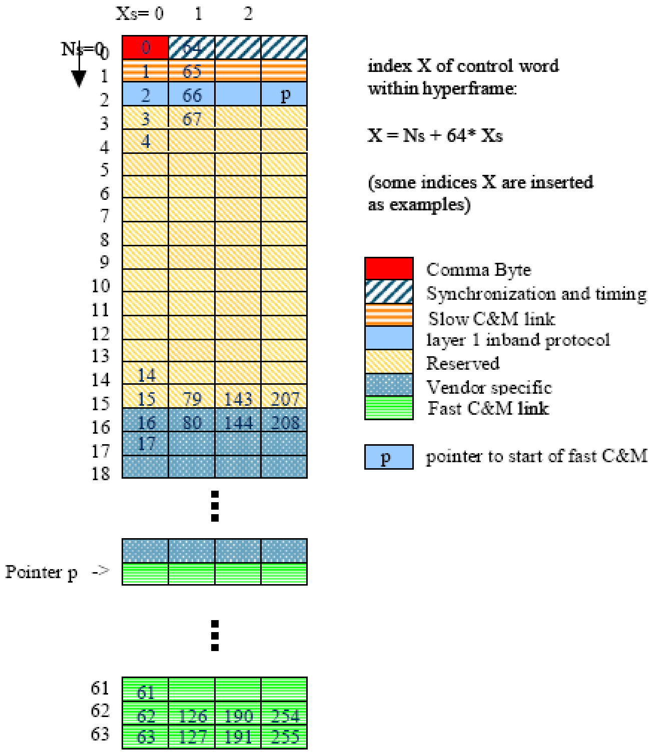


Fig. 7-48: Organization of the control words in subchannels

7.2.3 Parameter Overview

Beside the main controls, like switching on the CPRI signal transmission, mode and save/ recall of settings, the interface is controlled by various parameters, which are grouped by function:

Parameter Group	Purpose	Examples
Hardware	Hardware information on the R&S EX-IQ-BOX and the CPRI breakout board, the status of signal transmission and hardware link settings.	Hardware versions, Alarm, CPRI mode, Reference Clock, LOF or LOS (**L**oss **O**f **F**rame / **S**ignal), line bit rate, internal loopback, Input and outputs.
Downlink/Uplink	Signal definition for transmitting / receiving signals to or from the DUT, including graphical display of the CPRI frames.	Appending signals with copy function, signal source, digital standard, numeric format, allocation and AxC container definition.
Control & Management	Settings for slow or fast C&M interfaces, e.g. selecting the interface, Ethernet pointer position, host address or inserting control commands directly.	Slow C&M: Bit rate, HDLC status, Source or mode. Fast C&M: Ethernet pointer, bit rate, host, port and login data. Command editor/edit field.
Vendor Data	Vendor-specific information.	The data table enables to send binary raw data to the DUT, e.g., to test functions like AGC.

Parameter Group	**Purpose**	**Examples**
Test & Diagnostics	Diagnostics on the link interfaces and TX / RX test possibilities.	Identifier, vendor, connector type, transceiver type, module temperature, warnings. Layer events, low level BER Tests, RX Alarms.
ARB Settings	Table with information on the currently loaded waveform files.	File name, option, sample rate, samples, state and status display.
Recorder Settings	Settings for recording an I/Q signal and storing the data in a waveform file.	Data source, recording length, trigger, status display and file management

7.2.4 Control Elements and Connectors

This section explains the control elements and connectors of the breakout board for CPRI applications, i.e. the R&S EX-IQ-BOX option EXBOX-B85. With the help of the following schematic view, the control elements and the connectors are briefly described, including references to the chapters with detailed information.

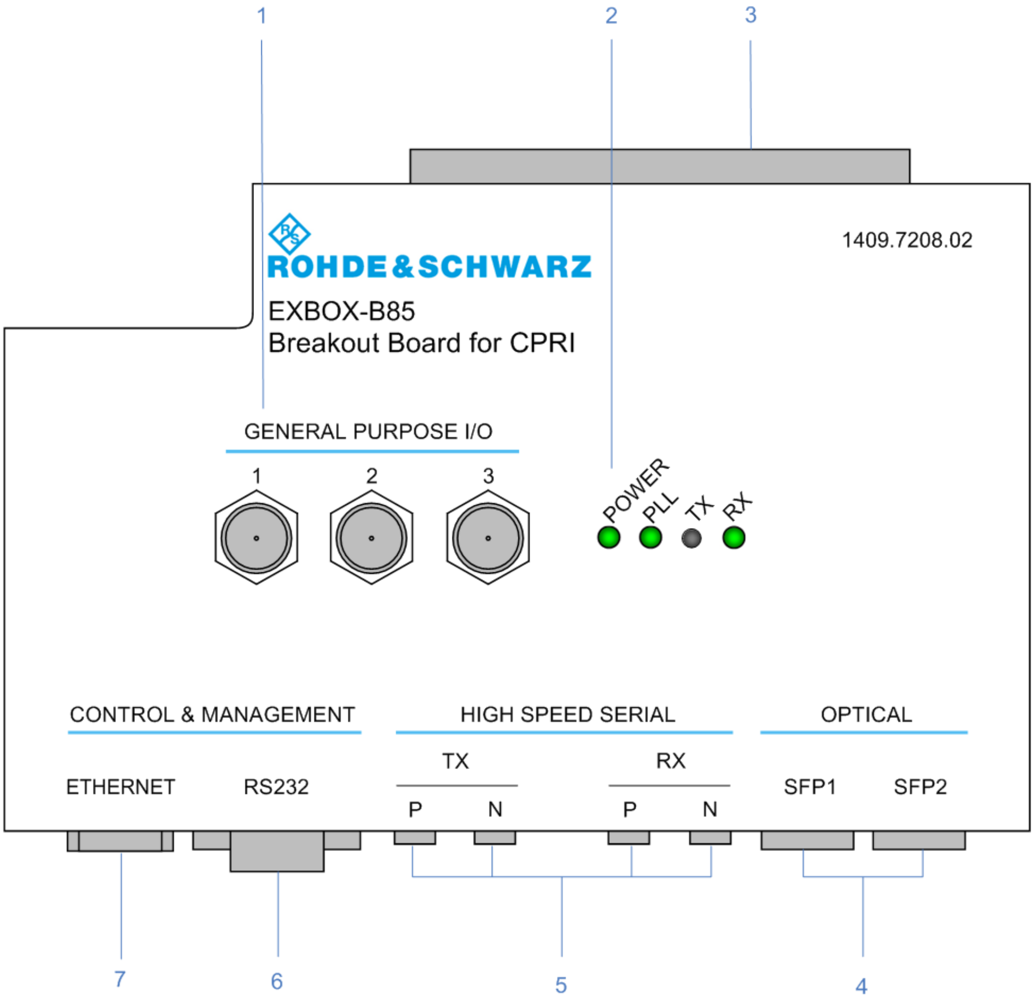
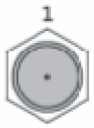


Fig. 7-49: Schematic view of the CPRI breakout board, option R&S EXBOX-B85

1 = GENERAL PURPOSE I/O - Marker signals input / output
2 = Status LEDs
3 = User Interface
4 = SFP1/SFP2 - Modules
5 = RX/TX P/N - High Speed Serial Connectors
6 = RS-232-C - Slow C&M Interface
7 = ETHERNET- Fast C&M Interface

7.2.4.1 Top View

On the top of the case, the CPRI breakout board is equipped with three BNC connectors for general purpose signals, and four status LEDs which visually indicate the status of the CPRI communication link.



GENERAL PURPOSE I/O - Marker signals input / output
BNC connectors for GPIO (**G**eneral **P**urpose **I**nput/**O**utput) to interface with the DUT, e.g. the RRH (Remote Radio Head) of a base station.

The interfaces act bidirectional, i.e. as input, to read signals from the DUT, or as output, to control the DUT. The connectors are configurable for user-specific purposes, e.g. marker or clock signals can be used as trigger signals.

The input and output voltage levels are LVTTL.

Status LEDs
The status LEDs Power, PLL (**P**hase **L**ocked **L**oop) and **TX** / **RX** visually indicate the status of the CPRI CL (**C**ommunication **L**ink) as shown in the table.

	Power	**PLL**	**Tx (downlink) / Rx (uplink)**
🟢	CL is active	locked	The CPRI frame is active, synchronized and DL and UL are active
🟡	-	-	The CPRI frame is synchronized
🔴	-	unlocked	not synchronized
⚫	CL is not active	-	-

Note: The TX/RX LEDs refer either to the SFP or to the SMA connection, depending on the settings of the high speed serial switch in the hardware section.

7.2.4.2 Rear View

The rear panel of the CPRI breakout board contains the user interface for connection with the R&S EX-IQ-BOX. Data transmission between the R&S devices is executed via this interface.

User Interface
TYCO Z-Dok adapter board connector at the rear of the CPRI breakout board. At this interface, the breakout board is connected directly to the R&S EX-IQ-BOX by a 168 pin connector, type TYCO Z-Dok (56 differential pairs).

see chapter 10.1.1, "Z-DOK-Adapter Board Connector", on page 441

7.2.4.3 Front View

On the front panel, the CPRI breakout board provides the interfaces to the DUT. The breakout board supports the optical CPRI link with two SFP modules, and contains a differential electrical interface, realized by four SMA connectors. In addition, the interfaces Ethernet and RS-232-C provide the input or output for C&M (**C**ontrol and **M**anagement) data. The connectors are labeled on the top on the case.

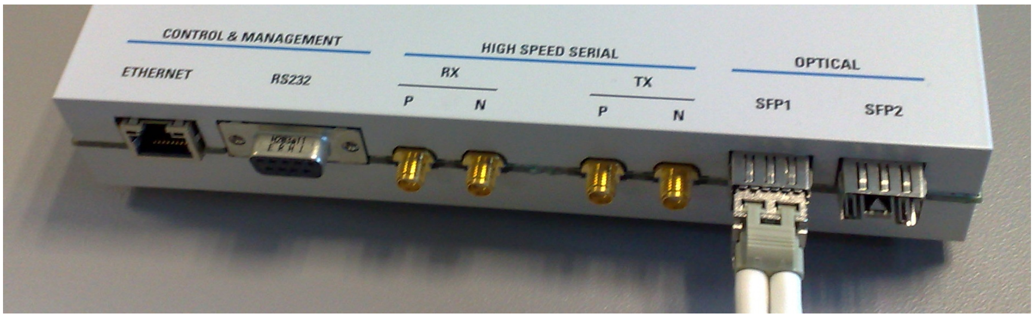


Fig. 7-50: Front panel view

SFP1/SFP2 - Modules

SFP (**S**mall **F**orm-factor **P**luggable) transceiver that interfaces the CPRI breakout board with the DUT via a fiber glass cable or a copper cable.

These interfaces can be manually adapted by interchangeable slide-in modules and therefore provide adjustment to the special demand of the applications.

The CPRI breakout board covers two cages, i.e. sockets to insert an SFP module, that are standardized according to MSA (**M**ulti-**S**ource **A**greement of September the 14th, 2000).

SFP transceivers are available for several communications standards. They support high data rates in electro optical netwoks and also in fiber optic networks.

RX/TX P/N - High Speed Serial Connectors

Two SMA (**S**ub**M**iniature version **A**) connectors for differential data transmission. These SMA connectors are coaxial connectors with a differential impedance of 100 Ohm, and the logic type CML (**C**urrent **M**ode **L**ogic), a differential digital logic family for high speed data transmission. CML follows the to XAUI (**X** **A**ttachment **U**nit **I**nterface) standard, while X stands for 10 Gigabit.

Note: CPRI primarily uses the optical link via the SFP interfaces. Additionally, the breakout board delivers the signals at these interfaces, e.g., to execute a concurrent monitoring of the signals. See chapter 7.2.7.5, "SMA Settings", on page 151 to activate the interface and to set the corresponding parameters.

RS-232-C - Slow C&M Interface

RS-232-C interface for slow transmission of control and management data between the PC and the CPRI breakout board.

The interface supports bidirectional data transmission of C&M data from a customized software.

Note: For transmission of control signals by means of R&S DigIConf, use the USB connection between the control PC and the R&S EX-IQ-BOX.
Set the corresponding data source in the Slow C&M (HDLC) panel of R&S DigIConf according to your setup.

Select the bit rate Slow C&M (HDLC) panel of R&S DigIConf.

See also chapter 7.2.9.1, "Slow C&M (HDLC)", on page 174.

ETHERNET - Fast C&M Interface
Ethernet IEEE 802.3u interface for fast transmission of control and management data between the controlling PC and the CPRI breakout board. The interface supports bidirectional data transmission of C&M data either from a customized software, or from R&S DigIConf.

The PC is connected to the CPRI breakout board with the aid of a commercial RJ-45 CAT7 crossover cable.

Note: Depending on the line rate and the position of the Ethernet pointer, the data transfer rate varies. For information in detail, refer to chapter 7.2.9.2, "Fast C&M (Ethernet)", on page 177.

7.2.5 Start with CPRI - Setup Example

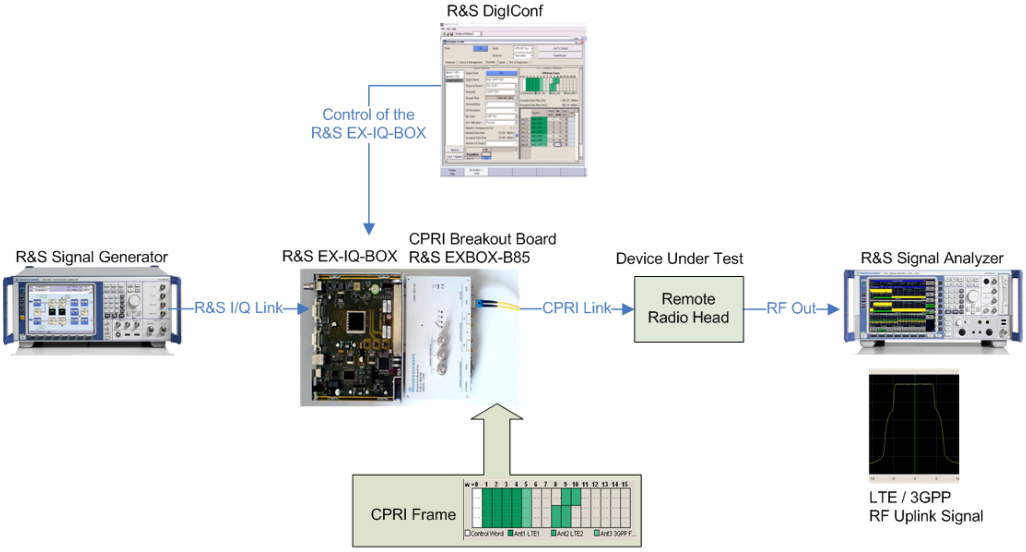
This section describes a **RE** (**R**adio **E**quipment) test setup for testing **RRH** (**R**emote **R**adio **H**ead) with the CPRI transmission protocol in downlink mode.

This description refers to an example of a CPRI application and shows the configuration of this test setup. Therefore it cannot be applied directly to other test setups. For information on how to set up your CPRI application refer to the characteristics of your DUT.

For connection in general refer to chapter chapter 4.5, "Connecting the R&S EX-IQ-BOX", on page 42.

Note: You find a detailed explanation of the CPRI parameter settings under chapter 7.2.6, "Main Configuration Dialog", on page 145, and the following chapters.

7.2.5.1 Overview



The signal generator feeds the baseband signal digitally to the R&S EX-IQ-BOX, i.e. in the R&S specific I/Q format. The R&S EX-IQ-BOX converts the signal format into the

CPRI transmission protocol with the aid of the breakout board. The CPRI link transmits the I/Q baseband signal and also control & management information to the RRH, i.e. the CPRI RE Device.

The RRH device extracts the baseband signal from the CPRI link and executes an I/Q modulation to a certain carrier frequency. The resulting RF signal is sent to the R&S signal analyzer, to perform various performance measurements.

7.2.5.2 Used Devices and Cables

Devices:

- R&S EX-IQ-BOX V04 including external power supply
- R&S EXBOX-B85 CPRI breakout board
- an SFP module for the SFP1 cage of the CPRI breakout board
- an R&S signal generator, e.g. R&S SMU200A, or R&S AMU200A, equipped with digital baseband output, option B18
- an R&S signal analyzer, e.g. an R&S FSQ, or an equivalent instrument, which can demodulate 3GPP W-CDMA, LTE, WiMAX signals
- a DUT, e.g. a Remote Radio Head, with power supply

Cables:

- a LVDS cable SMU-Z7
- 2 BNC cables
- an RF cable
- an optical cable
- an USB cable

7.2.5.3 Setup of the Devices

Cabling

1. Connect the R&S EX-IQ-BOX to the AC supply.
   The R&S EX-IQ-BOX is power supplied with an external power supply unit and a separate power cable.
2. Connect the CPRI breakout board to the R&S EX-IQ-BOX, i.e. at the Z-DOK user interface connector.
   The R&S EX-IQ-BOX powers the CPRI breakout board via the user interface.
3. Establish the connection between the BBOUT of the R&S signal generator and the DIG IQ IN/OUT 1 of the R&S EX-IQ-BOX.
   Currently, the interface DIG IQ IN/OUT 1 is firmly set to input.
4. Connect the analyzer's REF OUT and the generator's REF IN, and connect the generator's REF OUT with REF IN of the R&S EX-IQ-BOX.

5. Connect the USB cable plug A to the PC, and plug B to the R&S EX-IQ-BOX (USB IN)
6. Plug the SFP module into the SFP cage on the breakout board
7. Connect the power supply to the RRH.
8. Establish the optical connection between the breakout board and the RX/TX input of the RRH.
9. Connect the RF output of the RRH, i.e. the RRH antenna with the analyzer's RF input.

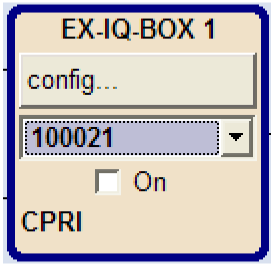
Make sure that you use adequate attenuation in order not to damage the analyzer, as the output power may exceed the analyzer's maximum power. You find the maximum input level of your analyzer in the data sheet.

Setting the R&S Signal Generator

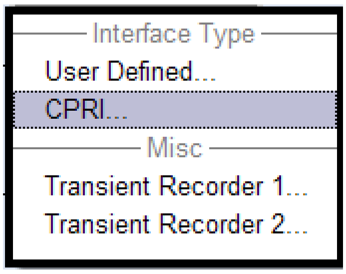
1. Preset the R&S signal generator.
2. Set reference frequency on externally, as the reference frequency is fed in from the signal analyzer.
3. Activate the test signal, e.g. 3GPP FDD in the respective baseband block.
4. Set the sample rate of the digital signal output according to the settings in R&S DigIConf, i.e. 7.68 MHz.
5. Set the sample rate of the digital signal output to 7.68 MHz in "User Defined" mode.

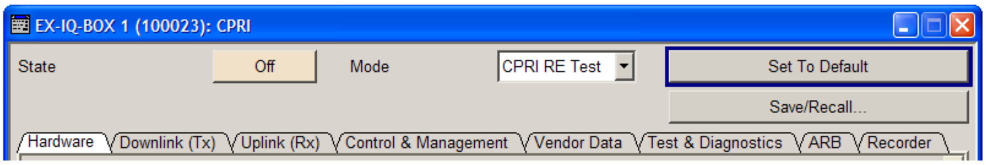
Setting the CPRI Protocol

1. Start the R&S DigIConf software on the PC.
   R&S DigIConf recognizes connected R&S EX-IQ-BOX devices and indicates their IDs in the selection list below the "config..." button in the block diagram.

2. Select the respective R&S EX-IQ-BOX.
3. Open the CPRI settings dialog with "config...".

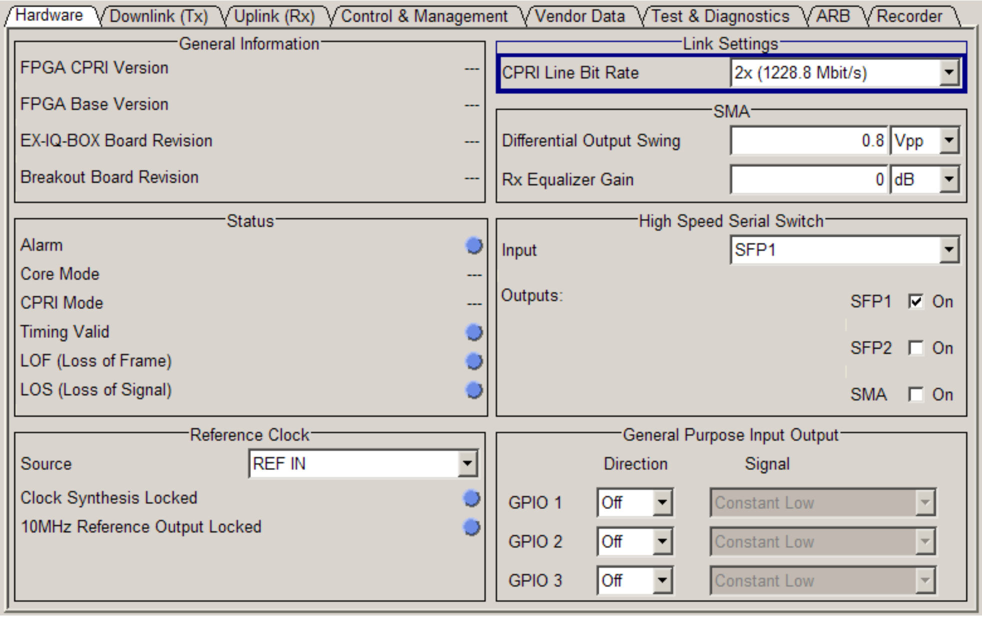



EX-IQ-BOX 1 (100023): CPRI

State: Off

Mode: CPRI RE Test

4. "Set to Default" to start in a defined state.


General Information

FPGA CPRI Version: ---

FPGA Base Version: ---

EX-IQ-BOX Board Revision: ---

Breakout Board Revision: ---

Link Settings

CPRI Line Bit Rate: 2x (1228.8 Mbit/s)

SMA

Differential Output Swing: 0.8 Vpp

Rx Equalizer Gain: 0 dB

Status

Alarm: ●

Core Mode: ---

CPRI Mode: ---

Timing Valid: ●

LOF (Loss of Frame): ●

LOS (Loss of Signal): ●

High Speed Serial Switch

Input: SFP1

Outputs: SFP1 ☑ On; SFP2 ☐ On; SMA ☐ On

Reference Clock

Source: REF IN

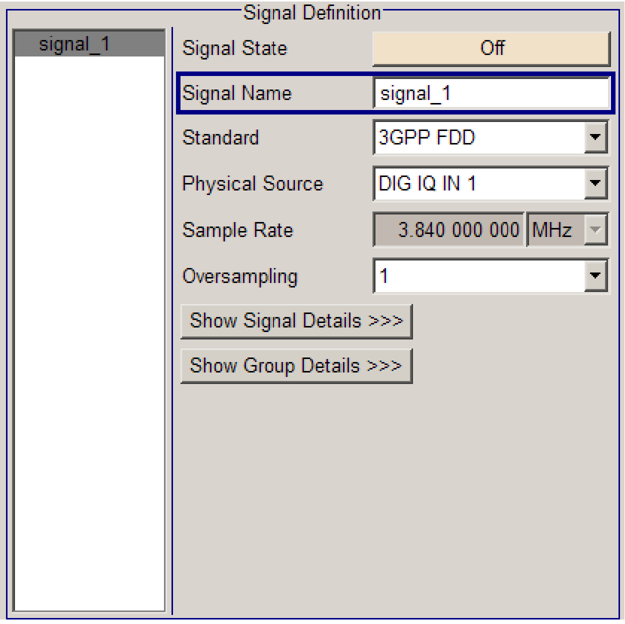
Clock Synthesis Locked: ●

10MHz Reference Output Locked: ●

General Purpose Input Output

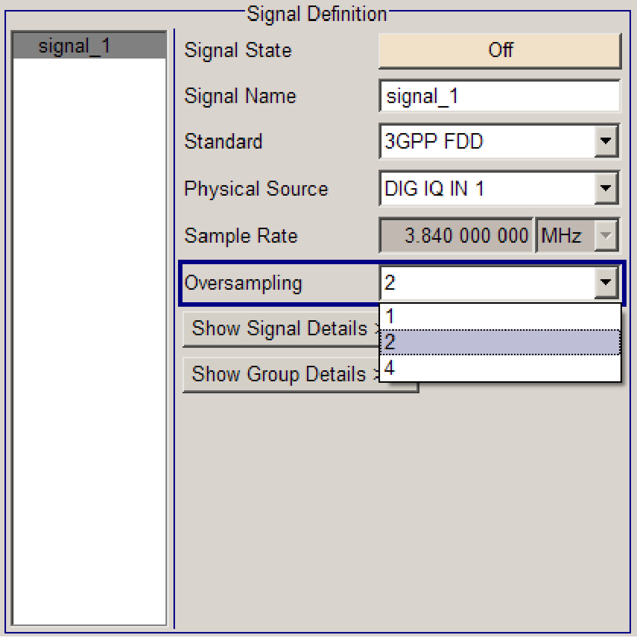
	Direction	Signal
GPIO 1	Off	Constant Low
GPIO 2	Off	Constant Low
GPIO 3	Off	Constant Low

5. Select the appropriate output port in the "Hardware" tab, and set the "CPRI Line Bit Rate", the SFP connection supports.
6. Switch to the "Downlink" tab, and select the *3GPP FDD* signal.



Signal State: Off
Signal Name: signal_1
Standard: 3GPP FDD
Physical Source: DIG IQ IN 1
Sample Rate: 3.840 000 000 MHz
Oversampling: 1

7. Set "Oversampling" *2*.



Signal State: Off
Signal Name: signal_1
Standard: 3GPP FDD
Physical Source: DIG IQ IN 1
Sample Rate: 3.840 000 000 MHz
Oversampling: 2

8. The sampling rate and oversampling correspond to the incoming 3GPP FDD signal:

   Sample Rate $_{\text{EX-IQ-BOX}}$ · Oversampling = Sample Rate $_{\text{Signal Generator}}$
   3.84 MHz · 2 = 7.68 MHz

   Now the R&S EX-IQ-BOX is configured to communicate with the RRH via the CPRI transmission protocol in downlink mode.

9. Switch on "Signal State" and "State".

10. Press "Apply Setup" to assign the settings.

Setting the RRH

DUT dependent settings

For the setup of the RRH, refer to the information on your instruments and the respective tools and utilities.

Setting the R&S Signal Analyzer

1. Preset the R&S signal analyzer.
2. Set it to center frequency *2.5 GHz*, corresponding to the carrier frequency of the DUT.
3. Set "Span" *20 MHz*, and set "Level" *+10 dBm*.

7.2.5.4 Measuring process

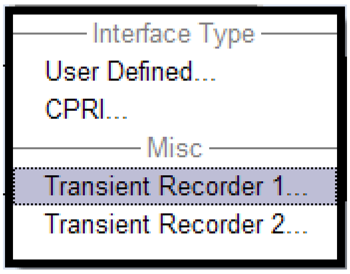
If the CPRI link is active, and the RRH transmits the signal correctly, all LEDs on the breakout board are green.

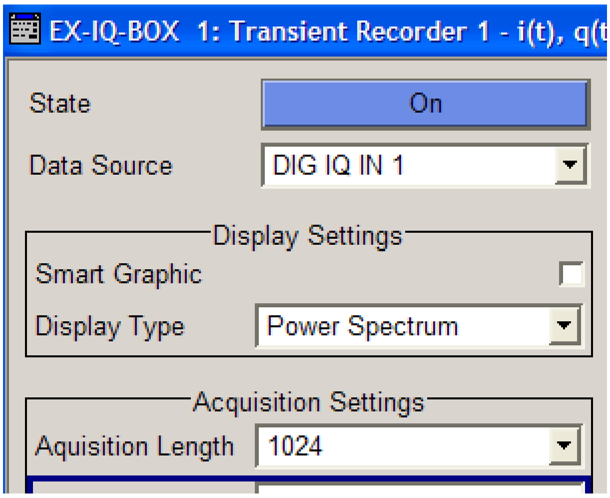
Measuring the I/Q Signal

Check signal output

To see if the signal is properly transmitted, you can record and display the signal with the transient recorder.

1. Switch on the transient recorder of the active R&S EX-IQ-BOX.





EX-IQ-BOX 1: Transient Recorder 1 - i(t), q(t

State: On

Data Source: DIG IQ IN 1

Display Settings

Smart Graphic ☐

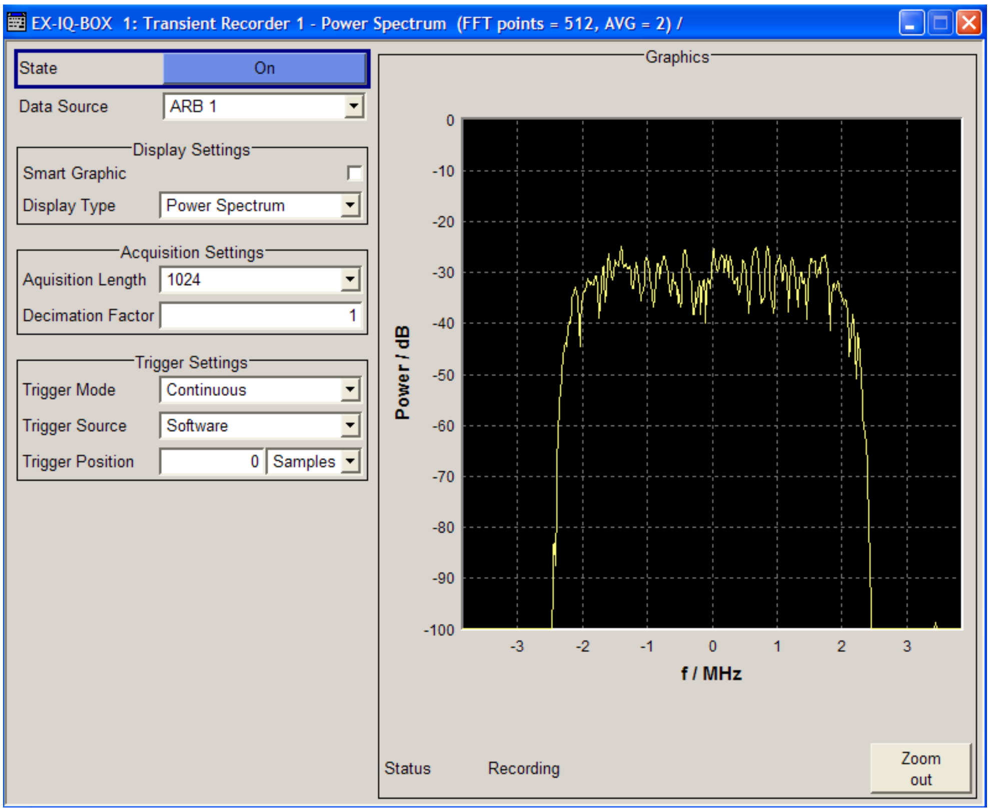
Display Type: Power Spectrum

Acquisition Settings

Aquisition Length: 1024

2. To capture the digital I/Q signal, set:
   a) "Data Source": *Dig IQ IN 1*
   b) "Display Type": *Power Spectrum*
   c) "Acquisition Length": *1024*

   The Recording Memory records the signal data and displays the 3GPP FDD signal in the graphics window.



EX-IQ-BOX 1: Transient Recorder 1 - Power Spectrum (FFT points = 512, AVG = 2) /

State: On

Data Source: ARB 1

Display Settings

Smart Graphic ☐

Display Type: Power Spectrum

Acquisition Settings

Aquisition Length: 1024

Decimation Factor: 1

Trigger Settings

Trigger Mode: Continuous

Trigger Source: Software

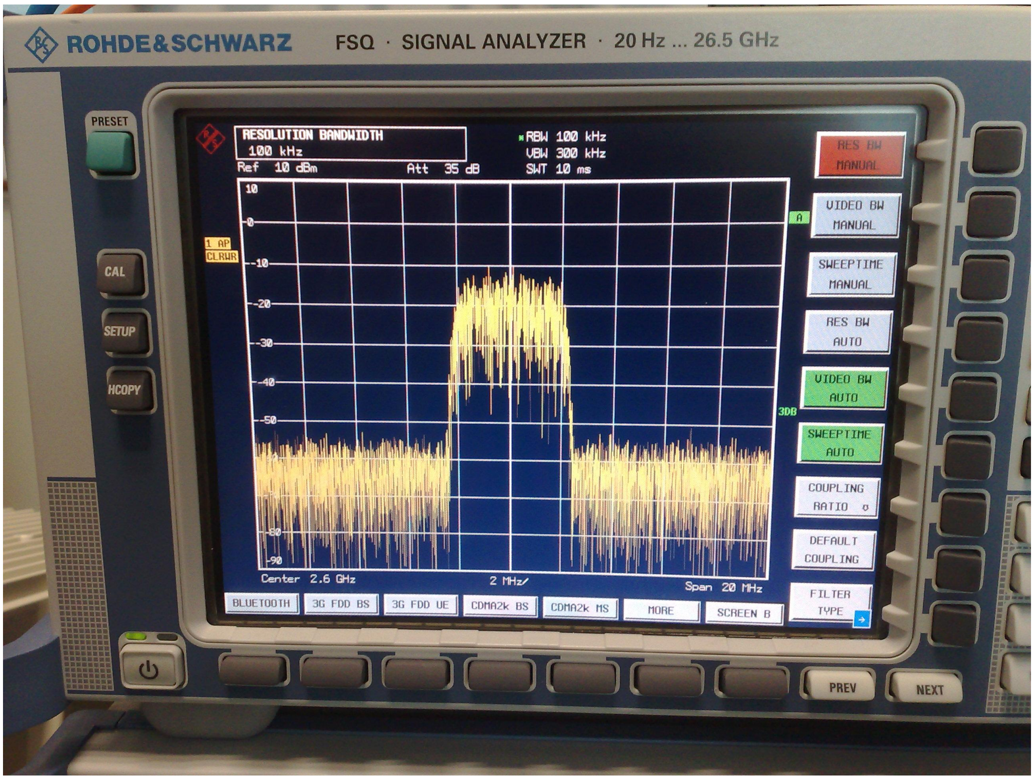
Trigger Position: 0 Samples

Status: Recording

Fig. 7-51: Recording the outgoing digital standard signal 3GPP FDD

Measuring the RF Output Signal of the RRH

The RRH sends the RF signal to the R&S spectrum analyzer.

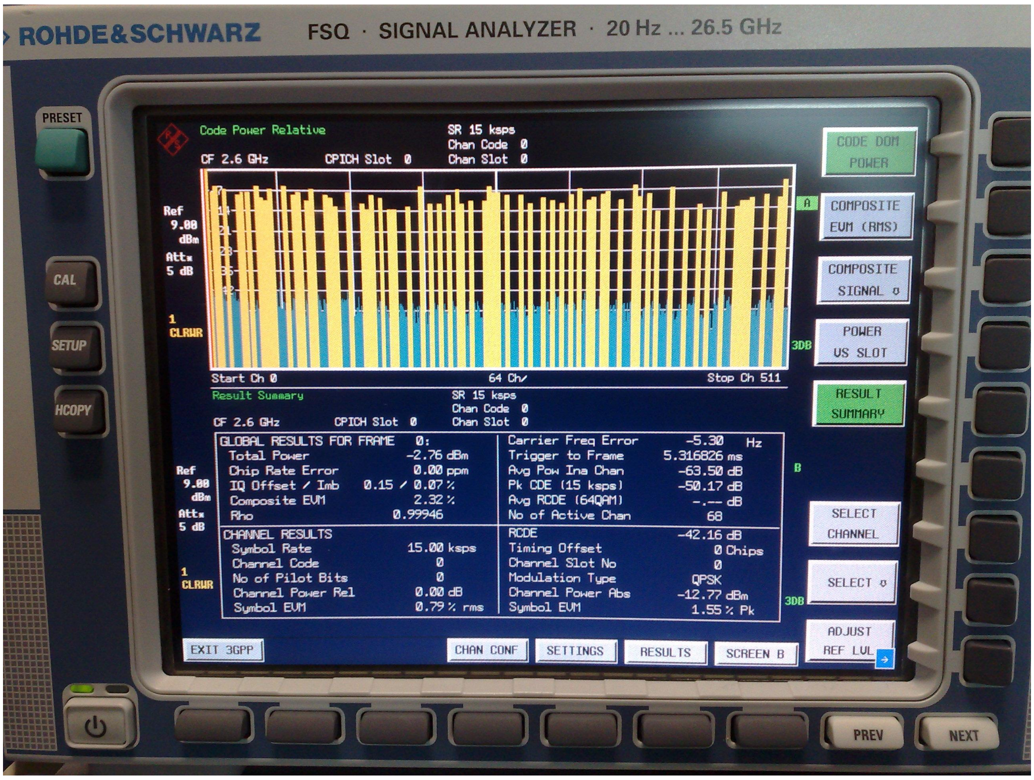


The analyzer displays power spectrum of the 3GPP FDD signal.

Now you can perform measurements that you need, such as, for example, ACP (**A**djacent **C**hannel **P**ower) measurements and EVM (**E**rror **V**ector **M**agnitude) evaluation, or additional measurements provided by the R&S signal analyzer.

Example:

Switch to 3GPP FDD BS demodulation.

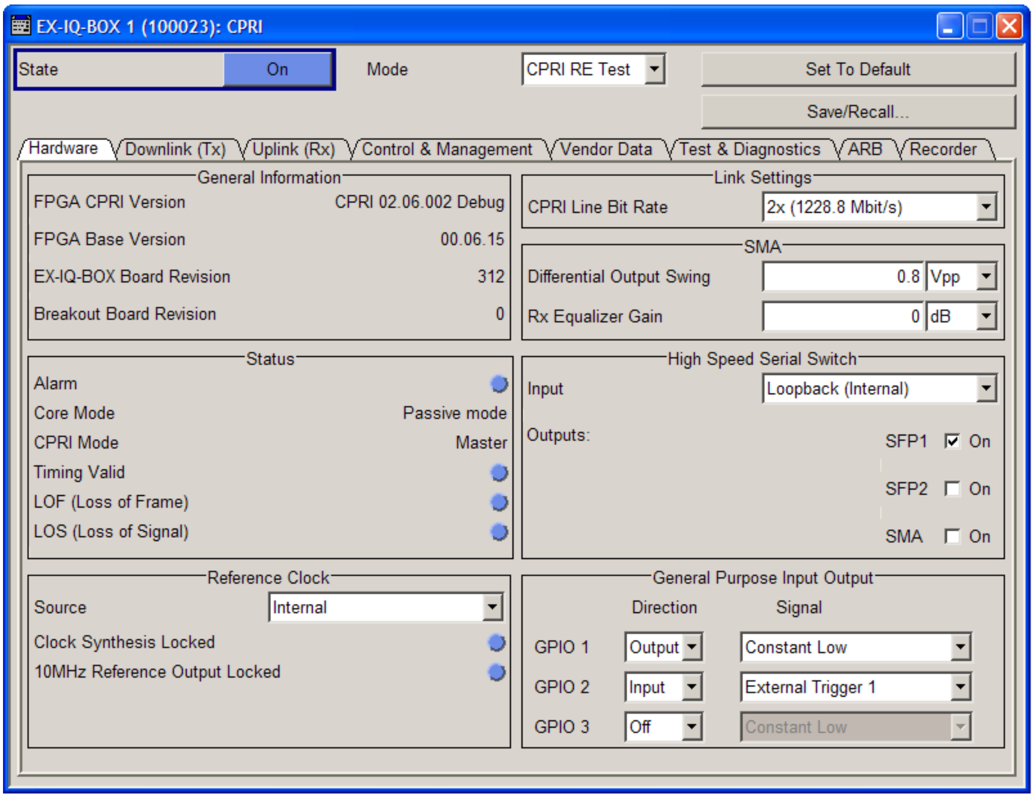


```
Result Summary                          SR 15 ksps
                                        Chan Code  0
CF 2.6 GHz        CPICH Slot  0         Chan Slot  0
GLOBAL RESULTS FOR FRAME   0:           Carrier Freq Error       -5.30   Hz
  Total Power                -2.76 dBm  Trigger to Frame     5.316826 ms
  Chip Rate Error             0.00 ppm  Avg Pow Ina Chan        -63.50 dB
  IQ Offset / Imb     0.15 / 0.07 %     Pk CDE (15 ksps)        -50.17 dB
  Composite EVM               2.32 %    Avg RCDE (64QAM)          -.-- dB
  Rho                      0.99946      No of Active Chan          68
CHANNEL RESULTS                         RCDE                    -42.16 dB
  Symbol Rate               15.00 ksps  Timing Offset               0 Chips
  Channel Code                  0       Channel Slot No             0
  No of Pilot Bits              0       Modulation Type          QPSK
  Channel Power Rel          0.00 dB    Channel Power Abs       -12.77 dBm
  Symbol EVM                 0.79 % rms Symbol EVM               1.55 % Pk
```

The analyzer displays the demodulation result of the incoming signal

7.2.6 Main Configuration Dialog

Besides the settings that are relevant for CPRI protocol settings, the CPRI configuration dialog comprises the common main controls as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading previously defined settings. The main controls are fixed and always indicated, independently from the active subdialog, and from the active transmission protocol. A detailed description of these general functions is given in chapter 7.2.6.1, "Main Controls", on page 146.



State: On
Mode: CPRI RE Test

FPGA CPRI Version: CPRI 02.06.002 Debug
FPGA Base Version: 00.06.15
EX-IQ-BOX Board Revision: 312
Breakout Board Revision: 0

CPRI Line Bit Rate: 2x (1228.8 Mbit/s)
Differential Output Swing: 0.8 Vpp
Rx Equalizer Gain: 0 dB

Alarm: ●
Core Mode: Passive mode
CPRI Mode: Master
Timing Valid: ●
LOF (Loss of Frame): ●
LOS (Loss of Signal): ●

Input: Loopback (Internal)
Outputs: SFP1 ☑ On; SFP2 ☐ On; SMA ☐ On

Source: Internal
Clock Synthesis Locked: ●
10MHz Reference Output Locked: ●

GPIO 1: Output, Constant Low
GPIO 2: Input, External Trigger 1
GPIO 3: Off, Constant Low

Fig. 7-52: CPRI main configuration dialog

Grouped by functionality the configuration dialog also comprises subdialogs for Hardware settings, for Downlink and Uplink configuration, for Control & Management parameters and Test & Diagnostics. For the description in detail, refer to chapter 7.2.7, "Hardware", on page 148, chapter 7.2.9, "Control & Management", on page 174, chapter 7.2.8, "Downlink and Uplink", on page 154, and chapter 7.2.11, "Test & Diagnostics", on page 181.

Additionally, you find a tab for ARB settings in the dialog, that is used if the R&S EX-IQ-BOX is equipped with an option for waveform memory. Find the respective information on ARB functions in chapter 7.2.12, "ARB", on page 186.

Finally, you find the "Recorder" tab, see chapter 7.2.13, "Recorder", on page 189 for description. If the R&S EX-IQ-BOX is equipped with tehj appropriate option for waveform recording, you can record the I/Q signals.

7.2.6.1 Main Controls

Besides the settings that are relevant for the CPRI transmission protocol, the CPRI configuration dialog contains the common main controls as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading settings. The main controls are permanently indicated, independently of the active subdialog and interface standard.

State

Activate or deactivate the CPRI standard. The corresponding FPGA (**F**ield **Pro**grammable **A**rray) is loaded automatically into the R&S EX-IQ-BOX.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:STATe` on page 359

Mode

Select a CPRI test scenario. In RE test mode, the R&S EX-IQ-BOX is working as a baseband module (REC) for testing the RE. Vice versa, in REC test mode, the R&S EX-IQ-BOX simulates the RF module (RE) for testing the opposite module REC.

"CPRI RE Test"	Select RE (**R**adio **E**quipment) test mode.
"CPRI REC Test"	Select REC (**R**adio **E**quipment **C**ontrol) test mode.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:MODE` on page 359

Set To Default

Set all parameters to default values. Refer to chapter A.3.2, "CPRI Default Settings", on page 466, containing an overview of the most important CPRI default settings.

SCPI command:

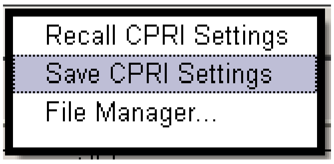
`[:SOURce<hw>]:EBOX:CPRI:PRESet` on page 359

Save / Recall

Open the "Save/Recall" dialog to store or to load CPRI the settings, or to call the file manager.

CPRI settings are stored as files with the predefined file extension ***.cpri**. File name and directory user-selectable.

The complete settings of the CPRI current configuration are stored.



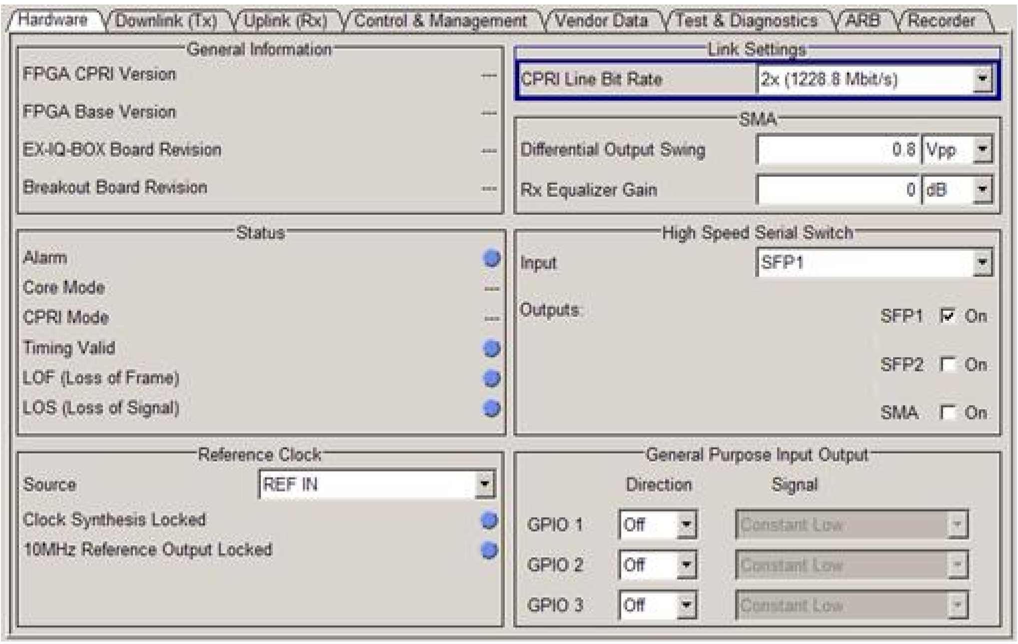
"Recall CPRI Settings"	Open the file select window for loading a previously saved CPRI configuration. Load the configuration of the selected (highlighted) file by pressing the "Select" button.
"Save CPRI Settings"	Opens the file select window for saving the CPRI settings. Determine the file name and save with the "Save" button.

"File Manager"	Calls the "File Manager". `*.cpri` is preset in the "File Type" entry field. The file manager is used to copy, delete, and rename files and to create new directories.

SCPI command:
Settings files catalog: `[:SOURce<hw>]:EBOX:CPRI:SETTing:CATalog` on page 365
Recall file: `[:SOURce<hw>]:EBOX:CPRI:SETTing:LOAD` on page 365
Save file: `[:SOURce<hw>]:EBOX:CPRI:SETTing:STORe` on page 366

7.2.7 Hardware

The **Hardware** tab contains all settings of CPRI hardware parameters, including the assignment to the connected interfaces, special settings of the link, status information, reference clock settings, and general information on the CPRI option R&S EXBOX-B85.



FPGA CPRI Version ---
FPGA Base Version ---
EX-IQ-BOX Board Revision ---
Breakout Board Revision ---
CPRI Line Bit Rate 2x (1228.8 Mbit/s)
Differential Output Swing 0.8 Vpp
Rx Equalizer Gain 0 dB
Alarm ●
Core Mode ---
CPRI Mode ---
Timing Valid ●
LOF (Loss of Frame) ●
LOS (Loss of Signal) ●
Input SFP1
Outputs: SFP1 ☑ On
SFP2 ☐ On
SMA ☐ On
Source REF IN
Clock Synthesis Locked ●
10MHz Reference Output Locked ●
GPIO 1 Off Constant Low
GPIO 2 Off Constant Low
GPIO 3 Off Constant Low

Fig. 7-53: CPRI hardware dialog box

7.2.7.1 General Information

Section "General Information" indicates the board revisions, and the FPGA versions of the R&S EX-IQ-BOX and of the breakout board.

FPGA CPRI Version
Indicates the version of the FPGA (**F**ield **Prog**rammable **G**ate **A**rray) CPRI design.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:FCVersion` on page 350

FPGA Base Version

The version of the FPGA (**F**ield **Pro**grammable **G**ate **A**rray) basic design.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:HW:FBVersion` on page 350

R&S EX-IQ-BOX Board Revision

Indicates the revision number of the R&S EX-IQ-BOX´s internal board.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:HW:EBRevision` on page 349

Breakout Board Revision

Shows the revision number of the connected breakout board.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:HW:BBRevision` on page 348

7.2.7.2 Status

Status indicates the status of the last query on the active link. By means of an LED display, R&S DigIConf indicates alarm and error messages as e.g LOF or LOS. In case of malfunction, the respective LEDs change from blue to red. Once CPRI is turned on, all parameters are updated continuously. If CPRI is off, the parameters are set to default value.

Alarm

Indicates red, if any alarm is detected. This LED acts on behalf of all warnings.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:HW:ALARm` on page 348

Core Mode

Indicates the current state of the CPRI core.

The CPRI core can work in the following states:

- "Link is up"
  normal operating mode
- "Reset"
  at the starting point of establishing the link
- "L1 Synchronization"
  attempt of L1 synchronization
- "Setup protocol version"
- "Setup C&M parameter"
- "Passive mode"
  only I/Q data are active, C&M is not used

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:HW:CORE` on page 349

CPRI Mode
Displays the role of the R&S EX-IQ-BOX, i.e. either master (CPRI RE test) or slave (CPRI REC test).

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:CMODe` on page 349

Timing valid
Indicates red, if the R21 timing calculation is invalid (CPRI requirement 21).

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:TIMing` on page 358

LOF (Loss of Frame)
Indicates red, if the CPRI frame delimiter K28.5 is not found.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:LOF` on page 354

LOS (Loss of Signal)
Indicates red, if the data lost their synchronization.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:LOS` on page 355

7.2.7.3 Reference Clock

Section "Reference Clock" provides the selection of the clock source for the CPRI communication link. Depending on the CPRI test mode, the possible sources for the reference signal differ.

Source
Selects the source of the reference signal. In test mode CPRI RE, the R&S EX-IQ-BOX is synchronized either external or internally. Test mode CPRI REC uses the reference clock embedded in the CPRI link.

"REF IN"	CPRI RE test setup with a connected R&S instrument. The R&S EX-IQ-BOX synchronizes the CPRI communication link with the reference signal provided by an R&S instrument. The 10 MHz signal is fed to the BNC connector REF IN on the back of the R&S EX-IQ-BOX.
"Internal"	CPRI RE test setup, if the R&S EX-IQ-BOX is working stand-alone. The R&S EX-IQ-BOX uses its internal reference oscillator for synchronization.
"Clock Recovery"	CPRI REC test mode. The reference clock is extracted from the CPRI link. This selection is mandatory in a CPRI REC test setup, since the R&S EX-IQ-BOX operates in CPRI slave mode.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:SOURce` on page 356

Clock Synthesis Locked
Indicates red, if the main PLL of the R&S EX-IQ-BOX is unlocked. This state is fundamental and must be locked in every operating mode of the R&S EX-IQ-BOX.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:CSLocked` on page 355

Clock Recovery Locked
Indicates red, if clock recovery is unlocked. Clock recovery must be locked in CPRI REC test mode.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:CRLocked` on page 355

10MHz Reference Output Locked
Turns red, if the reference clock output is not available.

A second synthesizer generates a 10 MHz reference clock selectable at one of the GPIO interface connectors. The status LED turns blue, if the clock output is available.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:ROLocked` on page 356

7.2.7.4 Link Settings

In section "Link Settings" you can set the line bit rate for the communication link.

CPRI Line Bit Rate
Select the line bit rate for the communication link. The line bit rate defines the total number of bits transferred per second over the CPRI communication link, including control and I/Q data, and 8B10B line coding.

Available line bit rates are:

- "2x1228.8" Mbit/s
- "5x3072.0" Mbit/s
- "4x2457.6" Mbit/s

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:LBRate` on page 354

7.2.7.5 SMA Settings

This section of the "Hardware" tab contains the electrical parameters of the SMA interface.

Differential Output Swing
Determine the differential output voltage swing of the CML (**C**urrent **M**ode **L**ogic) transmitter.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:SMA:DOSWing` on page 357

RX Equalizer Gain

Set the input gain of the equalizer. This equalizer is an active high-pass filter, that equalizes the low-pass behavior of the transmission medium, such as e.g. the FR4 backplane. The gain, expressed in dB, relates to the frequency of 2 GHz.

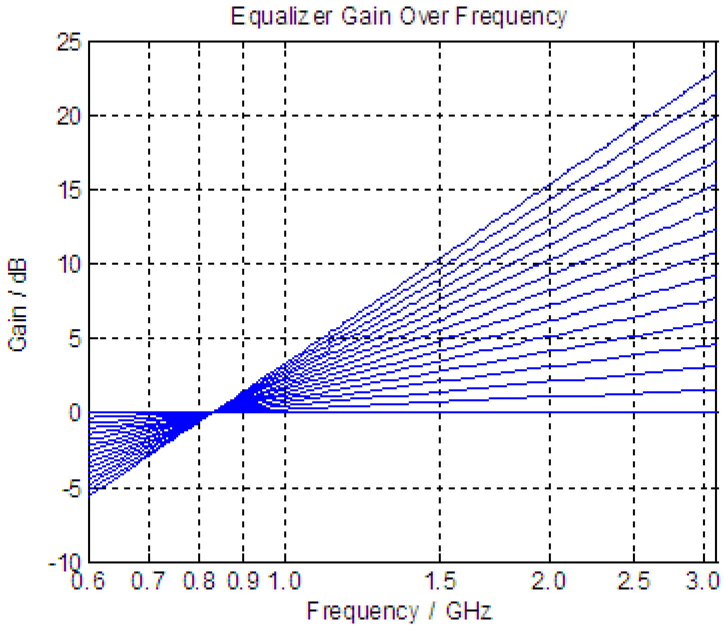


Fig. 7-54: CPRI - equalizer gain over frequency

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:HW:SMA:RXEGain` on page 357

7.2.7.6 High Speed Serial Switch

In this section, you can assign input or output to the connected interfaces.

Note that CPRI recommends to use optical transceivers that follow the High Speed Serial Link standards. CPRI mainly transfers the signal via the optical connection.

Use the electrical connection at the SMA connectors for debugging routines.

Basically the R&S EX-IQ-BOX receives a CPRI signal via one of the optical interfaces SFP1, or SFP2. SMA is used, primarily, to the diagnosis.

For test purposes, the signal can be looped back internally. Then all the signal processing, as well as the CPRI transmitter and receivers operate normally without having an external device to be connected.

Input

Determine the interface for signal input. Note that only one interface can be active at the same time.

Basically the R&S EX-IQ-BOX receives a CPRI signal via one of the optical interfaces SFP1, or SFP2.

"SFP1 / 2"	Selects the respective SFP (**S**mall **F**orm-factor **P**luggable) interface, at which the R&S EX-IQ-BOX is connected to the DUT to receive the signal.
"SMA"	Selects the SMA (**S**ub**M**iniatur version **A**) interface, if the R&S EX-IQ-BOX receives the signal from the DUT on this transmission line.
"Loopback internal"	Assigns the internal loopback, if the signal is routed back internally.
"None"	Deactivates the input, if no connection is established.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:INPut` on page 352

Outputs

Determine the interface for signal output, i.e. align the transmitter type of the DUT.

For the signal output, more than one interface can be activated simultaneously, e.g. SFP1 for signal transmission to the DUT, and SMA for the signal monitoring.

"SFP1 / 2"	Select the respective SFP (**S**mall **F**orm-factor **P**luggable) interface, at which the R&S EX-IQ-BOX is connected to the DUT for sending the signal.
"SMA"	Select the SMA (**S**ub**M**iniatur version **A**) interface, if the R&S EX-IQ-BOX is sending the signal to the DUT on this transmission line.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP1[:STATe]` on page 353
`[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP2[:STATe]` on page 353
`[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SMA[:STATe]` on page 354

7.2.7.7 General Purpose Input Output

Section "General Purpose Input Output" contains settings for control signals to or from external devices. Use this feature to trigger external devices or to monitor several internal clocks, as e.g. the Node B frame tick, or to use external signals to trigger the I/Q recorder.

The BNC connectors for general purpose signals are located on top of the breakout board.

Direction GPIO 1-3

Determine the tranmission direction at the connected GPIO interfaces. You can individually activate each of the three interfaces separately. Find additional information on the connectors in chapter 7.2.4.1, "Top View", on page 134, and chapter 10.3.3.1, "Connector Locations - CPRI Breakout Board", on page 453.

"OFF"	Deactivate the GPIO interface.
"Output"	Select the respective GPIO interface as output, i.e. send a control signal to the external device.

"Input"	Select the appropriate GPIO interface as input, which means you receive a signal from the external device, e.g. for trigger purpose.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:GPIO<ch>:DIRection` on page 350

Signal GPIO 1-3
Determine the type of the control signal. You can define separate signals for each of the three interfaces.

"Constant Low/ High"	GPIO output Set the control signal to constant level high or low.
"DL/UL Basic Frame"	GPIO output Take the information in the CPRI basic frame for control. According to the WCDMA clock rate, the CPRI protocol synchronizes its basic frame with 3.84 MHz.
"DL/UL Hyper Frame"	GPIO output Use the CPRI hyper frame clock for control. The hyper frame clock rate is 15 kHz.
"DL/UL Node B Frame"	GPIO output Use the information in the CPRI Node B frame for control. CPRI updates the B node every 10 ms, i.e. you can control the DUT with a clock rate of 100 Hz.
"Timing Measurement Clock"	GPIO output Use the CPRI signal processing clock, e.g. 61.44 MHz at 2x line rate. This clock is used for timing measurements like response time, latency, etc..
"10 MHz Reference Clock"	GPIO output Use the CPRI signal processing clock, e.g. 61.44 MHz at 2x line rate. This clock is used for timing measurements like response time, latency, etc..
"External Trigger 1/2/3"	GPIO input In input mode, each of the three GPIO ports provide also an external trigger signal.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:HW:GPIO<ch>:SIGnal` on page 351

7.2.8 Downlink and Uplink

The **Downlink** and the **Uplink** tabs contain the settings for the CPRI basic frame. Downlink and uplink parameters are similar; they both define the signals I/Q data and its distribution inside the CPRI basic frame container (AxC allocation).

The CPRI basic frame contains 16 words. The first word, the control word, contains control information like, e.g., synchronization, timing, slow or fast C&M, or vendor specific data. The remaining words carry the I/Q data.

Terms used in the description and familiar synonyms

UL (Uplink): The UL defines the direction from a mobile device to a base station. A synonym to UL is RL (Reverse Link).

DL (Downlink): The DL defines the direction from the base station to the mobile device. A synonym to DL is FL (Forward Link).

Depending on the CPRI test mode, the R&S EX-IQ-BOX works either as a transmitter (TX) or receiver (RX), as shown in the following diagrams.

- In **CPRI RE** test mode, the R&S EX-IQ-BOX works in the DL (downlink) as a transmitter (TX) and in the UL (uplink) as a receiver (RX).

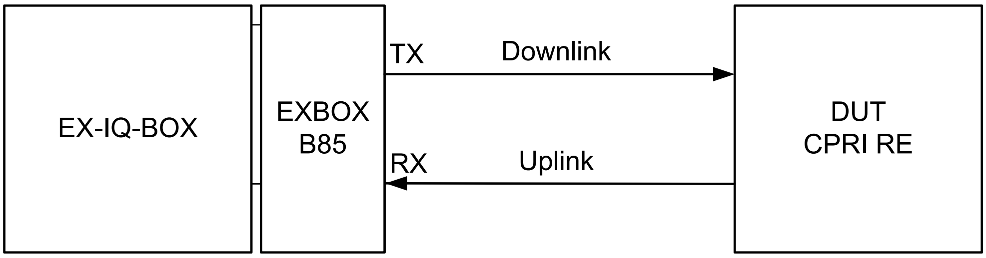


Fig. 7-55: CPRI RE test - schematic representation

- In **CPRI REC** test mode, the R&S EX-IQ-BOX works in the DL as a receiver (RX) and in the UL as a transmitter (TX).

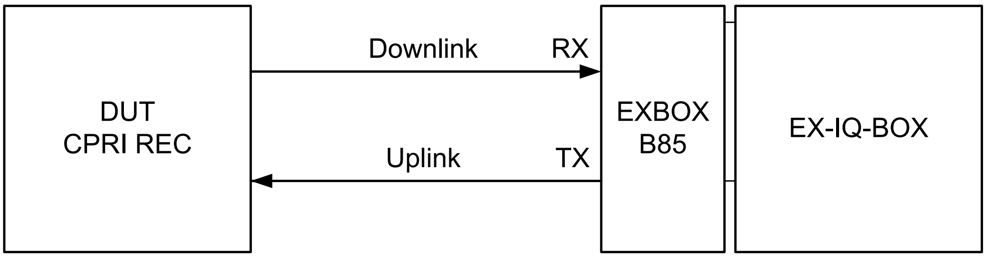
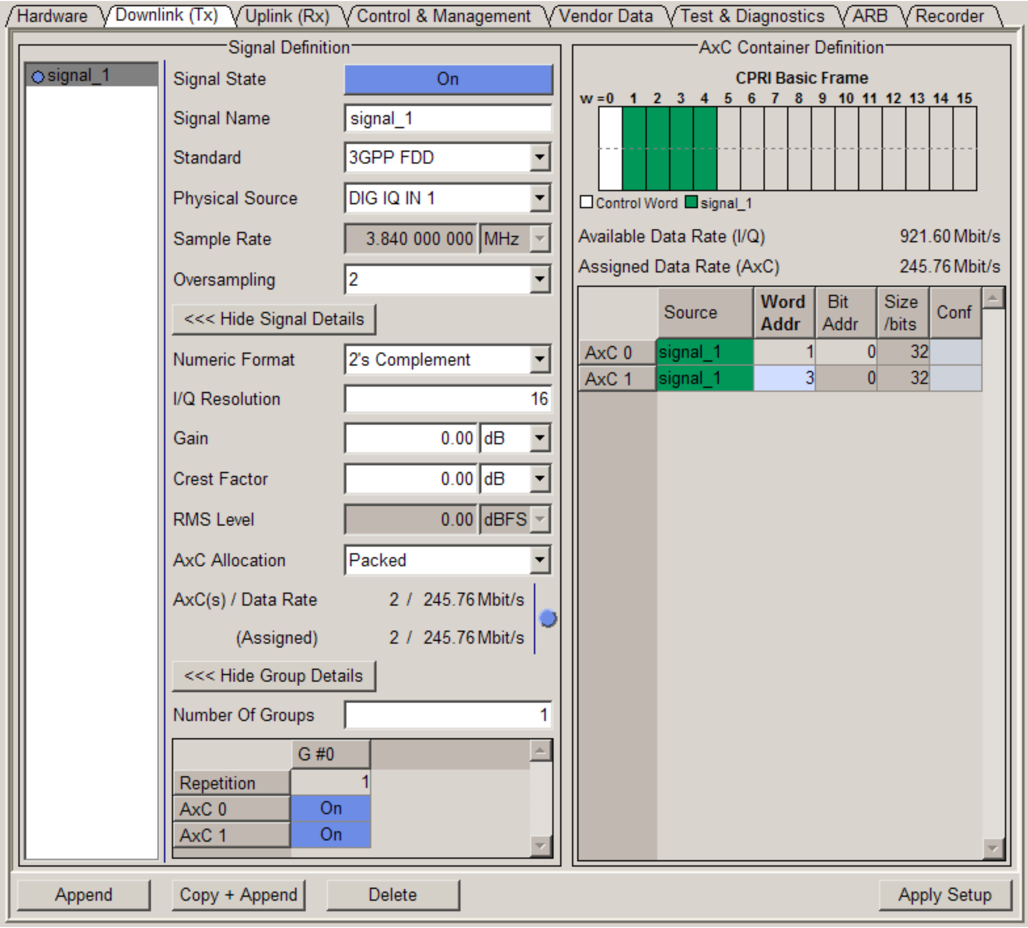


Fig. 7-56: CPRI REC test - schematic representation

The settings dialogs for the transmitter (TX) and the receiver (RX) are identical in both CPRI test modes (RE / REC).

Accordingly, the DL (downlink) dialog of CPRI RE and the UL (uplink) of CPRI REC are similar, and vice versa, the UL dialog of the CPRI RE test is identical to the DL dialog of CPRI REC.

The following description comprises the parameters of both dialogs, the UL and the DL, since they use the same parameters. Specific settings that relate to a particular link direction, are separately expressed.



Signal State: On

Signal Name: signal_1

Standard: 3GPP FDD

Physical Source: DIG IQ IN 1

Sample Rate: 3.840 000 000 MHz

Oversampling: 2

Numeric Format: 2's Complement

I/Q Resolution: 16

Gain: 0.00 dB

Crest Factor: 0.00 dB

RMS Level: 0.00 dBFS

AxC Allocation: Packed

AxC(s) / Data Rate: 2 / 245.76 Mbit/s

(Assigned): 2 / 245.76 Mbit/s

Number Of Groups: 1

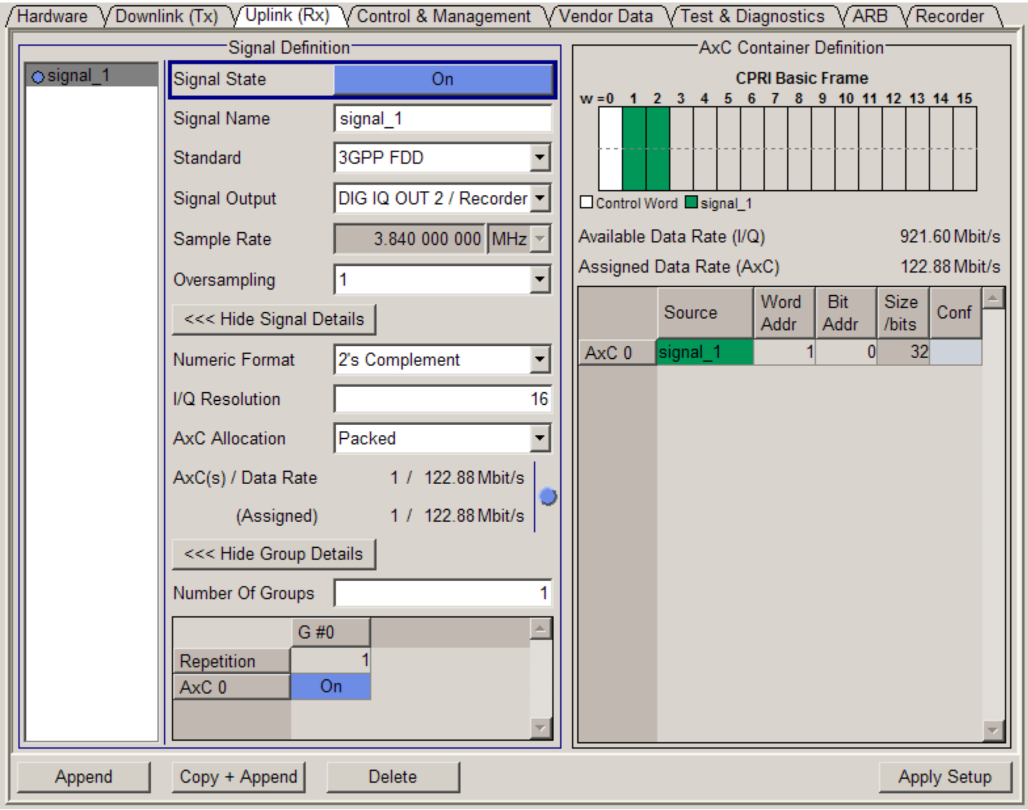
	G #0
Repetition	1
AxC 0	On
AxC 1	On

Available Data Rate (I/Q): 921.60 Mbit/s

Assigned Data Rate (AxC): 245.76 Mbit/s

	Source	Word Addr	Bit Addr	Size /bits	Conf
AxC 0	signal_1	1	0	32	
AxC 1	signal_1	3	0	32	

Fig. 7-57: CPRI downlink dialog



Signal State	On
Signal Name	signal_1
Standard	3GPP FDD
Signal Output	DIG IQ OUT 2 / Recorder
Sample Rate	3.840 000 000 MHz
Oversampling	1
Numeric Format	2's Complement
I/Q Resolution	16
AxC Allocation	Packed
AxC(s) / Data Rate	1 / 122.88 Mbit/s
(Assigned)	1 / 122.88 Mbit/s
Number Of Groups	1

	G #0
Repetition	1
AxC 0	On

Available Data Rate (I/Q) 921.60 Mbit/s

Assigned Data Rate (AxC) 122.88 Mbit/s

	Source	Word Addr	Bit Addr	Size /bits	Conf
AxC 0	signal_1	1	0	32	

Fig. 7-58: CPRI uplink dialog

7.2.8.1 Signal Definition

Section "Signal Definition" contains all information which is important to define the I/Q signals to be transmitted, or received via the CPRI link. On the left the table lists all defined signals, and on the right of it input and display fields show the respective settings of the selected signal. Signals are added, copied or removed by means of buttons and a groups table indicates the AxCs assigned to a group.

The active AxCs are shown on the top right of this tab graphically. You find the description to this graphic under chapter 7.2.8.2, "AxC Container Definition", on page 169.

Signal Table

The table lists the all defined signals. Select a signal in the table, to view the current settings of this signal.

The list can take up at most 24 signals, according to the maximum number of AxCs, since a signal needs at least one AxC.

Note: By default, R&S DigIConf names the signals `signal_` with an attached `<index>` number. The index number represents the position in the list. In order to assign a user defined name, enter the name in the field "Signal Name" on the right.

Append

Add a new signal to the list. R&S DigIConf attaches a signal with default parameter values, a predetermined name and a name index following the last list entry.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal:APPend` on page 378

Copy + Append

Create a copy of a selected signal. This function copies the parameter values and assigns the same name with suffix for distinction. The new signal is added at the end of the list.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:COPY` on page 383

Delete

Remove the currently selected signal from the list. The function removes the corresponding AxCs from the list of used AxCs.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:DELete` on page 383

Signal State

Activate a selected signal.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:STATe` on page 392

Signal Name

Enter or change the signal name.

By default, R&S DigIConf assigns the name `signal_` with an attached `<index>` number. The index number represents the position in the list.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:NAME` on page 386

Standard

Select a communication standard. R&S DigIConf provides the selection of a standard signal with automatically assigned sample rate. Alternatively, select a signal from a waveform file, the ARB function, or assign user-specific values.

R&S DigIConf supports all current standards and their variants. When selecting a standard signal, the program automatically sets the relevant parameters and values.

For example, a loaded digital standard automatically adjusts the needed AxCs, assigns the sample rate, and sets up several other relevant parameters.

Note: The digital standard signals, or user defined signals refer to external signal input or output, i.e. the physical signal sources DIG IQ IN or DIG IQ OUT.

"GSM/EDGE"	Select a signal that follows te GSM/EDGE standard. GSM/EDGE (**G**lobal **S**ystem for **M**obile Communications/**E**nhanced **D**ata Rates for **G**SM **E**volution) covers the 2nd generation mobile radio technology. Selecting this signal standard, the sample rate is set to 270,833333 kSps. This sample rate does not fit well into the CPRI basic frame rate. Therefore, the sampling rate of GSM/EDGE is only achieved by using a rather complicated group setup, the AxC settings over time.
"3GPP FDD"	Select the parameters of the W-CDMA standard 3GPP FDD. W-CDMA (**W**ideband **C**ode **D**ivision **M**ultiple **A**ccess) covers the radio technology UMTS (**U**niversal **M**opbile **T**elecommunications **S**ystem). 3GPP (**3**rd **G**eneration **P**artnership **P**roject) is a collaboration between groups of telecommunication associations, which define a globally applicable third generation mobile phone system specification. 3GPP standardization comprises all GSM and W-CDMA specifications.
"CDMA 2000"	Select a signal that follows the CDMA standard. **CDMA2000** (**C**ode **D**ivision **M**ultiple **A**ccess) uses a multiple access scheme for digital radio, to send voice, data, and signaling data (such as a dialed telephone number) between mobile phones and cell sites.
"LTE"	Select an LTE (**L**ong **T**erm **E**volution) signal. Based on UMTS, LTE provides a wireless broadband internet system with voice and other services built on top, e.g. authentication. LTE bandwidths: 1.4 | 3.0 | 5.0 | 10.0 | 15.0 | 20.0 MHz
"IEEE 802.16 WiMAX"	Select the digital standard IEEE 802.16 WiMAX (**W**orldwide **I**nter-operability for **M**icrowave **A**ccess). WiMAX provides wireless transmission of data using a variety of transmission modes, as e.g. point-to-multipoint links or mobile internet access. WiMAX bandwidths: 3.5 | 5.0 | 7.0 | 8.75 | 10.0 | 20 MHz
"User defined"	Specify a user defined signal for transmission, define a signal with arbitrary parameters.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:STANdard` on page 390

Physical Source

Select the signal source for signal transmission to the DUT. The signal comes either from an R&S instrument via the digital interface of the R&S EX-IQ-BOX, or the signal is generated internally or by means of the waveform memory in the R&S EX-IQ-BOX.

The R&S EX-IQ-BOX converts the I/Q format of the signal into the CPRI protocol format. Embedded with additional control information, the link transfers the data to the DUT.

Note: You can select the signal source if the R&S EX-IQ-BOX works as transmitter, i.e. if it sends a signal to the DUT. That is, if you work in the **RE Test Downlink** or the **REC Test Uplink** mode. Hence, the parameter is available only in the corresponding DL or UL tab.
However, when the R&S EX-IQ-BOX receives a signal, "Signal Output" is available in the corresponding tabs instead of "Physical Source". See also "Signal Output" on page 160.

"Sync Pattern"	Use the internal pattern generator as signal source.

"DIG IQ IN 1"	An R&S instrument applies a digital baseband signal at DIQ IQ IN 1 connector of the R&S EX-IQ-BOX. The green IN/OUT LED of this interface indicates, that it operates in input mode.
"ARB 1...4"	Selects one of the waveform memories with a loaded I/Q signal. **Note:** ● This feature requires, that the R&S EX-IQ-BOX is equipped with the appropriate waveform memory option. ● A conflict arises, if no signal is loaded in the memory, or is not activated. The LED next to "Wave File" and "Sample Rate" tuns red. The Multi Waveform option supports simultaneous playback of up to four signals. For information on the available options refer to chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory ", on page 23.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX:SIGNal<ch>:SOURce` on page 373

Signal Output
Select an output interface, to transmit the received baseband signal from the DUT to an R&S instrument and/or to the built-in I/Q recorder.

The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, and forwards it to an R&S instrument. Simultaneously, you can also record the signal with the I/Q recorder, see chapter 7.2.13, "Recorder", on page 189.

Note: You can select "Signal Output" if the R&S EX-IQ-BOX works as receiver, i.e. if it receives a signal from the DUT. That is, if you work in the **RE Test Uplink** or the **REC Test Downlink** mode. Hence, the parameter is available only in the corresponding DL or UL tab.
However, when the R&S EX-IQ-BOX transmits a signal, "Physical Source" is available in the corresponding tabs instead of "Signal Output". See also "Physical Source" on page 159.

"DIG IQ OUT <n> / Recorder"	Selects the digital output interface DIQ IQ IN 2 of the R&S EX-IQ-BOX to send the signal to an R&S instrument. The yellow IN/OUT LED of this interface indicates, that it operates in input mode.
"Recorder"	Selects the built-in I/Q recorder as the destination for the received signal. This feature requires, that the R&S EX-IQ-BOX is equipped with the appropriate recording memory option. For information on the available options refer to chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory ", on page 23.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:RX:SIGNal<ch>:OUTPut` on page 373

Wave file
Indicates the loaded waveform file, if the physical signal source is one of the waveform memories.

Note: This parameter is relevant when operating with ARB. I.e., if you load a file and select the signal source ARB, R&S DigIConf indicates the file name. For standard communication signals, the field is hidden.
R&S DigIConf loads waveforms calculated by simulation software such as Matlab or R&S WinIQSIM2 into the memory of the R&S EX-IQ-BOX. With the aid of the CPRI breakout board, the R&S EX-IQ-BOX then embeds the signal into the CPRI protocol.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:ARB:FILE` on page 379

Sample Rate

Shows the sample rate. If you process user defined signals, you can set the value.

Note: Consider that the sampling rate of the R&S signal generator fits to the sampling rate of R&S DigIConf, as well as to the sampling rate of the R&S signal analyzer.

The table shows the predefined sample rates of the available signals. The sample rate of a digital standard varies corresponding to the frequency.

Table 7-3: Sample rate values, depending on the signal type

Standard	Frequency variant	Sample Rate
GSM/EDGE		270.8333 kHz
3GPP FDD		3.84 MHz
CDMA 2000		1.228 MHz
LTE	1.4 MHz	1.92 MHz
	3.0 MHz	3.84 MHz
	5.0 MHz	7.68 MHz
	10.0 MHz	15.36 MHz
	15.0 MHz	23.04 MHz
	20.0 MHz	30.72 MHz
WiMAX	3.5 MHz	4.0 MHz
	5.0 MHz	5.6 MHz
	7.0 MHz	8.0 MHz
	8.75 MHz	10.0 MHz
	10.0 MHz	11.2 MHz
Sync Pattern		3.84 MHz

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:SRATe` on page 389

Pattern Length

Define the length of the pattern used by the internal pattern generator.

Note: The parameter applies to the physical source "Sync Pattern".

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:PLENgth` on page 388

Oversampling

Determine the oversampling factor.

Values: 1 | 2 | 4

Note: Oversampling refers to external signals, i.e. to digital standards or to user defined signals. If the R&S EX-IQ-BOX is working with an internal signal, that is generated by a pattern or a waveform file, the parameter is already considered and therefore not relevant.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:OSAMpling` on page 388

Show/Hide Signal Details

Shows/hides a section with additional parameters for more detailed signal definition.

Numeric format

Select a numeric representation for data transmission.

"2's Complement"	Format the signal in two's-complement. The most significant bit has a value of -2^{-1}, the bits of lesser significance follow as: +2^{-2}...+2^{0}

"Binary Offset" Format the data in binary offset.

A binary offset of -2^{-1} is added such that the final values are always positive.

Example:

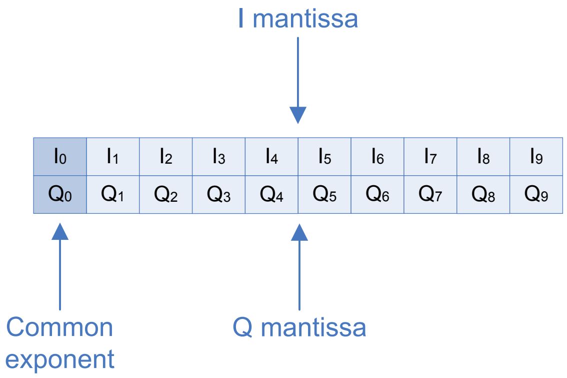
n = 4 → $-8 \leq z < 8$

Table 7-4: CPRI > Numeric format coding

z		2´s Complement					Binary Offset			
-8		1	0	0	0		0	0	0	0
-7		1	0	0	1		0	0	0	1
-6		1	0	1	0		0	0	1	0
-5		1	0	1	1		0	0	1	1
-4		1	1	0	0		0	1	0	0
-3		1	1	0	1		0	1	0	1
-2		1	1	1	0		0	1	1	0
-1		1	1	1	1		0	1	1	1
0		0	0	0	0		1	0	0	0
1		0	0	0	1		1	0	0	1
2		0	0	1	0		1	0	1	0
3		0	0	1	1		1	0	1	1
4		0	1	0	0		1	1	0	0
5		0	1	0	1		1	1	0	1
6		0	1	1	0		1	1	1	0
7		0	1	1	1		1	1	1	1

"2's Complement 9E2"

Format the signal in two's-complement variant 9E2.
9E2 encoding format is used in mobile base stations to extend the dynamic range of I and Q, while reducing the needed amount of bits. The coding is 9E2 with 9 bits mantissa and 2 bits exponent, that are shared from I and Q, as shown in the figure:



I_0	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9
Q_0	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9

Fig. 7-59: 2's complement 9E2

The I and Q samples of the 2's complement 9E2 are calculated with the formulas:
I sample 10 bits = 9 bits mantissa + 1 bit, i.e. bit_0 exponent

$$I = \left(\left(\sum_{i=0}^{7} 2^i \cdot I_{i+1} \right) - 2^8 \cdot I_9 \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

Q sample 10 bits: 9 bits Q mantissa + 1 bit, i.e. bit_1 exponent

$$Q = \left(\left(\sum_{i=0}^{7} 2^i \cdot Q_{i+1} \right) - 2^8 \cdot Q_9 \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:NFORmat` on page 386

I/Q Resolution
Set the I/Q resolution in bits. The resolution is valid for both, the I and the Q values. I.e, if you set the resolution to 16 bits, the sample rate is 32 bits wide, composed of 16-bit I and 16-bit Q.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:IQResolution` on page 385

Gain
Set a gain value for the I/Q signal. Positive values lead to a digital signal amplification, and negative values correspond to a digital signal attenuation. A gain value of 0 dB results in an unchanged level of the I/Q signal. By default, the value is set to 0 dB.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GAIN` on page 384

Crest Factor

This parameter is required for the correct display of the RMS Level value.

The rms level is calculated with the formula:

RMS [dB] = Peak [dB] - Crest Factor [dB] + Gain [dB]

The crest factor must correspond to the input signal. Enter the value, e.g. a connected baseband generator provides.

Note: Crest factor applies to external signals, i.e. to digital standards or to user defined signals. If the R&S EX-IQ-BOX is working with an internal signal, that is generated by a pattern or a waveform file, the parameter is already known must not be entered manually.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:CRESt` on page 383

RMS Level

Indicates the rms level of the signal. The signal level is expressed in terms of an rms value. It always refers to both signal components:

(SQR(I2+Q2)).

In order to get the RMS value correctly, the Crest Factor of the signal must be entered.

The rms level is calculated with the formula:

RMS [dB] = Peak [dB] - Crest Factor [dB] + Gain [dB]

Note: The RMS level refers to external signals, i.e. to digital standards or to user defined signals. If the R&S EX-IQ-BOX is working with an internal signal, that is generated by a pattern or a waveform file, the parameter is already known must not be entered manually.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:RMS` on page 389
Response: `-10 dbFS`

AxC Allocation

Define how to allocate the AxCs to the signal. R&S DigIConf automatically assigns the AxCs to a signal, and this parameter specifies the method.

"Packed"	The AxCs allocate a continuous area inside the CPRI basic frame. Word address and offset address of the first AxC define the starting position. If possible, the following AxCs are placed successively. The signal AxCs are automatically laid in a free area of the CPRI frame. If there is not enough free space, the signal AxCs are placed at the beginning of the base frame, i.e. at the position of word 1.
"Flexible"	Manually assign the position of the AxCs by word address and offset address. **Tip:** Use this setting, to embed each sample of a signal individually within the CPRI basic frame.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:ALLocation`
on page 379

AxC(s) / Data Rate

Indicates the needed number of AxCs and the required data rate.

Depending on the sample rate, a signal needs one or more AxCs to carry its I/Q data. If possible, R&S DigIConf automatically assigns the number of needed AxCs to the signal.

Note: The maximum number of AxCs for all signals is 24.

The needed number of AxCs is calculated with the formula:

$$AxCs_{needed} = ceil\left(\frac{Sample\,Rate \cdot Oversampling}{3.84[MHz]}\right)$$

The data rate is calculated with the formula:

$$Data\,Rate_{needed}\,[Mbit/s] = SampleRate \cdot Oversampling \cdot 2 \cdot I/Q\,\mathrm{Re}solution$$

Note: For signal source "Pattern" the needed number of AxCs is 1.

SCPI command:

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:COUNt:NEEDed on page 380

(Assigned)

Displays the assigned number of AxCs and the assigned data rate. The assigned data rate depends on the signal group settings, i.e. on the repetition rate and the number of active AxCs per group.

The assigned data rate is calculated with the formula:

$$Data\,Rate_{assigned}[Mbit/s] = 3.84[MHz] \cdot 2 \cdot I/Q\,\mathrm{Re}solution\left(\frac{\sum AxC\_on\_count_{grp} \cdot \mathrm{Re}\,petition_{grp}}{\sum \mathrm{Re}\,petition_{grp}}\right)$$

Note: In case of "Sync Pattern" signals, the assigned data rate depends on the pattern length and the sample rate. It is calculated by the sample rate as shown:

$$Data\,Rate_{assigned} = Sample\,Rate \cdot Pattern\,Length$$

SCPI command:

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:COUNt:ASSign on page 380

Status LED

In case of mismatch between the assigned data rate and the required data rate, the LED turns red. Blue indicates that the data rates fit.

Note: Deviations in data rates!. Refer to the example under chapter 7.2.8.2, "AxC Container Definition", on page 169, on what to do if the status LED turns red.

SCPI command:

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:DRATe:STATus on page 382

Show/Hide Group Details

Shows/hides the section with the parameters for group definition.

Number of Groups

Determine the number of groups for a signal. The grouping enables to achieve arbitrary sample rates that are not necessarily integer multiples of the CPRI basic frame rate. Each group defines an AxC configuration for a certain time, i.e. repetitions. Thus you can change the AxC assignment over time by using more than one group with different settings.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GROup:COUNt` on page 384

Groups Table

Set the AxC group settings. The displayed columns correspond to the groups, as displayed in the table header. The following rows indicate group repetition and state or pattern of the assigned AxCs.

Note: AxC status and AxC pattern depend on the used signal sources. Status refers to externally used sources and pattern indicates the coding of the AxCs with internal signal source.

"G #0 ... G #3"	Displays a column for each determined group. The maximum number of groups is 4. In remote control, the group is addressed in the repetition command, see below.
"Repetition"	Enter the number of repetitions, i.e. how many CPRI basic frames follow the current group setting.
"AxC<index> State"	Indicates the status of the respective AxCs. By default, all AxCs are "On". Click the desired field or press the enter key to switch between On and Off.

"AxC<index> (bin)"	Shows the binary data pattern of an AxC in hexadecimal format. By default, all data pattern is set to zero. Click on a field or press the Enter key to insert the required pattern. You can basically set up to 40 bits, but the currently possible number depends on the signal length that is specified in "Pattern Length" on page 161.

Note: AxC n (bin) refers to Sync Pattern signals.

Example:

The following example explains the need of the CPRI group definition:

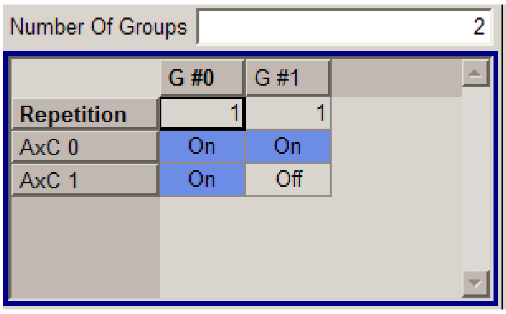
Let us assume we want to transmit an I/Q signal over the CPRI link with a sampling rate of 5.76 MS/s. The CPRI basic frame rate amounts the defined 3.84 MHz.

This means, if we assign one AxC per basic frame, we have the sample rate of 3.84 MS/s. If we assign two AxCs, we get a sample rate of 7.68 MS/s.

Note: An AxC is a container for one I/Q sample.

But, for the required sample rate of 5.76 MS/s, we would need 1.5 AxCs per basic frame.

How can we reach that?



Number Of Groups 2

	G #0	G #1
Repetition	1	1
AxC 0	On	On
AxC 1	On	Off

- We allocate 2 AxCs in the AxC container definition which corresponds to: ceiling = 1.5. For example, we use "AxC0" and "AxC1".
- In the "Number of Groups" entry field, we define two groups.
- Then, in the groups table, we define:
  - G#0: Repetition = *1*, AxC0 = *On*, AxC1 = *On*.
  - G#1: Recitation = *1*, AxC0 = *On*, AxC1 = *Off*.

With these settings, we transmit 2 samples (G#0) for one basic frame, and only 1 sample (G#1) for the following.

Now we have achieved the required average sample rate of 5.76 MS/ s.

Tip: By changing the repetition in combination with the AxC states, you can achieve almost any sample rate.

SCPI command:

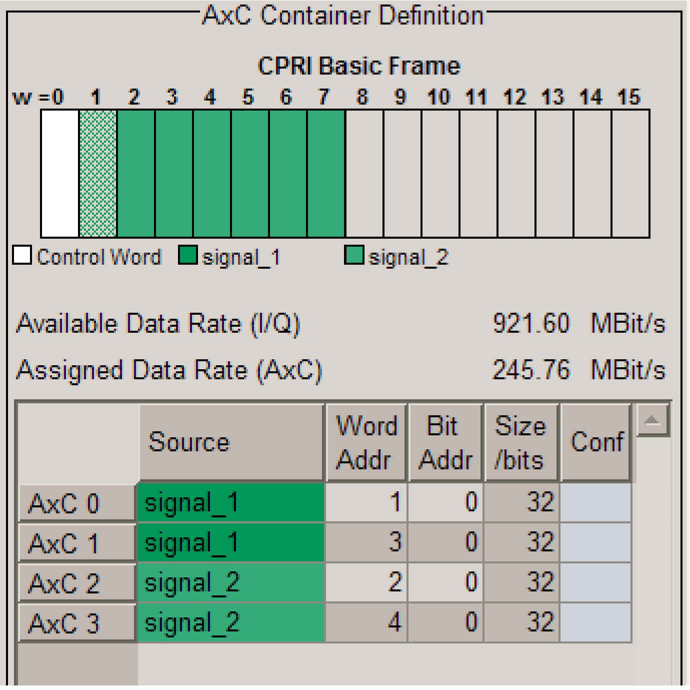
`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GROup<user0>:REPetition` on page 385

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GROup<user0>:AXC<ch0>:STATe` on page 385

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GROup<user0>:AXC<ch0>:PATTern` on page 384

7.2.8.2 AxC Container Definition

The **AxC Container Definition** section graphically displays the CPRI basic frame and indicates the I/Q and AxC data rates. The table in the lower part contains the used AxCs with their assigned signals, and basic signal parameters such as word address, bit address and word size. LEDs in the last column indicate emerging conflicts between AxCs.

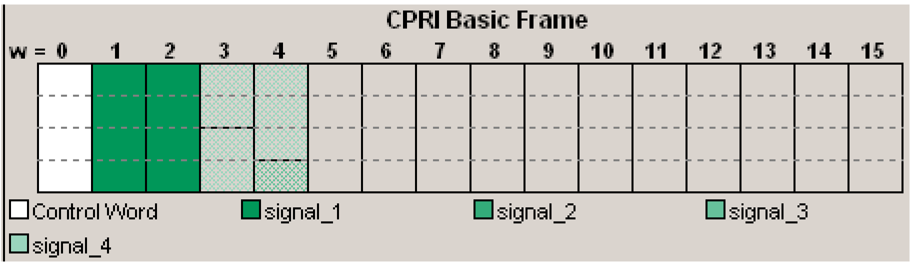


Available Data Rate (I/Q) 921.60 MBit/s

Assigned Data Rate (AxC) 245.76 MBit/s

	Source	Word Addr	Bit Addr	Size /bits	Conf
AxC 0	signal_1	1	0	32	
AxC 1	signal_1	3	0	32	
AxC 2	signal_2	2	0	32	
AxC 3	signal_2	4	0	32	

CPRI Basic Frame Graph
The basic frame graph indicates the 16 words of a CPRI basic frame in a control matrix. First the control word is shown, then the remaining words follow, carrying the I/Q data. The data words are structured in AxCs (antenna carriers). A signal needs one or more AxCs for carrying the I/Q data, depending on the sample rate.



The word length depends on the CPRI line bit rate parameter. This parameter defines the number of bits transferred per second over the CPRI communication link, including control and I/Q data.

The following table shows the word length related to the bit rate.

Table 7-5: CPRI Line bit rate vs. Word length

Line bit rate	**Word length**	
[Mbit/s]	[bits]	[Bytes]
2x (1228.8)	16	2
4x (2457.6)	32	4
5x (3072.0)	40	5

Note: When a word consists of more than 1 byte, the graph indicates these bytes and separates them with a hyphen.

The first word contains control information while the following words carry the AxCs. i.e. the I/Q data.

R&S DigIConf shows the signals in different colors, as well as the related AxCs. Active signals are strongly colored, while the inactive signals are shown in pale colors. If the signals in the graph overlap, the active signals are always in the foreground. Below the graph, a legend explains the signals and their assigned colors.

Available Data Rate (I/Q)

Displays the available data rate of the I/Q data, calculated with the formula:

$$\begin{aligned} Data\,Rate_{avaliable}[Mbit/s] &= Data\,Word\,Count \cdot Word\,Length[bit] \cdot 3.84[MHz] \\ &= 15 \cdot Word\,Length[bit] \cdot 3.84[MHz] \end{aligned}$$

Note: The word length depends on the line bit rate, as listed in "CPRI Basic Frame Graph" on page 169.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:DRATe:AVAilable` on page 377

Assigned Data Rate (AxC)

Displays the assigned I/Q data rate of all active signals. This parameter depends on the size of each assigned AxC and is calculated with the formula:

$$Data\,Rate_{assigned}[Mbit/s] = \sum AxC\_size_{axc} \cdot 3.84[MHz]$$

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:DRATe:ASSigned` on page 377

AxC Table

Shows the settings of the assigned AxCs. An AxC is defined by the position inside the CPRI basic frame and its length.

"Source"	Indicates the signal the AxC is assigned to.
"Word Address"	The position of the AxC within the CPRI basic frame is defined by word address and bit address. The word address specifies, with which word the AxC begins, while the bit address specifies the bit index inside the word.

"Bit Address"	Specifies the starting bit inside the word.
"Size /bits"	Displays the size of the AxC in bits. The size depends on the selected signal source. With the exception of signals from the signal source Sync Pattern, the size is calculated using the following formula: $AxC\_size_{axc}\left[bit\right] = I/Q\,\mathrm{Re}\,solution_{signal} \cdot 2$ For Sync Pattern signals, calculate the source with the formula: $AxC\_size_{axc}\left[bit\right] = Pattern\ Length_{signal}$
"Conflict"	A conflict arises, when AxCs overlap. A red LED indicates the overlapping with a previous AxC.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:SOURce` on page 376

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:WADDress` on page 376

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:BADDress` on page 375

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:SIZE` on page 375

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:CONFlict` on page 375

Apply

Assign the settings in order to become effective.

In case settings have been changed, but not accepted, a warning icon is displayed.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:WARNing` on page 392

`[:SOURce<hw>]:EBOX:CPRI:TX|RX:APPLy` on page 374

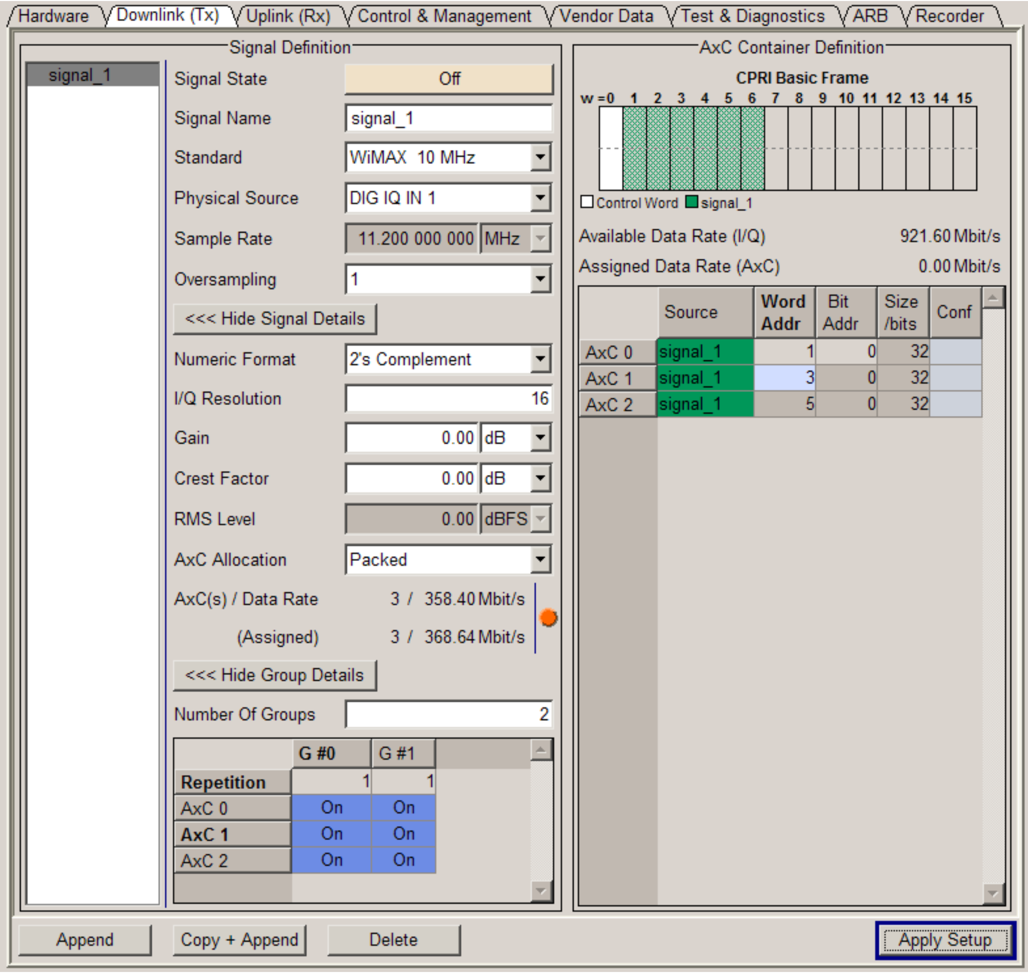
Example to CPRI Groups Concept

Note: Since the CPRI protocol is based on the standards of 3G and LTE, the CPRI basic frame length uses the UTRA FDD Chip period, 1/3.84 MHz, i.e. the resulting data rate amounts 3.84 MHz.
Therefore, variations in the data rate appear with all signals whose data rate do not fit in this 3.84-MHz pattern. The reason is that for these signals, the total sampling rate per AxC group is not an integer multiple of the CPRI basic frame rate.

CPRI has developed a special method for the adjustment. By adjusting the grouping, the repetitions and variable allocations of the AxCs, each signal can be individually customized to this pattern. In addition, CPRI adds stuffing samples, for example, vendor specific bits, in order to adjust the data rate to an integer multiple of the CPRI frame rate.

Example:

By means of a 10 MHz WiMAX signal, with an oversampling factor of 1 and an I/Q resolution of 16 Bit, the following settings present a possible solution.



Signal State	Off
Signal Name	signal_1
Standard	WiMAX 10 MHz
Physical Source	DIG IQ IN 1
Sample Rate	11.200 000 000 MHz
Oversampling	1
Numeric Format	2's Complement
I/Q Resolution	16
Gain	0.00 dB
Crest Factor	0.00 dB
RMS Level	0.00 dBFS
AxC Allocation	Packed
AxC(s) / Data Rate	3 / 358.40 Mbit/s
(Assigned)	3 / 368.64 Mbit/s
Number Of Groups	2

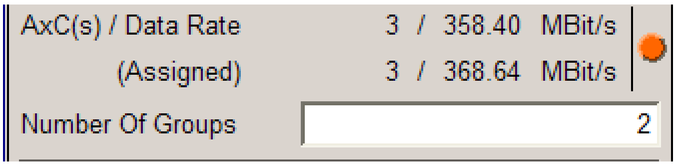
	G #0	G #1
Repetition	1	1
AxC 0	On	On
AxC 1	On	On
AxC 2	On	On

Available Data Rate (I/Q) 921.60 Mbit/s
Assigned Data Rate (AxC) 0.00 Mbit/s

	Source	Word Addr	Bit Addr	Size /bits	Conf
AxC 0	signal_1	1	0	32	
AxC 1	signal_1	3	0	32	
AxC 2	signal_1	5	0	32	

In this example, the WiMAX data rate amounts 11.2 MHz and requires 3 AxCs for its data. Since 3.84 MHz does not fit into 11.2 MHz, change the following parameters:

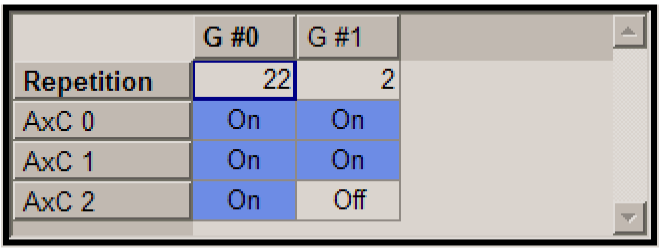
- Increase the number of groups to 2.



AxC(s) / Data Rate 3 / 358.40 MBit/s
(Assigned) 3 / 368.64 MBit/s
Number Of Groups 2

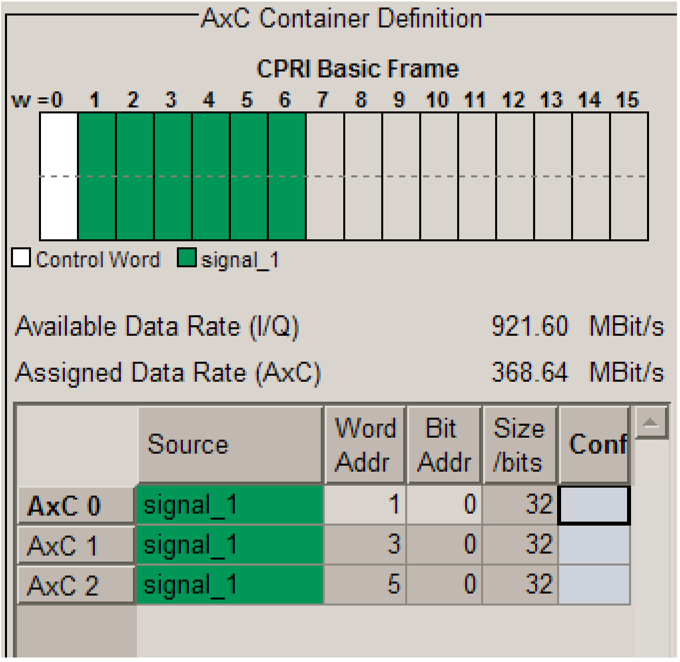
- Enter 22 repetitions for Group #0, and 2 for Group #1.
- Allocate all the AxCs of the first group consecutively, and from the second group only AxC0 and AxC1.

The combination of repetition and the variable allocation of the AxCs provides a correct distribution of the signal in the CPRI frame.



	G #0	G #1
Repetition	22	2
AxC 0	On	On
AxC 1	On	On
AxC 2	On	Off

The graph in the AxC Container Definition shows the distribution of the data in the CPRI frame slots.



Available Data Rate (I/Q) 921.60 MBit/s

Assigned Data Rate (AxC) 368.64 MBit/s

	Source	Word Addr	Bit Addr	Size /bits	Conf
AxC 0	signal_1	1	0	32	
AxC 1	signal_1	3	0	32	
AxC 2	signal_1	5	0	32	

Group #0

	0	1	2	3	4	5	6
22x		AXC_1 0		AXC_1 1		AXC_1 2	

Group #1

	0	1	2	3	4
22x		AXC_2 0		AXC_2 1	

Argument

Let us prove that using the formula:

$$Data\,Rate_{assigned}[Mbit/s] = 3.84[MHz] \cdot 2 \cdot I/Q\,\mathrm{Re}\,solution\left(\frac{\sum AxC\_on\_count_{grp} \cdot \mathrm{Re}\,petition_{grp}}{\sum \mathrm{Re}\,petition_{grp}}\right)$$

$$Data\ Rate_{assigned}\left[Mbit/s\right]=3.84\left[MHz\right]\cdot 2\cdot 16\left[bit\right]\left(\frac{3\cdot 22+2\cdot 2}{22+2}\right)=358.4\left[Mbit/s\right]$$

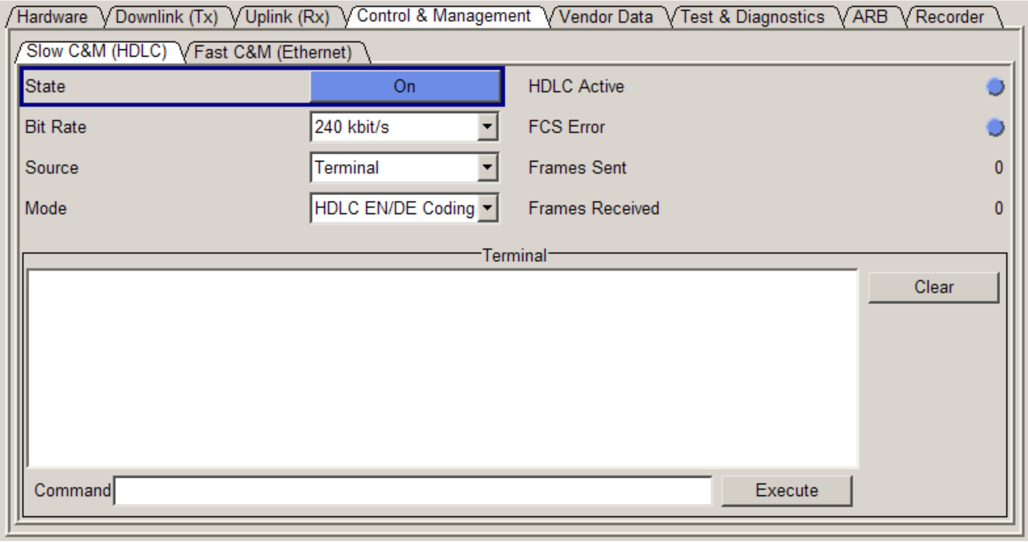
7.2.9 Control & Management

The **Control & Management** (C&M) tab comprises all settings related to the process of exchanging control information between RE (**R**adio **E**quipment) and REC (**R**adio **E**quipment **C**ontrol) in base station systems. CPRI supports two different protocols for C&M data, the slower variation HDLC (**H**igh-Level **D**ata **L**ink **C**ontrol) and the fast Ethernet.

7.2.9.1 Slow C&M (HDLC)

The **HDLC Settings** section comprises the necessary parameters for activating HDLC control and management data protocol.

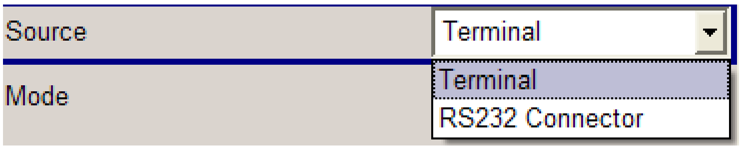
In chapter chapter 4.5, "Connecting the R&S EX-IQ-BOX", on page 42, you find information on how to connect the interface. For more information on the hardware, see the data sheet of the R&S EX-IQ-BOX, option R&S EXBOX-B85 (CPRI breakout board).



State	On	HDLC Active	●
Bit Rate	240 kbit/s	FCS Error	●
Source	Terminal	Frames Sent	0
Mode	HDLC EN/DE Coding	Frames Received	0

Fig. 7-60: CPRI Control & Management dialog - Slow C&M (HDLC)

R&S DigIConf provides two methods for transmitting or receiving Slow C&M Data:



Source: Terminal

Mode

1. Using the internal **Terminal**, you can enter text commands. With EXECUTE, the CPRI breakout board encodes the plain text commands in HDLC format. Then, it

transmits the data over the CPRI link. This method is only available in CPRI RE test mode.

2. Using the **RS-232-C connector**, the CPRI breakout board expects already HDLC encoded data on the RS-232-C input. Then, it transmits the encoded data in direct mode to the DUT. The internal encoding and decoding are deactivated. This method works full duplex, i.e. encoded HDLC frames are received from the DUT and output at the RS-232-C port. In the other direction, encoded HDLC frames are entered on the RS-232-C and then transmitted via the slow C&M CPRI link to the DUT.

You can use this method in both test modes, the CPRI RE and the CPRI REC test mode.

State

Activate the C&M data exchange by means of HDLC protocol.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:STATe` on page 347

Bit Rate

Set the bit rate for transmission of the C&M data.

"<bit rate> kbit/s "	Select a bit rate from the avalaible values in the list. Available HDLC bit rates: 240 | 480 | 960 | 1920 | 2400 kbit/s **Note:** The maximum HDLC rate for slow C&M depends on the CPRI Line Bit Rate. The following table shows the available HDLC bit rates for the corresponding CPRI bit rates.

CPRI Line Bit Rate	2x (1228.8 Mbit/s)	4x(2457.6 Mbit/s)	5x (3072.0 Mbit/s)
Possible HDLC Bit Rates in kbit/s	240 480 960	240 480 960 1920	240 480 960 1920 2400

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:BRATe` on page 344

Source

Select the source of the HDLC C&M data.

"Terminal"	Use the integrated terminal of R&S DigIConf for C&M data input or output. **Note:** This method is only available in the CPRI RE test mode.
"RS-232-C Connector"	Use the RS-232-C connector for C&M data input or output. **Note:** This method is applicable to both, the CPRI RE and the CPRI REC test mode.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:SOURce` on page 347

Mode

Select the mode for HDLC C&M data transmission.

"Direct"	The R&S EX-IQ-BOX transmits the data directly to the DUT, i.e. without internal encoding or decoding. **Note:** This mode applies to HDLC source "RS-232-C Connector".
"HDLC EN/DE Coding"	The R&S EX-IQ-BOX either encodes the plain text data before transmission to the DUT, or it decodes and then displays the incoming data. **Note:** This mode applies to HDLC source "Terminal".

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:MODE` on page 346

HDLC Active

The LED indicates red, if the interface is inactive. Blue indicates that the interface is active.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:ACTive` on page 344

FCS Error

The LED indicates red, if a frame check sequence error occurs. The HDLC protocol provides a CRC (**C**yclic **R**edundancy **C**heck) check. This CRC is evaluated during operation.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:FCS` on page 346

Frames Sent

Indicates the number of sent HDLC frames.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:SFRames` on page 346

Frames Received

Indicates the number of received HDLC frames.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:RFRames` on page 346

Input Window, Command line, Execute

The lower part of the slow C&M tab provides an entry field to enter control commands manually. The commands are displayed in the input window above. EXECUTE executes the command, or the command sequence.

Note: These controls apply to slow C&M source "Terminal". In direct mode, i.e. with data coming via the RS-232 interface, the controls are not active.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:COMMand` on page 345

`[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:EXECute` on page 345

Clear

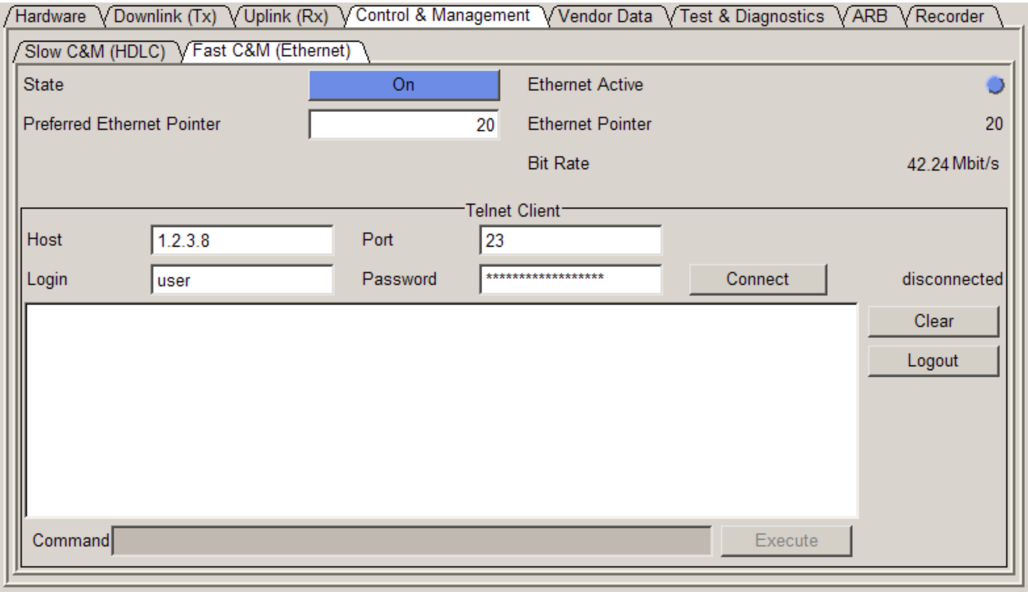
Erases the entries and the input window.

SCPI command:
n.a.

7.2.9.2 Fast C&M (Ethernet)

The **Ethernet Settings** section comprises the necessary parameters for activating fast control and management data exchange via the Ethernet interface.

In chapter chapter 4.5, "Connecting the R&S EX-IQ-BOX", on page 42, you find information on how to connect the interface. For more information on the hardware, see the data sheet of the R&S EX-IQ-BOX, option R&S EXBOX-B85 (CPRI breakout board).



State: On

Preferred Ethernet Pointer: 20

Ethernet Active: ●

Ethernet Pointer: 20

Bit Rate: 42.24 Mbit/s

Host: 1.2.3.8

Port: 23

Login: user

Password: ******************

disconnected

Fig. 7-61: CPRI Control & Management dialog - Fast C&M (Ethernet)

R&S DigIConf provides the following setup for transmitting or receiving Fast C&M Data:

By using the fast C&M option, the R&S EX-IQ-BOX tunnels the **Ethernet** protocol over CPRI. The Ethernet port on the breakout board therefore refers to the Ethernet port of the DUT. The Ethernet settings of the DUT are forwarded to the connector of the breakout board. If the DUT uses IP (**I**nternet **P**rotocol), you can access the DUT directly with its IP address via the Ethernet connector on the breakout board.

In CPRI RE test mode, R&S DigIConf also provides an integrated **Telnet** console for fast C&M. However, this console requires that the DUT offers a telnet server on its Fast C&M port.

State

Activate the C&M data exchange via the Ethernet interface.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:ETH:STATe` on page 344

Pref. Eth. Pointer

Set the CPRI Ethernet pointer. This setting determines the Fast C&M bit rate, since this pointer represents the boundary between vendor data and Fast C&M Data in the CPRI control block. See also chapter 7.2.2, "CPRI Transmission Protocol - Overview", on page 129.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:ETH:PPTR` on page 343

Ethernet Pointer

Indicates the resulting Ethernet pointer after the link setup, i.e. the position after the handshake between the R&S EXBOX-B85 and the DUT.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:ETH:PTR` on page 344

Ethernet Active

The LED indicates red, if the interface is inactive. Blue indicates that the Ethernet data transfer is active.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:ETH:ACTive` on page 342

Bit Rate

Displays the resulting bit rate of fast C&M data exchange. This bit rate depends on the CPRI line bit rate and the Ethernet pointer.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:CM:ETH:BRATe` on page 343

Host

Enter the IP Address of the DUT.

Note: This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

Port

TCP port address for the access to the Telnet server of the DUT.

Note: This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

Login / Password

If a specific user name and password are requested for login, enter the user name in this field, and the password in the field right beside.

Note: This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

Connect
Set up the Telnet connection. On the right of the connect button, R&S DigIConf indicates the current status of the connection.

Note: This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

Input Window, Command line, Execute
The lower part of the fast C&M tab provides an entry field to enter control commands manually. The commands are displayed in the input window above. EXECUTE executes the command, or the command sequence.

Note: This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:CM:ETH:COMMand` on page 343
`[:SOURce<hw>]:EBOX:CPRI:CM:ETH:EXECute` on page 343

Clear
Erases the entries and the input window.

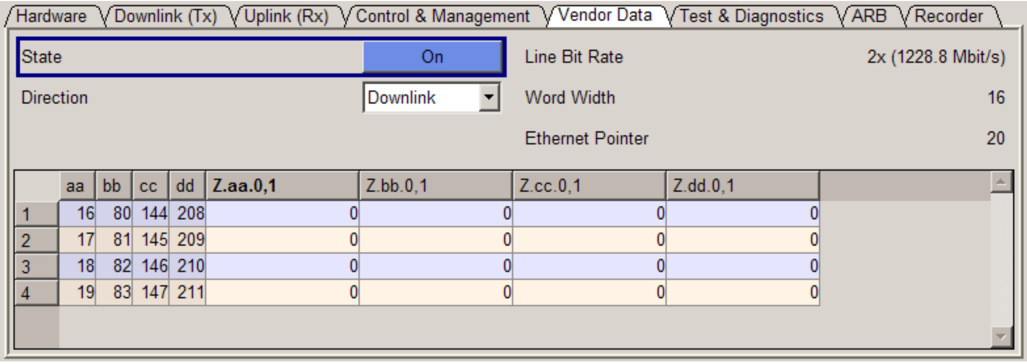
SCPI command:
n.a.

Logout
Logs off the session.

SCPI command:
n.a.

7.2.10 Vendor Data

The **Vendor Data** tab provides the input of user-specific information, like e.g., additional control data. The R&S EX-IQ-BOX then transmits the data embedded in the CPRI protocol.



State On
Direction Downlink
Line Bit Rate 2x (1228.8 Mbit/s)
Word Width 16
Ethernet Pointer 20

	aa	bb	cc	dd	Z.aa.0,1	Z.bb.0,1	Z.cc.0,1	Z.dd.0,1
1	16	80	144	208	0	0	0	0
2	17	81	145	209	0	0	0	0
3	18	82	146	210	0	0	0	0
4	19	83	147	211	0	0	0	0

Fig. 7-62: CPRI Vendor Data dialog

State

Activate the vendor data exchange.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:VENDor:STATe` on page 393

Direction

Select the transmission path of the data shown in the "Vendor Data Table" on page 181.

"Downlink"	- **CPRI RE test mode (TX)** User data entered in the table is embedded in the CPRI link for transmission to the DUT. - **CPRI REC test mode (RX)** Vendor data is extracted from the CPRI link and displayed in the table.
"Uplink"	- **CPRI RE test mode (RX)** Vendor data is extracted from the CPRI link and displayed in the table. - **CPRI REC test mode (TX)** User data entered in the table is embedded in the CPRI link for transmission to the DUT.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:VENDor:DIRection` on page 393

Line Bit Rate

Indicates the line bit rate. Depending on the line bit rate, the vendor data words can be 2, 4 or 5 bytes wide.

Note: Set the bit rate in the hardware tab, under "CPRI Line Bit Rate" on page 151. The bit rate and thus the word length is determined by the DUT.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:HW:LBRate` on page 354

Word Width

Indicates the word width. The word width depends on the CPRI line bit rate.

The following table shows the word width related to the line bit rate.

Table 7-6: Word width related to the line bit rate.

Line bit rate	Word width
[Mbit/s]	**[bits]**
2x (1228.8)	16
4x (2457.6)	32
5x (3072.0)	40

Note: By determining the line bit rate, the DUT also defines the word width. See also "CPRI Line Bit Rate" on page 151.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:VENDor:WWIDth` on page 393

Ethernet Pointer
Indicates the Ethernet pointer position resulting from the fast C&M settings. Refer to "Ethernet Pointer" on page 178.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:CM:ETH:PTR` on page 344

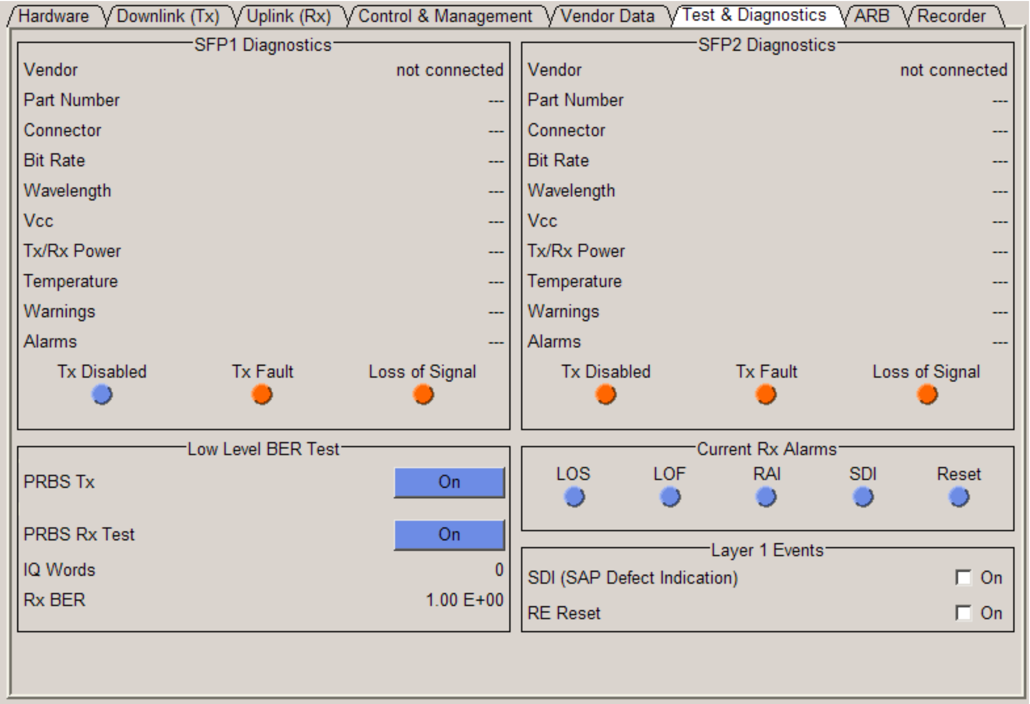
Vendor Data Table
For CPRI RE downlink or CPRI REC uplink, the table can be used to determine vendor-specific data for transmission. In receive direction, i.e. in uplink for CPRI RE and downlink for CPRI REC test modes, the table shows the received vendor specific data, and switches into read-only mode.

Find additional information on vendor data exchange in the CPRI specification.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:VENDor:DATA` on page 392

7.2.11 Test & Diagnostics

The **Test & Diagnostics** tab comprises diagnostics settings in order to evaluate signal transmission. Link parameters as well as transmission test parameters are available for monitoring signal transmission. For testing, e.g. the R&S EX-IQ-BOX transmits a known PRBS-modulated data sequence (**P**seudo **R**andom **B**inary **S**equence). The DUT loops the data back to the R&S EX-IQ-BOX. With the received PRBS sequence the transmission of the signal can be evaluated by means of the number of bit errors.



SFP1 Diagnostics

Vendor	not connected
Part Number	---
Connector	---
Bit Rate	---
Wavelength	---
Vcc	---
Tx/Rx Power	---
Temperature	---
Warnings	---
Alarms	---

SFP2 Diagnostics

Vendor	not connected
Part Number	---
Connector	---
Bit Rate	---
Wavelength	---
Vcc	---
Tx/Rx Power	---
Temperature	---
Warnings	---
Alarms	---

Low Level BER Test

PRBS Tx	On
PRBS Rx Test	On
IQ Words	0
Rx BER	1.00 E+00

Layer 1 Events

SDI (SAP Defect Indication) ☐ On

RE Reset ☐ On

Fig. 7-63: CPRI Test & Diagnostics dialog

7.2.11.1 SFP Diagnostics

Sections **SFP1/SFP2 Diagnostics** indicate the most important parameters of the SFP transceiver modules.

SFP 1|2 Diagnostics

Contains information on the SFP modules and their characteristics.

"Vendor"	Displays the vendor name of the SFP module.
"Part Number"	Displays the vendor part number of the SFP module.
"Connector"	Displays the connector type of the plugged-in SFP module, e.g. LC for a typical fiber connection.
"Bit Rate"	Displays the maximum supported bitrate of SFP module.
"Wave Length"	Displays the wavelength of the plugged-in Laser SFP module for optical data transmission.
"Vcc"	Displays the measured value of the power supply at the SFP interface in Volts.
"TX/RX power"	Shows the current values of the transmitted (TX) and the received (RX) optical power.
"Temperature"	Displays the current operating temperature of the SFP module.
"Warnings"	Displays various warnings in the case of high or low measured values of Vcc, TX/RX power and temperature.

"Alarms"	Displays several module alarms, e.g., if one or more of the Vcc, TX/RX power and temperature values lie beyond their value ranges.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:INFO` on page 369

SFP LEDs ← SFP 1|2 Diagnostics
The LEDs in sections SFP 1 and 2 indicate the states at the SFP interfaces. The LEDs must be blue. Red LEDs indicate errors.

"TX Disabled"	Indicates, if the interface of the breakout board and the SFP transmission line is disabled.
"TX Fault"	Indicates when a transmission error occurs. If the SFP is disconnected, R&S DigIConf displays "Not Available".
"Loss of Signal"	Indicates that data communication failed and the signal is lost.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:TX:DISabled` on page 370
`[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:TX:FAULt` on page 370
`[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:LOS` on page 370

7.2.11.2 Low Level BER Test

In section **Low Level BER Test**, you can activate a PRBS signal to test the data transmission in the CPRI communication link. The Bit-Error-Rate function evaluates the bit error ratio with a defined data sequence.

The test always uses the settings of the first signal defined in the "Downlink / Uplink" tabs. For illustration see also the graph of the basic frame and the "AxC" table in the downlink, or uplink tabs. The interface is determined in the "Hardware" tab, see chapter 7.2.7.6, "High Speed Serial Switch", on page 152 tab.

The downlink and uplink signals must be identical and the CPRI line must be looped back, e.g. in the DUT.

Example to Low Level BER Test using CPRI RE test mode

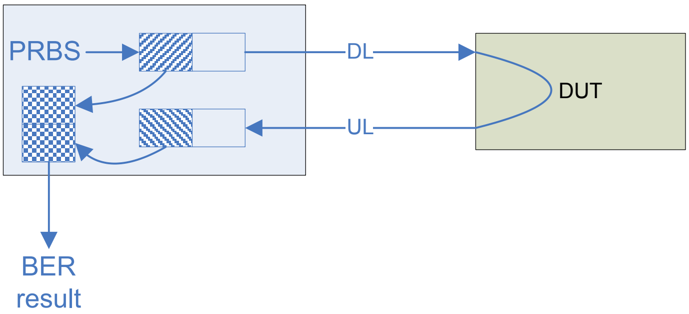


Fig. 7-64: Low Level BER Test

For testing a signal execute the following steps.

1. Select a signal in the downlink tab, and define its parameters.
2. Enter the same settings in the uplink tab.
   Note: For testing the function itself, the signals in the downlink and uplink tab must be identical.
3. Set the connected DUT to CPRI loopback mode.
   Note: The integrated loop-back function in the CPRI breakout board provides sending and receiving signals, without plugging in an SFP module.
4. Activate the signals and switch to the "Test & Diagnostics "tab.
5. Switch on LOW LEVEL BER PRBS TX. The R&S EX-IQ-BOX generates the PRBS test data and assigns it to the downlink signal.
6. Switch on PRBS RX TEST. The function extracts received data from the uplink signal and compares it with the expected PRBS data. The total number of received words and the calculated BER are displayed.

   The bit error rate test function embeds a known PRBS sequence in the CPRI protocol and synchronizes the analysis on the receiver side with the received (looped) signal. It synchronizes the data which are returned internally, compares these data with the data being sent, and counts the bit errors. The ratio of the number of error bits to the total number of bits is the BER-result.

Use this function to see whether the link is working properly. You can monitor the test result continuously in the "Test & Diagnostics" tab.

Expected Results:

When you send a signal and the settings for the received signal are identical, the error must be "0".

Simulate an error:

1. Change the word address in the uplink tab, e.g. set the value *4* in the "AxC" table.
2. Return to the "Test & Diagnostics" tab, where you can see that the error rate is increasing steadily.

   This shows that the box detects the shift between the signals, and can thus detect the errors in real-world signals from the DUT and vice versa.

PRBS TX
Switch on the transmission of the test data.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TEST:BER:TX:STATe` on page 368

PRBS RX Test
Switch on the test receiver.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:STATe` on page 367

IQ Words
Indicates the total number of received words. Low Level BER Test consecutively counts the number of received words in order to compare them with the sent data and to determine the error rate.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:WORDs` on page 367

RX BER
Displays the number of bit errors. This function consecutively counts the number of discrepancies that occur during the test. The BER result is the ratio, which is calculated by dividing the number of error bits by the total number of bits.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:RATE` on page 367

7.2.11.3 Current RX Alarms

The alarm LEDs within this range refer to errors, which are received from the DUT.

Current RX Alarms
These LEDs provide information about the transmission quality of signals received from the DUT.

The LEDs are blue, when the transmission works correctly. Red LEDs indicate DUT alarms.

"LOS"	The LOS (**L**oss **o**f **S**ignal) LED indicates a loss of signal.
"LOF"	LOF (**L**oss **o**f **F**rame) indicates, when the received data lost the synchronization, i.e. loss of frame.
"RAI"	RAI (**R**emote **A**rm **I**ndication) indicates, if any remote part of the end-to-end link has failed.
"SDI"	SDI (**S**ervice Access Point **D**efect **I**ndication) indicates, if the data communication failed.
"Reset"	The DUT is in reset state. In the CPRI RE test mode, the LED shows that a reset was performed, and in CPRI REC test mode, the LED indicates a reset request.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TEST:RX:LOS` on page 368
`[:SOURce<hw>]:EBOX:CPRI:TEST:RX:LOF` on page 368
`[:SOURce<hw>]:EBOX:CPRI:TEST:RX:RAI` on page 368
`[:SOURce<hw>]:EBOX:CPRI:TEST:RX:SDI` on page 369
`[:SOURce<hw>]:EBOX:CPRI:TEST:RX:RESet` on page 369

7.2.11.4 Layer 1 Events

In CPRI RE test mode the R&S EX-IQ-BOX acts as a CPRI REC (master). As defined in the CPRI standard specification, the CPRI REC provides the generation of Layer 1 messages. In this section, you can simulate some events. Use this function to see how the DUT responds to these events.

SDI (SAP Defect Indication)
Activate the SDI (**S**ervice Access Point **D**efect **I**ndication) defect indicator. This function intentionally provokes an SDI event, in order to examine whether the DUT evaluates it. In realtime applications, the function detects whether an SAP (**S**ervice **A**ccess **P**oint) is defective or is not working properly.

Note: This function applies to CPRI RE test mode. In this mode, the R&S EX-IQ-BOX acts as a CPRI REC (master). As defined in the CPRI standard specification, the CPRI REC provides the generation of Layer 1 messages. In this section, you can simulate some events. Use this function to see how the DUT responds to these events.

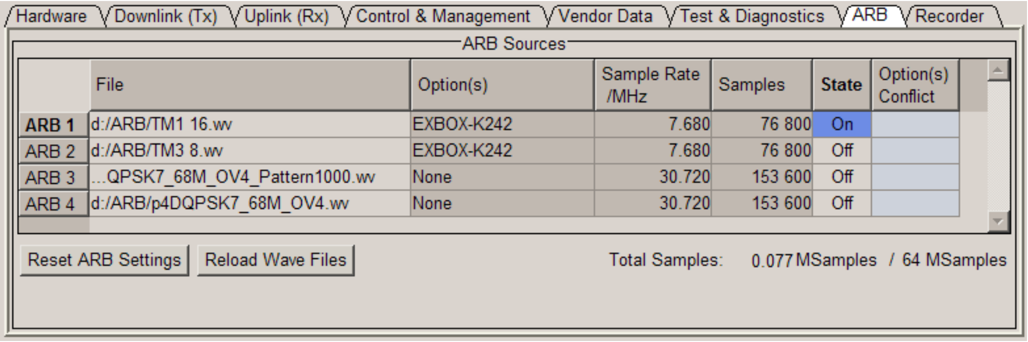
SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TEST:TX:SDI` on page 371

RE Reset
Set or clear the bit on the downlink connection which requests the RE to reset.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:TEST:TX:REReset` on page 370

7.2.12 ARB

The **ARB Sources** section displays all fields that are relevant for loading a waveform file in the waveform memory of the R&S EX-IQ-BOX.



	File	Option(s)	Sample Rate /MHz	Samples	State	Option(s) Conflict
ARB 1	d:/ARB/TM1 16.wv	EXBOX-K242	7.680	76 800	On	
ARB 2	d:/ARB/TM3 8.wv	EXBOX-K242	7.680	76 800	Off	
ARB 3	...QPSK7_68M_OV4_Pattern1000.wv	None	30.720	153 600	Off	
ARB 4	d:/ARB/p4DQPSK7_68M_OV4.wv	None	30.720	153 600	Off	

Total Samples: 0.077 MSamples / 64 MSamples

Fig. 7-65: CPRI ARB dialog box

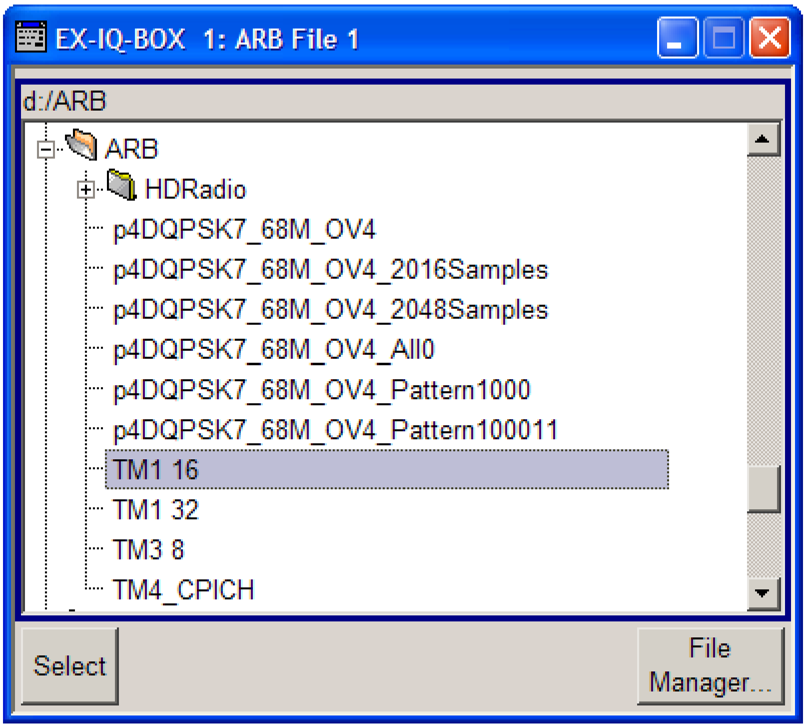
Instead of a signal generator as signal source, the R&S EX-IQ-BOX creates the signal from a waveform file and embeds it in the CPRI protocol. The ARB functionality applies to the transmission mode, when the R&S EX-IQ-BOX is sending to the DUT, i.e. in CPRI RE test mode, the R&S EX-IQ-BOX sends in the downlink, and in CPRI REC test mode in the uplink.

Conversely, for operating in receiver mode, the R&S EX-IQ-BOX provides a recording memory. The signal data, coming from the DUT can be recorded over a period of time and then saved in a file, see chapter 7.2.13, "Recorder", on page 189.

Waveform Memory and Recording Memory are provided, when the R&S EX-IQ-BOX is equipped with the respective options. For information on available options refer to chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory ", on page 23.

File

Open an explorer dialog for loading a waveform file.



The **recent data sets** directory shows the files last used.

Select the directory where waveform files are stored. The available waveform files, identifiable by the file extension `*.wv` are shown.

The "Select" button loads the marked file and returns to the "ARB" dialog box. The "ARB Sources" table indicates the file name and its path, i.e. the directory where the file is stored.

Note: The FILE MANAGER button leads to a dialog used to copy, delete and rename files, and to create new directories.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:FILE` on page 341

Option(s)

If the wave form file is provided by R&S WinIQSIM2, and is based on a digital standard, R&S DigIConf indicates the name of the option, like e.g., EXBOX-K242, which represents the 3GPP-FDD-Standard. "None" indicates that the loaded waveform file was created with another software, or does not base on a digital standard signal.

Note: Find the list of supported R&S options in chapter chapter 3.2.2.4, "Digital Standards with R&S WinIQSIM2", on page 23.

SCPI command:
Installed options: `[:SOURce<hw>]:EBOX:OPT` on page 307

Sample Rate /MHz
Displays the sample rate of the signal, loaded from the waveform memory. The sample rate represents the number of samples per second that are used for digitizing.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:SRATe` on page 341

Samples
Indicates the number of samples the loaded signal is composed of.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:ARB:SAMPles:TOTal` on page 340

Level dBFS
Displays the signal level in terms of an rms value, in dBFS (**F**ull **S**cale ratio).

SCPI command:
n.a.

PEP dBFS
Displays the signal level in terms of a peak envelope power value (PEP). The unit of the peak envelope power is dBFS (**F**ull **S**cale ratio).

SCPI command:
n.a.

State
Activate, that the signal from the ARB waveform file can be used in the CPRI link.

In order to activate signal transmission, assign the signal to the signal source of the CPRI downlink, as described in "Physical Source" on page 159. The R&S EX-IQ-BOX then embeds the signal into the CPRI protocol.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:STATe` on page 342

Options Conflict
A conflict arises, if a waveform requires an option, that is not installed on the R&S EX-IQ-BOX, or is not enabled. A red LED indicates the conflict.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:CONFlict` on page 340

Reset
Erases the ARB table, i.e. all loaded waveform files and their settings.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:ARB:PRESet` on page 340

Reload
Update the waveform file in R&S DigIConf, in case waveform data have changed. Reload updates all currently assigned files.

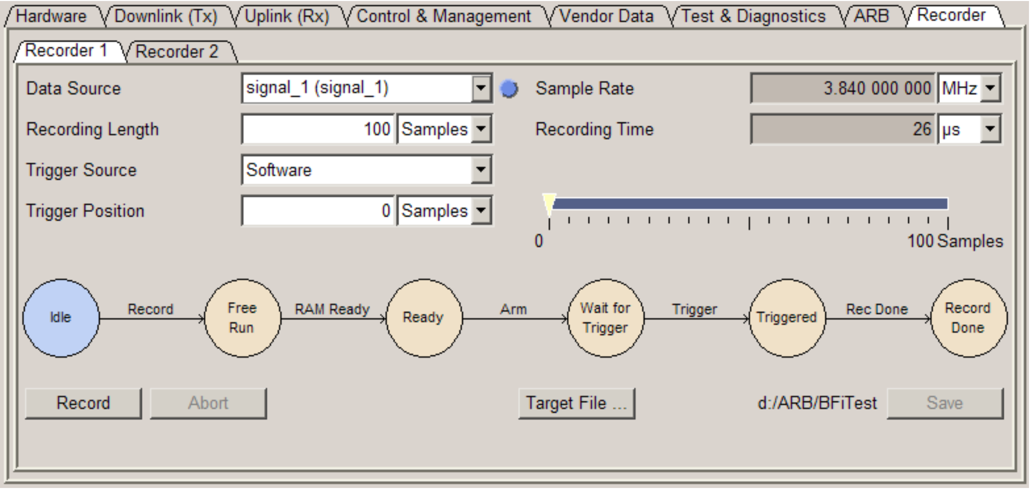
SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:ARB:RELoad` on page 340

Total Samples
Indicates the total number of samples, added up from all active ARB files.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:ARB:SAMPles:TOTal` on page 340

7.2.13 Recorder

The **Recorder** dialog covers the parameters relevant for recording an I/Q signal and storing the data in a waveform file.



Data Source: signal_1 (signal_1)
Sample Rate: 3.840 000 000 MHz
Recording Length: 100 Samples
Recording Time: 26 µs
Trigger Source: Software
Trigger Position: 0 Samples
d:/ARB/BFiTest

Fig. 7-66: CPRI Recorder dialog box

Two recorders are available for the recording of incoming signals. In all both provide 512 MB memory. As a sample takes up 4 bytes of storage, the available recording length is up to 128 MS.

In order to use the maximum record length, the 128 MS can be fully used by one recorder. Alternatively, the two recorders share the memory space, as e.g., each uses 64 MS.

The recording memory provides a predefined resolution of 16 bits, each for I and Q. I.e. recorded I/Q data use always 16 bits in memory, regardless of the resolution of the source.

The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, records it over a period of time and provides storing the recorded data in a waveform file.

The recorder function applies to receiver mode, when the R&S EX-IQ-BOX is receiving a signal from the DUT. I.e., it is possible to record an uplink signal of the CPRI RE test mode or a downlink signal of the CPRI REC test mode.

Conversely, for operating as transmitter, the R&S EX-IQ-BOX provides a waveform memory, see chapter 7.2.12, "ARB", on page 186. Stored signal data can be replayed and then sent to the DUT.

Waveform Memory and Recording Memory are provided, when the R&S EX-IQ-BOX is equipped with the respective options. For information on available options refer to chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory ", on page 23.

The I/Q signal data are stored in the R&S waveform format (.wv), the same format as used in the ARB.

The stored waveforms can be used customer-specific, or replayed in the ARB of the R&S EX-IQ-BOX. Use this function for post-processing the signals offline.

Data Source

Select the signal source. All RX signals are available. In order to record a signal, the signal must be selected and activated in the respective RX. Either the uplink signal in CPRI RE test mode, or the downlink signal of the CPRI REC testmode are possible. Assign the signal "DIG OUT 2 IQ / Recorder" or "Recorder". Switch on the signal in "Signal State" on page 158.

The LED next to "Data Source" must be blue. It indicates that the selected signal is active. Otherwise recording cannot be startet.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:RECorder:DATA:SOURce:CATalog` on page 360

`[:SOURce<hw>]:EBOX:CPRI:RECorder:DATA:SOURce` on page 360

Recording Length

Set the length of data trace in samples.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:RECorder:RLENgth` on page 362

Trigger Source

Select the trigger source for starting the recording. A trigger event can be initiated by the software itself or by hardware events.

"Software"	Software trigger starts the recording immediately after the RECORD button is pressed. No other event is necessary.

"External Trigger 1...3"

Start recording with an external trigger event.
External trigger events are generated by the hardware and fed via the CPRI communication link or at the GENERAL PURPUSE IO interface.

Available hardware trigger events:

- CPRI:
  - CPRI DL/UL Basic Frame
  - CPRI DL/UL Hyper Frame
  - CPRI DL/UL NodeB Frame
- GPIO
  - External Trigger 1 |2 | 3

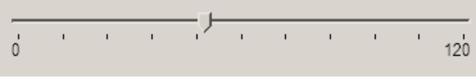
Refer to chapter 7.2.2.1, "Short Description of the CPRI Frame Structure", on page 131 and chapter 7.2.4.1, "Top View", on page 134.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:RECorder:TRIGger:SOURce` on page 364

Trigger Position
Determine the position of the trigger event on the waveform. The position provides to realize a pre-trigger recording, as well as a post-trigger recording. The value is set in samples from 0 to "Recording Length"-1.

- **Post-trigger**, i.e. position 0 at the beginning of the waveform enables to evaluate the signal after the trigger event.
- **Pre-trigger**, with the trigger position at the end of the waveform, provides the evaluation of the signal before the trigger event.

The trigger position is graphically displayed on the right.



SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:RECorder:TRIGger:POSition` on page 364

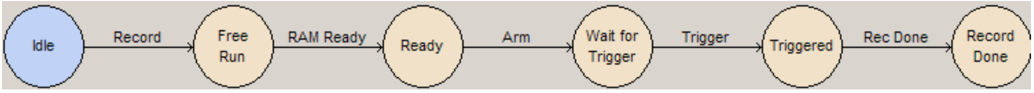
Sample Rate
Indicates the sample rate of the signal to be recorded.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:RECorder:DATA:SRATe` on page 361

Recording Time
Indicates the duration of recording. The recording time results from the recording length and the sample rate.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:RECorder:RTIMe` on page 362

Recorder Status Diagram



Displays graphically the current process step of the recording.

"Idle"	The recording process is inactive. Configure the recorder in that state. The recorder remains in Idle state until you start with the "Record" button.
"Free Run"	The recorder records the signal continuously in a ring memory. These data are required for pre-trigger analyzes.
"Ready"	Recording passed through the ring memory once at least, i.e. it described the memory completely. At this point the data is valid and R&S DigIConf activates the trigger signal automatically.
"Wait for Trigger"	The recorder continues recording until the trigger event occurs. Then the process switches to the next state. **Note:** If trigger source "Software" is used, the trigger event occurs immediately.
"Triggered"	After the trigger event, only the remaining samples after the trigger position are recorded (post-trigger data).
"Record Done"	If all post-trigger data are recorded, the recording is completed and the recorder stops. All data are available in memory.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:RECorder:STATus` on page 363

Record
Starts the recording.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:RECorder:EXECute` on page 361

Abort / Discard
Stops and cancels the recording. You can abort the recording process at any time.

After recording "Record Done", the ABORT button label changes to DISCARD.

Note: Avoid data loss!. Discard erases the recorder memory. In order to keep the data, save it first by pressing TARGET FILE....

DISCARD changes the recording status from "Record Done" back to "Idle" and is ready for a new recording.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:RECorder:ABORt` on page 360

Save to File
Save the data in a file.

Note: CPRI stores the recorded data in the R&S WinIQSim2 waveform file format with the predefined file extension `*.wv`. By default, waveform files are stored in the directory **%Program Files%/Rohde-Schwarz/DigIConf/Settings**, unless another directory is selected. File name and the directory are user-selectable.

SCPI command:
`[:SOURce<hw>]:EBOX:CPRI:RECorder:FILE:CREate` on page 361

Save File...
Open a file dialog to select directory and file name for storing the recorded data.

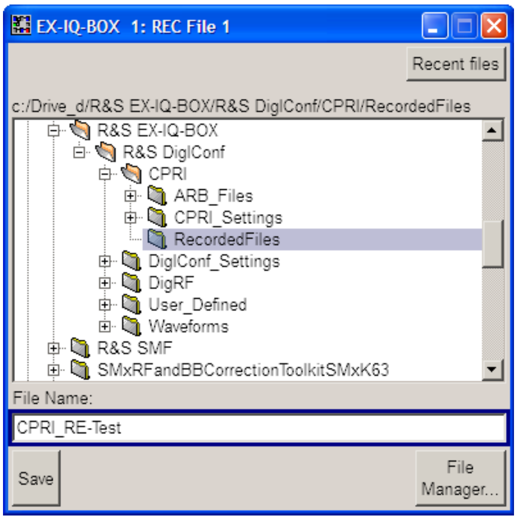


Fig. 7-67: CPRI Recorder > File dialog

The "Recent Files" directory shows the files last used. Select the directory where recorded files are stored. The available files, identifiable by the file extension *.wv are shown. The "Select" button loads the marked file and returns to the "Recorder" settings dialog.

The "File Manager" button leads to a dialog used to copy, delete and rename files, and to create new directories.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:RECorder:FILE:SELect` on page 362

7.3 DigRF

This part of the R&S EX-IQ-BOX manual comprises a brief overview of the standardized interface DigRF. The main part covers the configuration dialogs and explains the parameters in detail, provided by the configuration software R&S DiglConf. Find in chapter 6.1, "R&S DiglConf Configuration Software", on page 54 the description of R&S DiglConf in detail.

The configuration dialog is divided into tabs, according to functional groups. The description is similarly structured, therefore, find the appropriate information in:

- chapter 7.3.6, "Main Configuration Dialog", on page 213
- chapter 7.3.7, "Hardware", on page 215
- chapter 7.3.8, "IQ Sources", on page 239
- chapter 7.3.9, "IQ Capture", on page 243
- chapter 7.3.10, "Operation & Script", on page 250
- chapter 7.3.11, "Marker", on page 257
- chapter 7.3.12, "Test", on page 264
- chapter 7.3.13, "Status", on page 267

"IQ Sources" and "Capture" require that the R&S EX-IQ-BOX is equipped with the respective waveform memory and recording options, see chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory ", on page 23.

7.3.1 Introduction

DigRF^{SM} is a publicly available digital communication protocol standardized by a MIPI (**M**obile **I**ndustry **P**rocessor **I**nterface) Alliance working group.

The new state of the art in mobile communications, such as 3G and LTE mobile communication digital standard formats results also in changes in the functionality of mobile phones. For example, the previous analog connection between BB-IC and RF-IC is now built by a digital connection that serially transmits I/Q and control data at high data rates. I.e. you need a digital signal source in order to test the RF-IC instead of the previously used analog sources, you must comply with more strict time frames and you need appropriate measuring equipment and tools.

To fulfill these requirements MIPI has specified DigRF, the standardized digital communication protocol. It is designed for connecting wireless mobile terminals over a common interface, namely the interface between a baseband IC (BB-IC) and one or more RF-ICs in a mobile terminal.

The MIPI working group also created advanced versions of DigRF, to meet the requirements of the enhanced digital transmission formats, as e.g. LTE:

- DigRF 3G, compatible to 3GPP or UMTS
- DigRF v4, supporting WiMax, LTE, etc.

For further information on the DigRF interface specification refer to www.mipi.org.

The DigRF standard transmission protocol comprises the electrical, logical and protocol parameters of the interface. Provided the required software on the baseband is given, the standard enables ICs from different vendors to interoperate.

In the TX and RX transmission paths differential signals are transmitted, i.e. DigRF uses separate lanes for every transmission path. It transmits I/Q data as well as control and status information embedded in a packet protocol, providing various data rates and sleep modes for power saving.

Rohde & Schwarz provides DigRF

For DigRF applications, **Rohde & Schwarz** provides the individually configurable digital interface module R&S EX-IQ-BOX offering a convenient developing and test environment. The R&S EX-IQ-BOX in combination with the DigRF breakout board and the provided software components facilitates the development between the digital baseband domain and the RF range.

For example, a test setup, consisting of the R&S EX-IQ-BOX with the DigRF breakout board connected, and an R&S signal generator, emulates the baseband IC in order to control the RF-IC via DigRF 3G. Returned data from the RF-IC is then evaluated by an R&S signal analyzer, as shown in chapter 7.3.2.1, "DigRF RF-IC Test Application Example", on page 198.

You can, e.g. measure the output power of the RF-IC in the TX path, or perform ACLR (**A**djacent **C**hannel **L**eakage **R**atio) or EVM (**E**rror **V**ector **M**agnitude) measurements. Or, in Rx direction, e.g. you can perform EVM or NF (**N**oise **F**igure) measurements.

Key features

Overview of the distinctive features offered by the R&S EX-IQ-BOX to control the digital data transmission at the DigRF interface:

- DigRF specific breakout board for interfacing with the DUT (option R&S EXBOX-B81)
  - Support of DigRF 3G and DigRF v4 signals
  - Clock frequencies of 19.2 / 26 / 38.4 / 52 MHz
  - GPIO and GPIO group signals as well as SPI / I2C and RFFE buses for communications with external devices
  - Four user I/O BNC connectors with freely assignable function (trigger, marker, etc.)
- Test of DigRF 3G/v4 RFICs by means of the options R&S EXBOX-K13/-K15
- Flexible hardware configuration and test case definition via freely configurable scripts
- Hardware scheduler with timing resolution of 6.4 ns
- PN16 and sine test signal generator for the physical layer DigRF signal
- Interface BER tester and DigRF payload BER tester

In addition, the standardardized LVDS (**L**ow **V**oltage **D**ifferential **S**ignaling) transmission protocol of Rohde & Schwarz offers convenient interaction between R&S equipment. E.g. an R&S vector signal generator delivers realistic digital baseband signals, including enhanced functions as fading and AWGN simulation for testing digital transceivers or other components. An R&S signal analyzer enables the reliable analysis of digital baseband components, measurements for digital standards and common RF measurements. All state-of-the-art standards such as 3GPP FDD, incl. HSDPA, HSUPA and HSPA+, LTE, WiMAX and CDMA2000 are supported.

DigRF - available options

Equipped with the appropriate options the R&S EX-IQ-BOX supports the following test modes of the DigRF standardized interface protocol:

- option R&S EX-IQ-BOX-B81, DigRF breakout board
- option R&S EX-IQ-BOX-K13, DigRF v3RF-IC
- option R&S EX-IQ-BOX-K14, DigRF v3BB-IC
- option R&S EX-IQ-BOX-K15, DigRF v4RF-IC
- option R&S EX-IQ-BOX-K16, DigRF v4BB-IC

The DigRF breakout board is directly connected to the R&S EX-IQ-BOX at the Z-Dok user interface. The connection to the device under test (DUT) is done from the breakout board, using the RX/TX SMA High Speed Serial Connectors, and the BNC or SMC 50-pole connectors for control signals. The interface is configured by the configuration software R&S DigIConf.

7.3.2 Concept of Operation

Using the following block diagram, the operation concept is briefly explained:

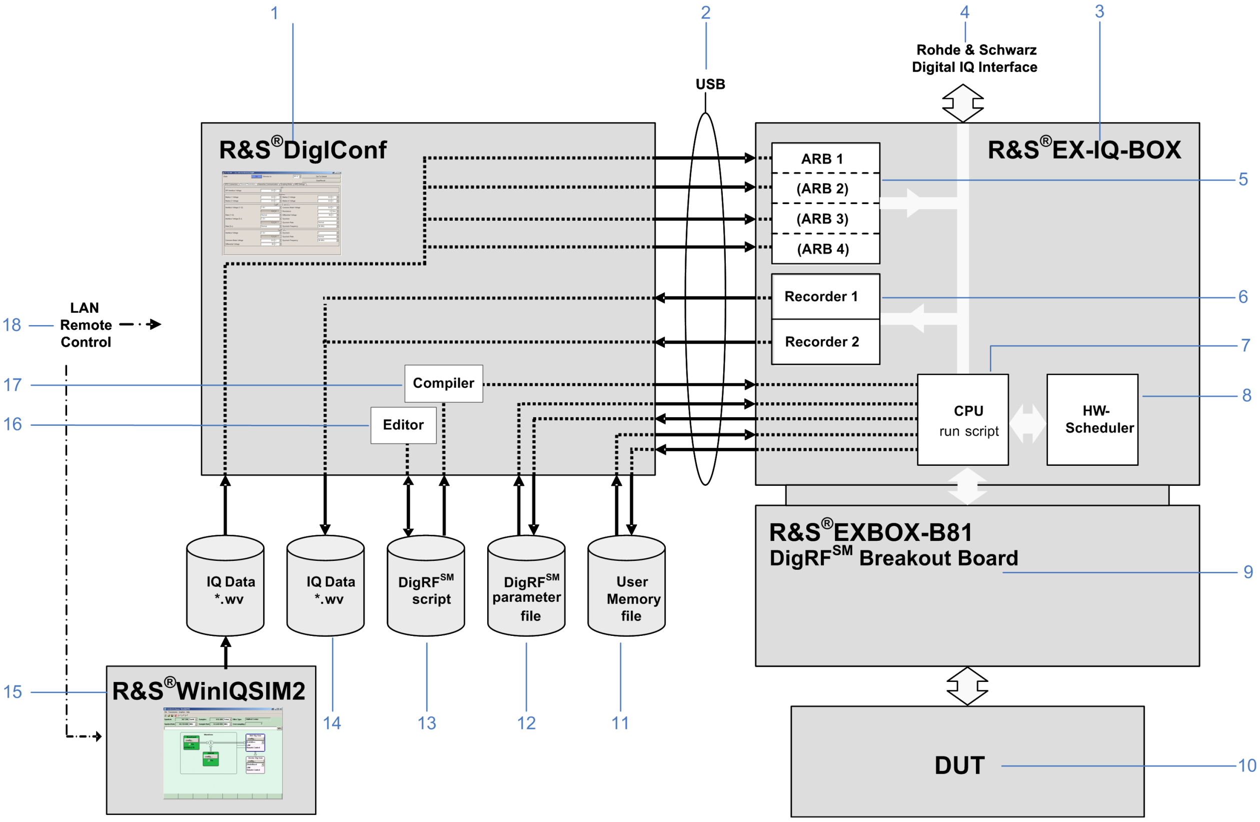


Fig. 7-68: R&S EX-IQ-BOX operation concept with DigRF

Table 7-7: Legend to DigRF operation concept

No	Description	No	Description	No	Description
1	R&S DigIConf	7	DigRF Script execution (CPU)	13	DigRF Script
2	USB interface	8	DigRF Hardware scheduler	14	IQ data source, e.g. signal generator
3	R&S EX-IQ-BOX	9	R&S DigRF Breakout board	15	IQ data source WinIQSIM2
4	R&S digital IQ interface	10	DUT	16	Script editor
5	ARB waveform memory	11	User memory storage	17	Script compiler
6	Recording memory	12	Parameter file storage	18	Remote control (LAN)

Connection

The **DUT** (**D**evice **U**nder **T**est) (**10**) is connected to the DigRF specific breakout board (**9**). The DigRF breakout board is directly connected to the R&S EX-IQ-BOX at the Z-Dok user interface.

The R&S EX-IQ-BOX (**3**) is controlled by the configuration software **R&S DigIConf** (**1**) from a PC via **USB** (**2**).

Settings

According to the test setup, the hardware parameters of the interface protocol are set directly via R&S DigIConf. However, the DUT is exclusively controlled by **scripts** (**13**), i.e. the DigRF script contains the configuration of the test case, including hardware control of the IC at test, timing, control and status information, and the payload data.

Scripts

Scripts (**13**) are written in **Pawn**, a scripting language with C-like syntax. As a tool for the Pawn scripts an editor (**16**) is embedded in the R&S DigIConf environment.

Parameter Files

You can create parameter tables (**12**) with up to 32 individually defined values for flexible processing in the script. Parameters are passed to the script, and are used there, e.g., as RF channel.

Signal Sources

Signal sources are configured in the script via so-called streams. Signals are supplied by various sources, such as directly from a signal generator (**4**) or via files loaded into the **ARB** (**5**) , the internal waveform memory of the R&S EX-IQ-BOX. The respective standard-compliant waveform files can be generated with R&S WinIQSIM2 (**15**) or another suitable external tool.

User Memory

In addition, you can also access to user-specific data in the User Memory (**11**), such as IC-specific calibration data or measurement results.

Hardware scheduler

As special feature the **hardware scheduler** (**8**) provides real-time operation of script processing for timing critical time sequences. The scheduler enables to precisely control the script processing, in order to bypass internal processing delays.

Processing

To start a test case, the script file is loaded in R&S DigIConf (**1**) and compiled (**17**). The compiled file is loaded into the R&S EX-IQ-BOX (**3**), started and executed by the R&S DigIConf (**7**). During execution parameters and data are exchanged via R&S DigIConf.

Recorder

The recording memory (**6**) enables the recording of I/Q data the R&S EX-IQ-BOX receives from the DUT via the DigRF link. It is also possible to record data in RAW mode and to evaluate it in the Frame Viewer, a tool provided by R&S DigIConf.

Additionally, R&S provides the ARB Toolbox Plus for the analysis of I / Q data.

Remote control

Finally, the entire test setup can also be automated by remote control (**18**).

7.3.2.1 DigRF RF-IC Test Application Example

The application example shows a DigRF test scenario, with the R&S EX-IQ-BOX emulating the BB-IC in order to control RF-IC via the R&S DigIConf 3G interface. The setup is combined with an R&S signal generator and an R&S signal analyzer that provide signal input and analysis of the RF-IC.

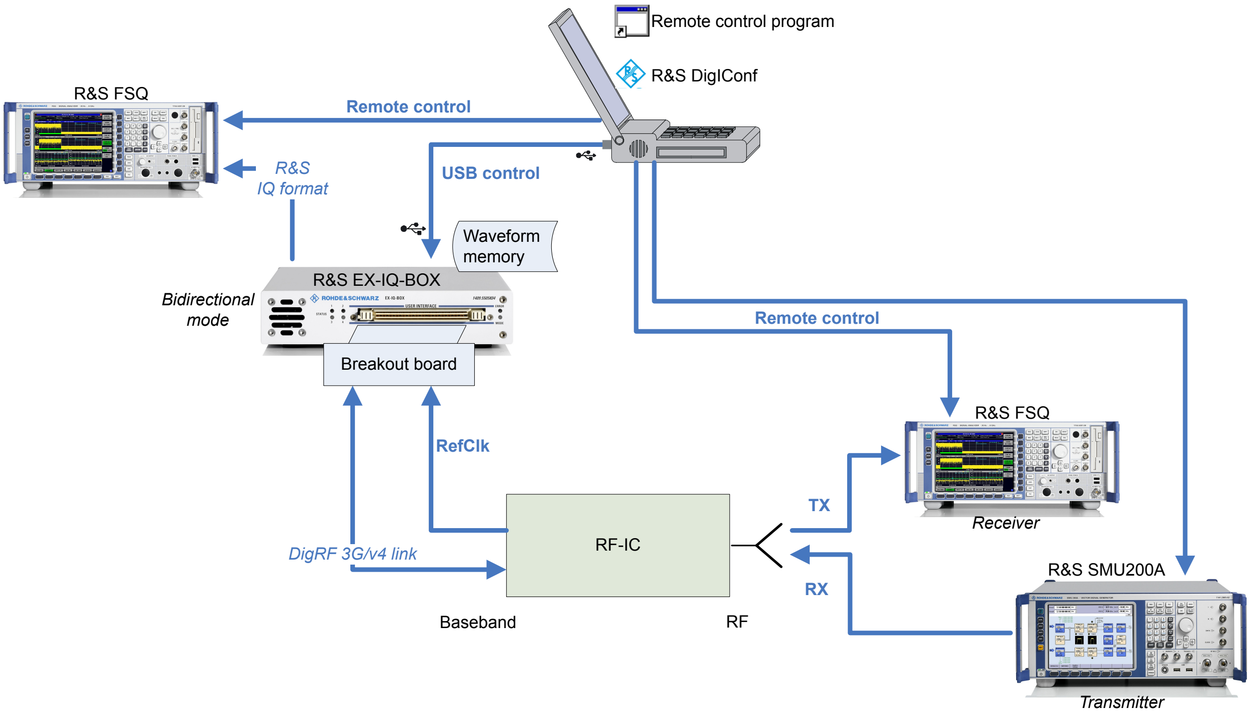


Fig. 7-69: DigRF RF-IC Test scenario, with the R&S EX-IQ-BOX emulating the baseband IC

The internal IQ source, the waveform memory of the R&S EX-IQ-BOX is used as data source.

The R&S EX-IQ-BOX feeds the I/Q data as well as control information into the TX module of the RF-IC in standard-compliant DigRF packages.

The DigRF protocol is controlled via a script in real-time.

The RX input of the RF-IC is supplied by a standard-compliant signal from the R&S signal generator, and the output signal of the TX module is measured and analyzed with an R&S signal analyzer.

The RF-IC converts the signal from RF to baseband and sends it to the R&S EX-IQ-BOX by using the DigRF link. The R&S EX-IQ-BOX extracts the IQ data from the DigRF protocol, converts it to the specific R&S IQ format and sends it to the R&S signal analyzer for evaluation.

A remote control program controls R&S DigIConf, which then transmits the settings to the R&S EX-IQ-BOX via the USB interface. The remote program runs either on the same PC as the R&S DigIConf software or on any PC in a network.

In this example, the complete test setup is automated by a remote control program. This program controls R&S DigIConf and the R&S instruments. R&S DigIConf in turn controls the R&S EX-IQ-BOX via the USB interface.

7.3.3 DigRF 3G Transmission Protocol

The DigRF protocol transfers the I/Q baseband data and control information in one link. It embeds the user data and control and status messages in the transmission protocol by using the multiplex method.

This section shows the structure of the DigRF 3G interface protocol, and briefly explains the components of a frame and some key functionalities.

DigRF 3G Block Diagram

As shown in the block diagram of the interface, DigRF 3G requires only the pairs of TX and RX data lines and two lines for the system clock. In the the TX / RX links, control and data signals are transmitted differentially in different logical channels. Via SysClkEn, the BB-IC activates the system clock of the RF-IC, which feeds the clock via the SysClk connection.

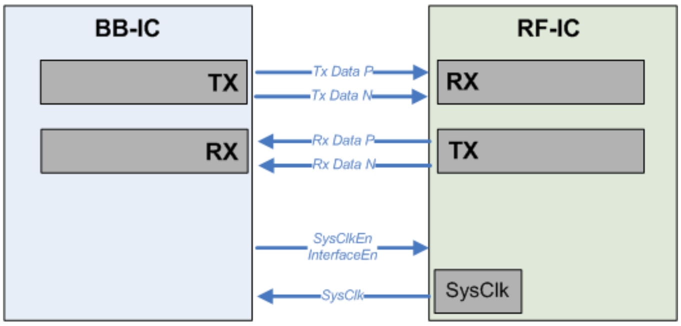


Fig. 7-70: DigRF 3G basic configuration

TX Data P/N = differential TX control and data interface from the BB-IC to the RF-IC
RX Data P/N = differential RX status and data interface from the RF-IC to the BB-IC
SysClkEn = enable signal for the SysClk driven by the BBIC
InterfaceEn = enable second and subsequent sets of TX/RX data links
SysClk = master system clock from the RF system

DigRF 3G supports the timing modes:

- HS (**H**igh **S**peed) and LS (**L**ow **S**peed) in the TX link
- HS (**H**igh **S**peed), MS (**M**edium **S**peed) and LS (**L**ow **S**peed) in the RX link

See chapter 7.3.3.4, "Timing Modes", on page 204 for details.

For interfacing with the DUT (RF-IC, BB-IC), the DigRF breakout board provides SMA connectors for data input (RX) and output (TX), and for the SysClk (input / output) and SysClkEn signals.

Additionally, you can work with control signals, like GPIO, GPIO GROUP signals, SPI, I2C and RFFE signals for communication with external devices, and User I/O data.

7.3.3.1 DigRF Frame Structure

Refer to the **MIPI Alliance Specification for Dual Mode 2.5G/3G Baseband/RFIC Interface** for detailed description and coding of the frame structure, see www.mipi.org.

You also find some information on the coding explained in chapter 7.3.11.3, "DigRF 3G Trigger Pattern", on page 260.

This section briefly describes some basic features and the frame structure of DigRF 3G.

DigRF embeds all data in frames. Each frame consists of 16 bits for synchronization, 8 bits header and up to 512 bits payload provided for user data.

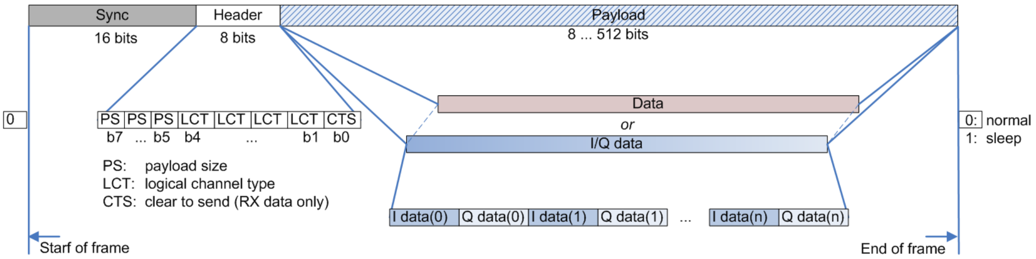


Fig. 7-71: Frame structure of the DigRF 3G transmission protocol

Starting with the synchronization sequence makes sure that the receiver selects the optimum clock phase to synchronize the data transfer. Next, DigRF transmits the header information, such as payload size "PS" and "LCT" logical channel type of the frame. The logical channel type determines the type of contents in the payload. The following bits of the frame contain "Payload" data, which may vary in size and functionality.

Sync

The first bits of the frame contain a bit sequence for synchronization with the receivers. The "Sync" pattern is always transmitted first.

1	0	1	0	1	0	0	0	0	1	0	0	1	0	1	1

Fig. 7-72: DigRF 3G Frame structure > Sync Pattern

The firmly defined 16 bit synchronization pattern is used for all transmission rates. It determines the clock phase in the interface receiver.

Header

The header of a frame consist of 8 bit, divided into 3 bits defining the payload size. The next 4 bits determine the logical channel type, and the last bit provides flow control in the RX link.

PS	PS	PS	LCT	LCT	LCT	LCT	CTS
b7	...	b5	b4	...		b1	b0

Fig. 7-73: DigRF 3G Frame structure > Header

Table 7-8: DigRF 3G structure of the header field

Header bits	Description
b7.. b5	**PS** (**P**ayload **S**ize), determines the payload size, the total frame size in bits, and the protocol overhead in %
b4 .. b1	LCT (**L**ogical **C**hannel **T**ype), selects the logical channel type of the frame
b0	CTS (**C**lear **T**o **S**end), supports the control on the transmission data buffer in the RX link
Derivated from the MIPI Alliance Specification for Dual Mode 2.5G/3G Baseband/RFIC Interface, Version 3.09.04, Table 6	

Payload

DigRF defines different logical channel types for different applications. You can vary the payload content accordingly, by defining the appropriate logical channel type in the header. Refer to chapter 7.3.3.3, "Logical Channel Types", on page 202 for a brief overview to the logical channel types.

DigRF starts with the MSB (**M**ost **S**ignificant **B**it) of the payload data, regardless of the payload size, and ends the sequence with the LSB (**L**ast **S**ignificant **B**it) [b0].

7.3.3.2 Payload Size

The three bits of the header field determine the payload size and therefore the total frame size in bits.

Setting the total frame size in relation to the protocol overhead, the overhead size in % can be calculated. The protocol overhead is composed of the sync and header bits.

Protocol Overhead [%] = (16 bits (Sync) + 8 bits (Header)) / Total Frame Size.

Table 7-9: DigRF 3G coding of the payload size

Payload size in bits	Total frame size in bits	Header [b7..b5]
8	32	0b000
32	56	0b001
64	88	0b010
96	120	0b011
128	152	0b100
Derivated from the MIPI Alliance Specification for Dual Mode 2.5G/3G Baseband/RFIC Interface, Version 3.09.04, Table 7		

Payload size in bits	**Total frame size in bits**	**Header** **[b7..b5]**
256	280	0b101
512	536	0b110
profile-defined	24 + payload size	0b111
Derivated from the MIPI Alliance Specification for Dual Mode 2.5G/3G Baseband/RFIC Interface, Version 3.09.04, Table 7		

7.3.3.3 Logical Channel Types

Logical channel types are distinguished between:

- **Interface Control** (TX and RX data link)
  Provides adjusting the DigRF interface.
- **Time Accurate Strobe Message** (TX datalLink)
  The content of this channel type coordinates the BB-IC transmission scheduling in the TX link, using either 8 bit or 32 bit payload size, determined by the RF-IC. It also enables to take time delays at the interface into account.
- **Unsolicited Status Logical Channel** (RX data link)
  Delivers status information in the RX link that is not requested by the BB-IC but typically unexpected and urgent.
- **RF-IC Control**(TX data link)
  Provides all interface related control information.
- **RF-IC Read** (RX data link)
  Provides responses to the RF-IC Control Logical Channel.
- **CTS Transfer** (RX data link)
  Provides control of the transmission data buffer.
- **RX /TX Data Channel**
  Data channel types include various types of data such as 3G or 2.5G (primary or diversity), each specified in a profile.

The four bits of the header field determine the logical channel type (LCT) in the payload field of a frame.

Table 7-10: DigRF 3G coding of logical channel types

Logical Channel Type	**Header** **[b4..b1]**
Interface Control (TX and RX data link)	0b0000
Time Accurate Strobe Message (TX data link) RF-IC Unsolicited Status (RX data link)	0b0001
RF-IC Control (TX data link) RF-IC Read (RX data link)	0b0010
Derivated from the MIPI Alliance Specification for Dual Mode 2.5G/3G Baseband/RFIC Interface, Version 3.09.04, Table 8	

Logical Channel Type	Header [b4..b1]
Reserved for future use (TX data link) CTS Transfer (RX data link)	0b0011
Data Channel A	0b0100
Data Channel B	0b0101
Data Channel C	0b0110
Data Channel D	0b0111
Data Channel E	0b1000
Data Channel F	0b1001
Data Channel G	0b1010
Data Channel H	0b1011
[0b1100..0b111] are reserved for future use.	
Derivated from the MIPI Alliance Specification for Dual Mode 2.5G/3G Baseband/RFIC Interface, Version 3.09.04, Table 8	

Interface Control Logical Channel

This logical channel type allows to adjust the DigRF interface settings. The coding of the logical channel functions is based on 8 bit payload size, defined as listed in the table.

Table 7-11: DigRF 3G functions of the Interface Control Logical Channel

Function	Description	Payload [b7..b0]
Enable SysClk	Reset/slow clocking hardware sequencing asserts SysClkEn to do this function but it’s logically part of Interface Control	---
RFIC clock multiplier start	Preparation for high-speed mode	0x02
RFIC clock multiplier stop	After fallback to low-speed mode	0x04
Select TXData slow	Switch from high-speed mode to low-speed	0x08
Select TXData fast	Switch from low-speed to high-speed mode	0x10
Select RXData slow	Switch from other mode to low-speed	0x20
Select RXData medium	Switch from other mode to medium-speed	0x40
Select RXData fast	Switch from other mode to high-speed	0x80
Enable RXData Link		0x31
Disable RXData Link		0x32
Derivated from the MIPI Alliance Specification for Dual Mode 2.5G/3G Baseband/RFIC Interface, Version 3.09.04, Table 9		

Function	Description	Payload [b7..b0]
Turn clock test mode on	Send 101010… on RXData continuously using the currently configured RXData clock rate; cancelled by cycling SysClkEn/InterfaceEn, or, if implemented, by issuing the “test mode off” command	0x34
Turn Frame loopback on	RFIC loops back incoming frames until cancelled by cycling SysClkEn/InterfaceEn or Frame contains “test mode off” command	0xFF
Turn test mode off	Cancels either clock test mode or Frame loopback mode if they are active. The implementation of this function is optional.	0x38
“Ping”	RFIC sends back a fixed, known result, if it supports status transmission on RXData	0x00
	Reserved for future use	0x01
Derivated from the MIPI Alliance Specification for Dual Mode 2.5G/3G Baseband/RFIC Interface, Version 3.09.04, Table 9		

Data Logical Channel Type Profiles

This section defines various data types and data combinations of 3GPP TX and RX DigRF 3G and 2.5G applications.

Table 7-12: 3GPP Data Formats

Logical Channel Type	RX data			TX data		
	DigRF	I/Q format	Payload size	DigRF	I/Q format	Payload size
Data Channel A	2.5G Primary	16 Bit	256 Bit	2.5G	4 Bit	256 Bit
Data Channel B	2.5G Diversity	16 Bit	256 Bit	reserved		
Data Channel C	3G Primary	8 Bit	256 Bit	3G	12 Bit	96 Bit
Data Channel D	3G Diversity	8 Bit	256 Bit	reserved		
Data Channel E	reserved			3G	16 Bit	128 Bit
Data Channel F-H	reserved			reserved		
Derivated from the MIPI Alliance Specification for Dual Mode 2.5G/3G Baseband/RFIC Interface, Version 3.09.04, Table 10						

The RX data link transfers in most cases I and Q data at twice the symbol rate (2.5G) or twice the chip rate (3G). The TX data link transfers usually BB-IC data at the symbol rate (2.5G) or the chip rate (3G).

7.3.3.4 Timing Modes

DigRF 3G provides depending on the operating mode the following data rates:

- **low-speed** mode: **SysClk / 4**
  - start-up and initialization in both paths (TX and RX)
  - control only operation in the TX link, from the BB-IC to the RF-IC

  - status only operation in the RX link (RF-IC to BB-IC)
- **medium speed** mode: **SysClk**
  - 2.5G only operation in the RX link
- **high speed** mode: **312 Mbps**
  - TX data transfer
  - multiplexed RF-IC control information in the TX link (BB-IC to RF-IC)
  - RX data transfer
  - multiplexed RF-IC status information in the RX link (RF-IC to BB-IC)

7.3.4 Introduction to DigRF Scripts

The test environment of R&S controls the DigRF interface via scripts which provide settings, data management and responses. You can create, compile and execute the scripts directly in R&S DigIConf, the configuration software of the R&S EX-IQ-BOX.

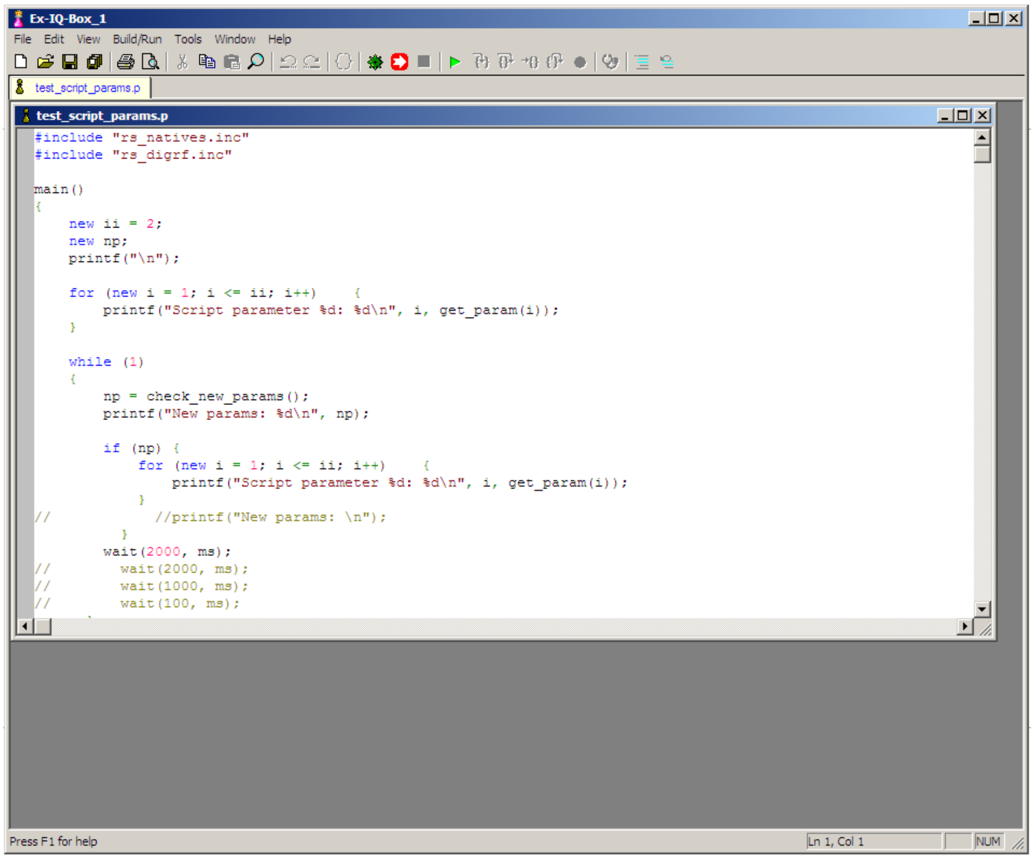
An editor, directly accessible from R&S DigIConf, enables you to edit scripts. Scripts are written in Pawn, a scripting language with C-like syntax. The R&S EX-IQ-BOX comes with a predefined set of script commands for the main settings of a measurement. You can also create your own library with functions especially defined for your ICs, in order to use it in several applications.

7.3.4.1 Brief Overview to the Script Editor

The editor is the script processing component of the development environment, required for DigRF test solutions with the R&S EX-IQ-BOX. The used editor, Quincy, an Open Source Product, uses Pawn scripting language for Microsoft®Windows applications. It has been specially modified for the DigRF applications and is coupled with the R&S EX-IQ-BOX configuration software R&S DigIConf.

Quincy integrates an editor and compiler, as well as the file management. Its debug feature is disabled. However, you can display results, trace messages and warnings in the "Script Console" of R&S DigIConf, since it is particularly designed to DigRF.

Quincy Editor

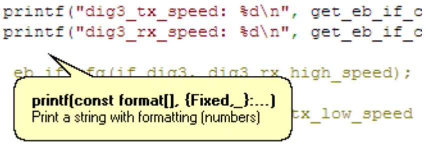


```
#include "rs_natives.inc"
#include "rs_digrf.inc"

main()
{
    new ii = 2;
    new np;
    printf("\n");

    for (new i = 1; i <= ii; i++)     {
        printf("Script parameter %d: %d\n", i, get_param(i));
    }

    while (1)
    {
        np = check_new_params();
        printf("New params: %d\n", np);

        if (np) {
            for (new i = 1; i <= ii; i++)     {
                printf("Script parameter %d: %d\n", i, get_param(i));
            }
//              //printf("New params: \n");
           }
        wait(2000, ms);
//         wait(2000, ms);
//         wait(1000, ms);
//         wait(100, ms);
```

Fig. 7-74: Quincy editor - main application window

Especially for DigRF applications, R&S has modified Quincy as follows:

- 

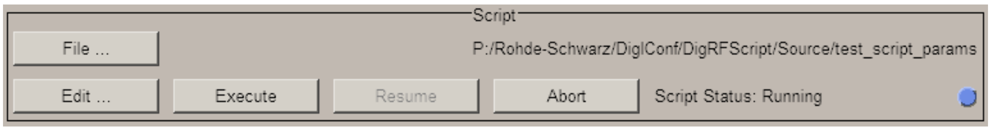
  "Compile", "Download" and "Start" buttons added in the "Quincy" toolbar
  Coupling of these functions with R&S DigIConf, i.e. you can execute the functions either in Quincy as well as in R&S DigIConf, see also table 7-13.
- A script loaded in Quincy is simultaneously activated in R&S DigIConf.
- 

  ```
  printf("dig3_tx_speed: %d\n", get_eb_if_c
  printf("dig3_rx_speed: %d\n", get_eb_if_c
  ```

  printf(const format[], {Fixed,_}:...)
  Print a string with formatting (numbers)

  "Tooltips" embedded to the commands in script editor mode.
  Just click with the cursor, e.g. the mouse pointer on a command, and a tooltip with information about the command and the required syntax appears.

Corresponding functions in R&S DigIConf



Script

P:/Rohde-Schwarz/DigIConf/DigRFScript/Source/test_script_params

Script Status: Running

Fig. 7-75: DigRF Operation > Script

The buttons in R&S DigIConf correspond to the functions in Quincy and therefore can be called and executed in both programs.

Table 7-13: Script processing functions in Quincy and R&S DigIConf

Quincy	R&S DigIConf	Function
--	Edit ...	Opens the Quincy editor.
📂	File ...	Opens a file dialog for selecting a script file.
✹	-	Compiles the selected script file.
➲	-	Downloads the compiled script file into the FPGA of the R&S EX-IQ-BOX.
▶	Execute	Starts the script file.
--	Resume	Continues script execution, if halted.
--	Abort	Stops script execution. Requires restart (not possible to continue).

Quincy Help

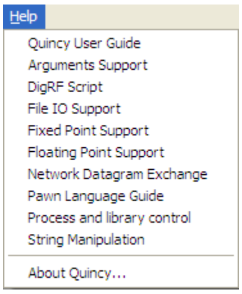


Fig. 7-76: Quincy editor - help menu

In the "Help" menu, Quincy provides various user guides and documentation for support, such as :

- Quincy User Guide
- Script Arguments Support Library
- File I/O Support Library

- Fixed Point Support Library
- Floating Point Support Library
- Datagram Exchange Module
- Pawn Language Guide
- Process Control and Foreign Function Interface
- String Manipulation Library

Additionally, the follwing documents are embedded for information.

- DigRF-Script
  This document describes the available script commands, divided into sections User script commands, architecture of the script implementation, and native commands.
  - **User script commands** describes all defined script commands for the configuration and control of the interfaces
  - **Architecture of the script implementation** describes the interaction of the programs and hardware.
  - **native commands** explains the basic functionality of the internally implemented commandos for DigRF.

7.3.4.2 Script Examples

The following examples provide a brief insight to the scripts:

Powering up the RF-IC and setting the transmission speed of the interface

This extract of the script puts the RF-IC into operation. It performs the basic initialization, and sets the DigRF 3G to high speed.

```
//*********************************************************************************
// power up RF-IC and set control and data interface to DigRF 3.09 highspeed
//*********************************************************************************

init_if_dig3()
{
    //*********************************************************************************
    // power up RF-IC
    //*********************************************************************************
    // do basic initialization of ExBox gpio (direction mask)
    gpio_cfg(0xFFFF13F6);
    wait(100, us);

    // perform ref-clock enable, set ball REF_CLK_EN high, wait until sysclk is stable
    gpo_pin(gpo_ref_clk);
    wait(2500, us);

    // additionally to release reset, set RESET_N
    gpo_pin(gpo_reset_n);

    // add. perform sys-clock enable, switch on digital part, set SYS_CLK_EN
```

```
    // wait until sysclk is stable
    gpo_pin(gpo_sys_clk_en);
    wait(250, us);

    //exit shutdowb, add. set pin SHUTDOWN_N
    gpo_pin(gpo_shutdown_n);
    wait(250, us);

    //*******************************************************************************
    // set control and data interface to DigRF3.09
    // all further Script control telegrams are sent via the configured control interface
    //*******************************************************************************
    // ExBox: switch control and data interface to DigRF3.09 (low speed)
    // no iclc is send
    eb_if_cfg(if_dig3, dig3_ci_di);
    eb_if_cfg(if_dig3, dig3_tx_low_speed);
    eb_if_cfg(if_dig3, dig3_rx_low_speed);
    wait(200, us);

    // RF-IC: turn on the pll
    // send iclc 0x02
    send_iclc(dig3_iclc_clk_mult_on);
    wait(150, us);

    // RF-IC: turn on DigRF3.09 transmitter (RF-IC -> BB)
    // send iclc 0x31
    send_iclc(dig3_iclc_rx_enable);
    wait(200, us);

    // RF-IC: switch DigRF3.09 transmitter to highspeed (RF-IC -> BB)
    // send iclc 0x80
    send_iclc(dig3_iclc_rx_hs);
    wait(400,ns);

    // RF-IC: switch DigRF3.09 receiver to highspeed (BB-> RF-IC)
    // send iclc 0x10
    send_iclc(dig3_iclc_tx_hs);
    wait(100,us);

    // ExBox: switch TX and RX to high speed)
    eb_if_cfg(if_dig3, dig3_tx_high_speed);
      eb_if_cfg(if_dig3, dig3_rx_high_speed);
    wait(150, us);
}
```

Ping test

Sends an echo request packet to the RF-IC and waits for response. This way you can verify reachability of the RF-IC.

```
// Test interface with ping

    new rdata[1];
    new rlen = 32;
     recv_clc_cfg(TRUE, dig3_lc_all); // enable the receive processing
    send_iclc(dig3_iclc_ping);
    recv_clc(rlen, rdata);
     recv_clc_cfg(FALSE, dig3_lc_all); // disable the receive processing
    if (rlen)    {
        printf("init_lib.inc:init_dig3_hs, RF-IC ping response: %x\n", rdata[0]);
    }    else    {
        printf("Error: RF-IC ping response failed.\n");
    }
```

Transfer of a data stream

This example shows the transmission of a data stream. It selects the data source, sets data format and control flags, starts transmitting and concludes the transmission at the end.

```
stream_demo()
{

    // open Tx stream:
    // source arb1, format 3G/12 bit i and q,
    // flow control by cts bit, logical data channel A
    stream_open(stream_tx, src_arb1, stream_3g_12b | stream_cts, dig3_lc_data_a);

    // start TX stream
    stream_start(stream_tx);

    // ....
    // stop and close TX stream
    stream_stop(stream_tx);
    stream_close(stream_tx);
}
```

7.3.5 Control Elements and Connectors

This section explains the control elements and connectors of the DigRF breakout board, i.e. the R&S EX-IQ-BOX option EXBOX-B81, refers to corresponding detailed descriptions in the manual. The schematic view represents the control elements and the connectors.

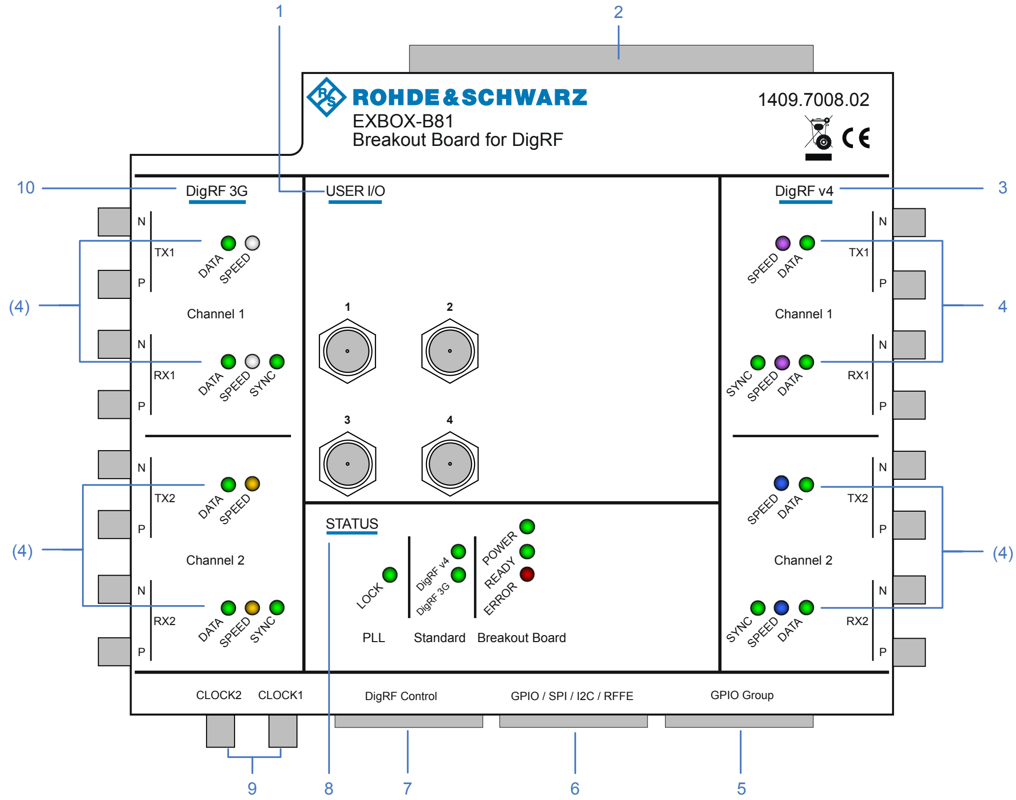
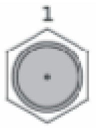


Fig. 7-77: Schematic view of the DigRF breakout board, option R&S EXBOX-B81

1 = USER I/O (Input/Output) - BNC Connectors
2 = User Interface - Tyco Z-Dok connector
3 = DigRF v4 TXn/RXn N/P - SMA (high speed serial) connectors of channel 1 and 2
4 = DigRF - Status LEDs of the appropriate channel
5 = GPIO Group (Input/Output) - SMC connector
6 = GPIO / SPI / I2C / RFFE (Input/Output) - SMC connector
7 = DigRF Control (Input/Output) - SMC connector
8 = DigRF - Status LEDs of the breakout board
9 = Clock 1/2 - High Speed Serial Connectors
10 = DigRF 3G TXn/RXn N/P - High Speed Serial Connectors of Channel 1 and 2

The DigRF breakout board's connectors are briefly described below. Detailed information about pin assignments especially of the 50-pole connectors and the user interface, see chapter 10.3.4, "DigRF - Option R&S EXBOX-B81", on page 455.



USER I/O

On top, the DigRF breakout board is equipped with four "USER I/O" (**I**nput/**O**utput) BNC connectors for connecting external instruments. The interfaces are for example for the output of signals, in order to trigger external instruments, such as R&S signal analyzers or oscilloscopes. Or use the ports as input, e.g. to trigger the Transient Recorder.

See also "User I/O Settings" on page 229, and chapter 10.3.4.3, "BNC Connectors", on page 457.

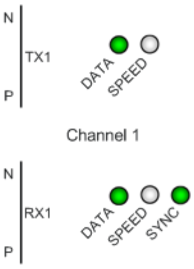
User Interface

TYCO Z-Dok adapter board connector at the rear of the DigRF breakout board. At this interface, the breakout board is connected directly to the R&S EX-IQ-BOX by a 168 pin connector, type TYCO Z-Dok (56 differential pairs), see chapter 10.1.1, "Z-DOK-Adapter Board Connector", on page 441.

RX/TX P/N

SMA (**Sub**M**iniature version **A**) connectors for differential data transmission (P/N).

The DigRF breakout board provides 2 channels for a standard, each with 2 TX and 2 RX ports.



DigRF 3G / v4 Transmission LEDs

On the upper right and left side, the DigRF breakout board contains several LEDs which inform about the status of the data transfer. The LEDs correspond directly to the adjacent connectors at the respective sides.

Each channel of the two standards (DigRF 3G, Channel 1 and Channel 2, and DigRF v4, Channel 1 and Channel 2) provides for both the transmitting and the receiving path, the following LEDs:

	Tx / Rx <n> **DATA**	**RX <n>** **SYNC**	**DigRF 3G Tx / Rx <n>** **SPEED**	**DigRF v4 Tx / Rx <n>** **SPEED**
🟢	sends / receives data frames	receiver is synchronized	medium (SysClk)	HS1.P (High speed 1 primary)
⚪	-	-	high speed 312 MHz	HS2.S (High speed 2 secondary)
🟡	-	-	low speed (SysClk/4)	low speed (SysBurst)
🔵	-	-	-	HS1.S (High speed 1 secondary)
🟣	-	-	-	HS2.P (High speed 2 primary)
⚫	not active	not active	not active	not active

Suffix <n> represents the channel number.

DigRF Control, GPIO / SPI / I2C / RFFE and GPIO Group

On the front, the DigRF breakout board covers three SMC 50-pole connectors for bidirectional communication with proprietary instruments.

Refer also to chapter 7.3.7.4, "General Purpose and User Settings", on page 227 and chapter 10.3.4.4, "SMC Connectors", on page 457.

CLOCK 1 / CLOCK 2

Two SMA (**Sub**M**iniature version **A**) connectors for input or output of reference clock signals.

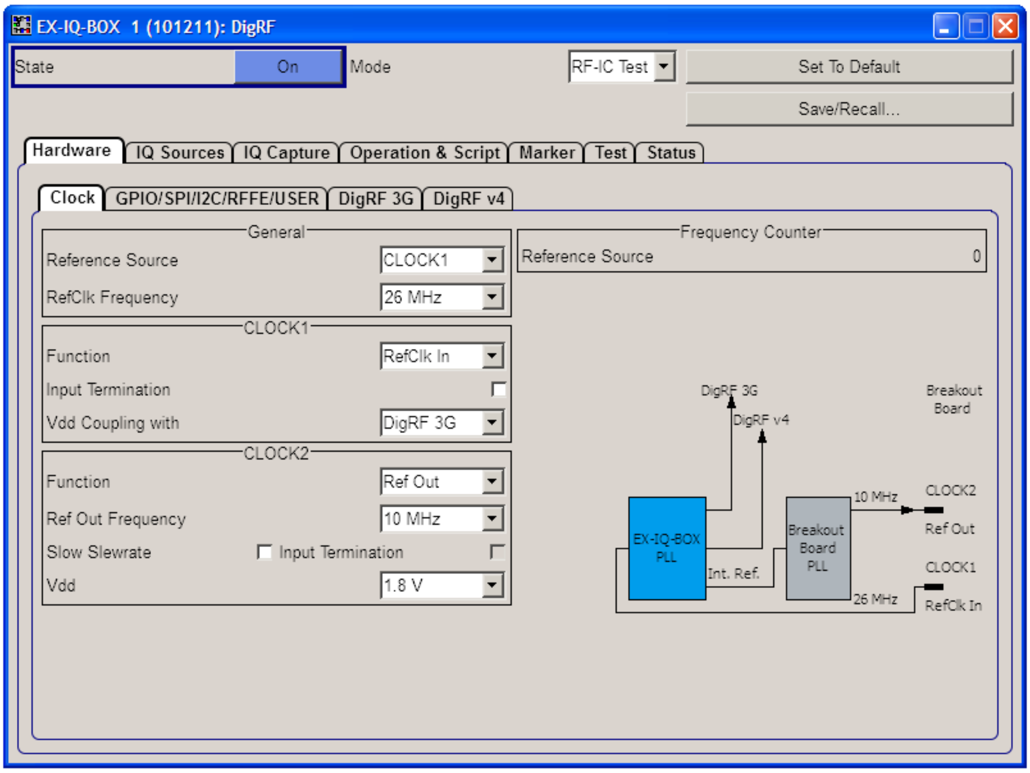
STATUS LEDs

The PLL, STANDARD and BREAKOUT BOARD LEDs on top visually indicate DigRF the status of these parameters:

	PLL LOCK	Standard DigRF v4 / DigRF 3G	Breakout Board		
			POWER	READY	ERROR
🟢	locked	the corresponding DigRF link is active	power supplied	ready for operation (FPGA loaded)	-
○	-	-	-	-	-
🔴	unlocked	-	-	-	error(s) occurred
⚫	-	-	power off	-	no errors

7.3.6 Main Configuration Dialog

Besides the settings that are relevant for the DigRF interface, the DigRF configuration dialog contains the common main controls as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading settings. The main controls are permanently indicated, independently of the active subdialog and the active interface standard. A detailed description of these general functions is given in chapter 7.3.6.1, "Main Controls", on page 214.



State: On
Mode: RF-IC Test

General
Reference Source: CLOCK1
RefClk Frequency: 26 MHz

CLOCK1
Function: RefClk In
Input Termination: ☐
Vdd Coupling with: DigRF 3G

CLOCK2
Function: Ref Out
Ref Out Frequency: 10 MHz
Slow Slewrate: ☐ Input Termination: ☐
Vdd: 1.8 V

Frequency Counter
Reference Source: 0

Fig. 7-78: R&S DiglConf > DigRF dialog box

Grouped by functionality the DigRF configuration dialog contains the following tabs, described in the corresponding chapters:

- chapter 7.3.7, "Hardware", on page 215 includes all hardware settings.

- chapter 7.3.8, "IQ Sources", on page 239, to configure the IQ signal sources.
- chapter 7.3.9, "IQ Capture", on page 243, with settings for waveform recording.
- chapter 7.3.10, "Operation & Script", on page 250, with settings for execution of scripts, script parameters and user memory. You also find a script-console, that shows you the scripting process, and you can display error and warning messages.
- chapter 7.3.11, "Marker", on page 257, to define signals for output at the user I/O interfaces.
- chapter 7.3.12, "Test", on page 264, covers settings for Interface and DigRF Payload tests.
- chapter 7.3.13, "Status", on page 267, contains error and statistics status in formation.

"IQ Sources" and "IQ Capture" functionality requires that the R&S EX-IQ-BOX is equipped with the appropriate options for waveform memory and waveform recording, see chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory ", on page 23.

7.3.6.1 Main Controls

The upper part of the DigRF configuration dialog contains the controls for activating, for setting default values, or for loading and saving predefined settings. These controls are always indicated, independently from the active subdialog.

State

Activate or deactivate the DigRF standard. The corresponding FPGA (**F**ield **P**ro**g**rammable **A**rray) is loaded automatically into the R&S EX-IQ-BOX.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:STATe` on page 417

Mode

Select a DigRF test scenario.

"RF-IC Test"	Activates the test mode to control the RF-IC. In this mode, the R&S EX-IQ-BOX emulates the BB-IC.
"BB-IC Test"	Activates the test mode to control the BB-IC. In this mode, the R&S EX-IQ-BOX emulates the RF-IC.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:MODE` on page 416

Set To Default

Set all parameters to default values. Refer to chapter A.3.3, "DigRF Default Settings", on page 469, containing an overview of the most important default settings.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:PRESet` on page 417

Save / Recall

Opens the "Save/Recall" dialog to store or to load DigRF settings, or to call the file manager.

R&S DigIConf stores the complete settings of the DigRF configuration in a file with the predefined file extension `*.digrf`. You can specify the file name and directory.

Fig. 7-79: DigRF Save / Recall menu

"Recall DigRF Settings"	Open the file select window for loading a previously saved DigRF configuration. Load the configuration of the selected (highlighted) file with "Select".
"Save DigRF Settings"	Opens the file select window for saving the current DigRF signal configuration. Determine the file name and save the settings.
"File Manager"	Calls the file manager. A DigRF settings file (*.digrf)" is preset in the "File Type" entry field. The file manager is used to copy, delete, and rename files and to create new directories.

SCPI command:
Settings files catalog: `[:SOURce<hw>]:EBOX:DRF:SETTing:CATalog` on page 438
Recall file: `[:SOURce<hw>]:EBOX:DRF:SETTing:LOAD` on page 439
Save file: `[:SOURce<hw>]:EBOX:DRF:SETTing:STORe` on page 439
Delete file: `[:SOURce<hw>]:EBOX:DRF:SETTing:DELete` on page 439

7.3.7 Hardware

The "Hardware" tab contains the settings of DigRF hardware parameters, further divided into tabs according to their technical functionality. These include reference "Clock" settings, that are also shown graphically in a diagram on the right, "GPIO", "SPI", "RFFE" and "User" interface settings, and the DigRF specific settings.

7.3.7.1 System Clock

The test environment of the R&S EX-IQ-BOX offers numerous options for synchronizing the test setup.

Basically, the RF-IC determines the system clock in a DigRF transmission protocol. That is, in the RF-IC test, the DUT (RF-IC) provides the reference clock frequency of the measurement setup. The R&S EX-IQ-BOX, emulating the BB-IC in this case, must synchronize on this reference. In BB-IC test mode, when the R&S EX-IQ-BOX is emulating the RF IC, it provides the reference clock frequency to the DUT (BB-IC).

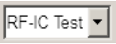
In both test modes, you have two options to apply the reference clock frequency, as shown in more detail in the following diagrams. In addition, the R&S EX-IQ-BOX test setup provides a second clock frequency, derived from the system clock. It is used to synchronize external devices.

R&S DigIConf shows the clock signals graphically, corresponding to the currently selected scenario in "Clock" tab. The corresponding graph of R&S DigIConf is shown to each of the test scenarios.

The system clock signal is defined in DigRF 3G as **SysClk**, whereas DigRF v4 uses **RefClk**. In the following description the term **RefClk** is used for both standards.

RF-IC Test

In this test mode, the RF-IC determines the reference clock signal. The R&S EX-IQ-BOX receives either an analog, or a digital signal, which has to be supplied at the appropriate socket. A digital reference signal additionally requires that the corresponding voltage level is set.



RF-IC Test with analog RefClk

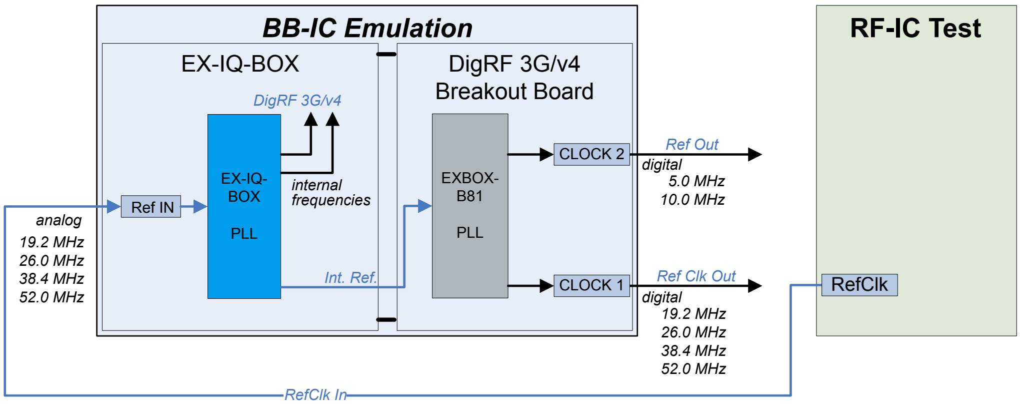
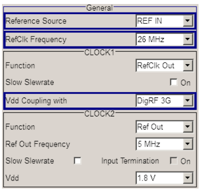


Fig. 7-80: DigRF RF-IC Test > analog RefClk

The analog signal, coming from the RF-IC is fed to the REF IN connector at the rear of the R&S EX-IQ-BOX.



General
Reference Source: REF IN
RefClk Frequency: 26 MHz
CLOCK1
Function: RefClk Out
Slow Slewrate ☐ On
Vdd Coupling with: DigRF 3G
CLOCK2
Function: Ref Out
Ref Out Frequency: 5 MHz
Slow Slewrate ☐ Input Termination ☐ On
Vdd: 1.8 V

To configure this test case, set the following in the "Clock" tab of R&S DigIConf:

1. Set "Reference Source" to "REF IN".
2. Select in "RefClk Frequency" one of the provided R&S DigIConf frequencies.
   The R&S EX-IQ-BOX synchronizes its baseband emulation test setup on this frequency.
3. Set in "Vdd Coupling with" the DigRF standard you use.
   The function assigns the Vdd voltage of the DigRF standard also to the digital reference signal, and provides it at the CLOCK 1 port of the breakout board.

R&S DigIConf shows this clock configuration like this:

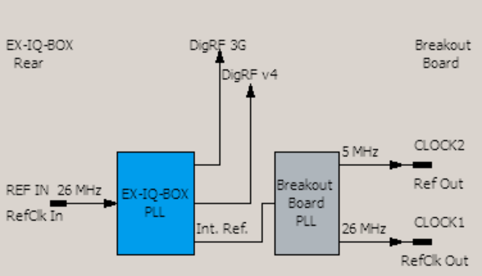
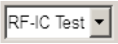


Fig. 7-81: RF-IC Test signal flow with reference source REF IN

Reference Source = "REF IN"
RefClk Frequency = 26 MHz
Function CLOCK1 = RefClk Out
Function (COCK2) = Ref Out
Ref Out Frequency = 5 MHz


RF-IC Test

RF-IC Test with digital RefClk

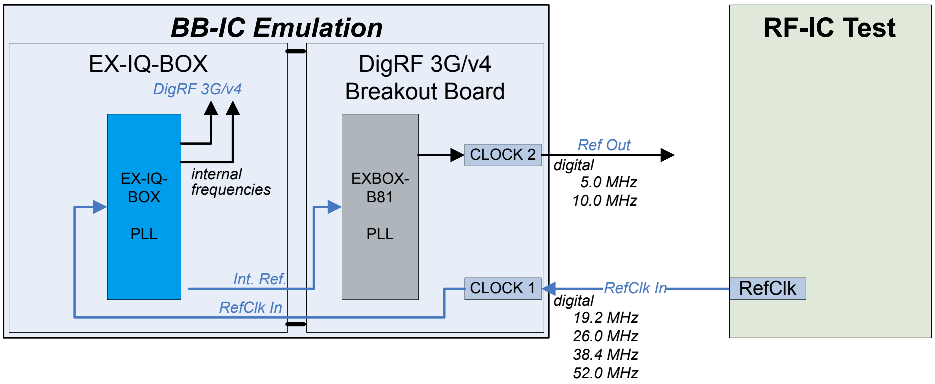
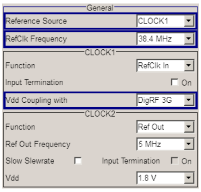


Fig. 7-82: DigRF RF-IC Test > digital RefClk

The digital signal is fed to the CLOCK 1 connector at the front of the DigRF breakout board.


General
Reference Source CLOCK1
RefClk Frequency 38.4 MHz
CLOCK1
Function RefClk In
Input Termination ☐ On
Vdd Coupling with DigRF 3G
CLOCK2
Function Ref Out
Ref Out Frequency 5 MHz
Slow Slewrate ☐ Input Termination ☐ On
Vdd 1.8 V

Required settings:

1. Set "Reference Source" to "CLOCK 1".
2. Select in "RefClk Frequency" one of the provided R&S DigIConf frequencies.
   The R&S EX-IQ-BOX synchronizes its baseband emulation test setup on this frequency. It is input digitally at the CLOCK 1 connector of the breakout board.
3. Set in "Vdd Coupling with" the DigRF standard you use.
   This parameter is coupled to the Vdd voltage parameter in the corresponding DigRF tab. The voltage level must comply to the Vdd voltage of the incoming clock signal.

You can set the remaining parameters in the "Clock" dialog according to your requirements.

Accordingly shown in R&S DigIConf:

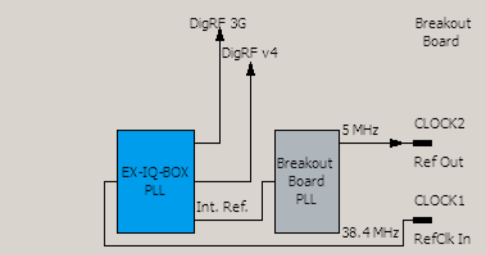
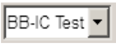


Fig. 7-83: DigRF RF-IC Test signal flow with Reference Source CLOCK1

Reference Source = "CLOCK1"
RefClk Frequency = 38.4 MHz
Function (CLOCK1) = RefClk In
Function (CLOCK2) = Ref Out
Ref Out Frequency = 5 MHz

BB-IC Test

In the BB-IC test, the R&S EX-IQ-BOX provides the reference clock signal. The frequency is either generated by the internal oscillator, or it is synchronized to the reference frequency of an R&S instrument.



BB-IC Test with external RefClk

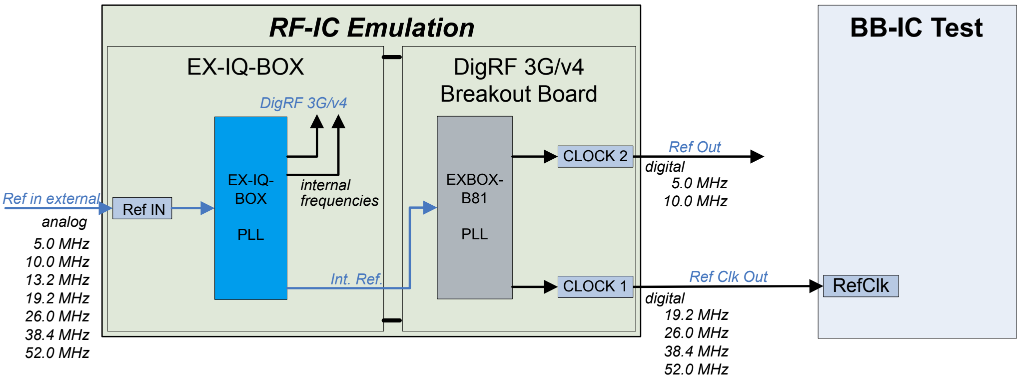
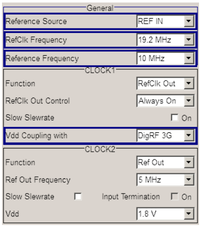


Fig. 7-84: DigRF BB-IC Test > RefClk externally supplied

The R&S EX-IQ-BOX obtains the reference frequency from a connected R&S instrument, i.e. a signal generator or analyzer. The analog signal is fed to the REF IN connector at the rear of the R&S EX-IQ-BOX.



General
Reference Source: REF IN
RefClk Frequency: 19.2 MHz
Reference Frequency: 10 MHz
CLOCK1
Function: RefClk Out
RefClk Out Control: Always On
Slow Slewrate ☐ On
Vdd Coupling with: DigRF 3G
CLOCK2
Function: Ref Out
Ref Out Frequency: 5 MHz
Slow Slewrate ☐ Input Termination ☐ On
Vdd: 1.8 V

For this test case, set the following in the "Clock" tab of R&S DigIConf:

1. Set "Reference Source" to "REF IN".
2. Select in "RefClk Frequency" one of the provided R&S DigIConf frequencies.
   This frequency synchronizes the BB-IC. It is output digitally at the CLOCK 1 connector of the breakout board.
3. Select the "Reference Frequency" according to the frequency of the incoming external signal.
   The R&S EX-IQ-BOX generates internally all frequencies necessary for DigRF from this reference frequency.

4. Set in "Vdd Coupling with" the DigRF standard you use.
   Vdd is set in the corresponding DigRF tab.

Accordingly displayed in R&S DigIConf:

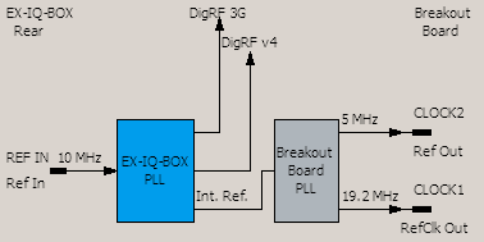
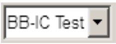


Fig. 7-85: BB-IC Test signal flow with reference source REF IN

Reference Source = "REF IN"
RefClk Frequency = 19.2 MHz
Reference Frequency = 10 MHz
Function CLOCK1 = RefClk Out
Function (COCK2) = Ref Out
Ref Out Frequency = 5 MHz


BB-IC Test

BB-IC Test with internal RefClk

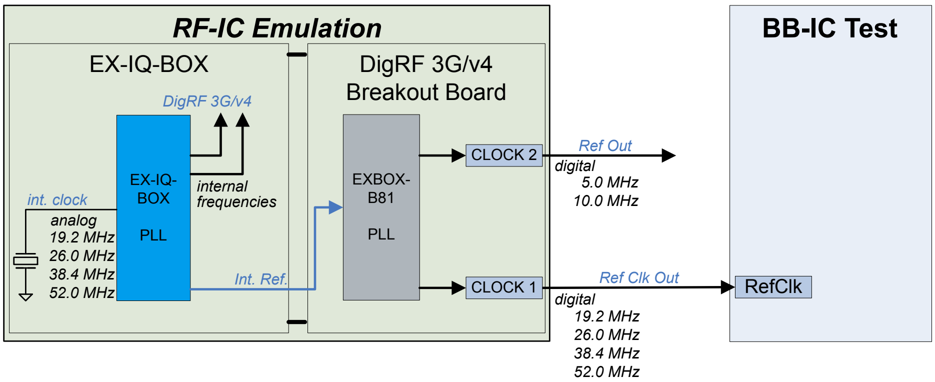
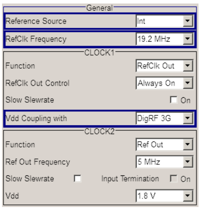


Fig. 7-86: DigRF BB-IC Test > RefClk internally generated

The R&S EX-IQ-BOX generates the reference frequency internally.


General
Reference Source: Int
RefClk Frequency: 19.2 MHz
CLOCK1
Function: RefClk Out
RefClk Out Control: Always On
Slow Slewrate ☐ On
Vdd Coupling with: DigRF 3G
CLOCK2
Function: Ref Out
Ref Out Frequency: 5 MHz
Slow Slewrate ☐ Input Termination ☐ On
Vdd: 1.8 V

Required settings:

1. Set "Reference Source" to "Int".
2. Select in "RefClk Frequency" one of the provided R&S DigIConf frequencies.
   This frequency synchronizes the BB-IC. It is output digitally at the CLOCK 1 connector of the breakout board.
3. Set in "Vdd Coupling with" the DigRF standard you use.
   This parameter assigns the Vdd voltage level also to the reference clock signal. Vdd is set in the corresponding DigRF tab.

Display in R&S DigIConf:

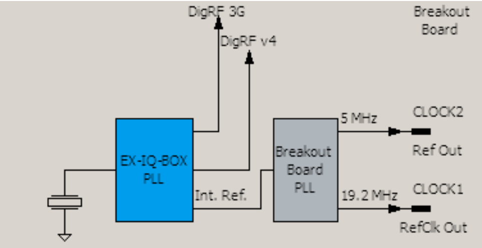


Fig. 7-87: BB-IC Test signal flow with Reference Source Int

Reference Source = "Int"
RefClk Frequency = 19.2 MHz
Function CLOCK1 = RefClk Out
Function (COCK2) = Ref Out
Ref Out Frequency = 5 MHz

7.3.7.2 DigRF Electrical Parameter Settings

This chapter is a brief summary of the electrical parameters of DigRF 3G/v4 TX. The voltage values are set in "Interface Standard" on page 231.

Vdd, Vcm, and Vdiff

DigRF TX signal circuit

The electric circuit shows graphically the voltages of the differential output signal.

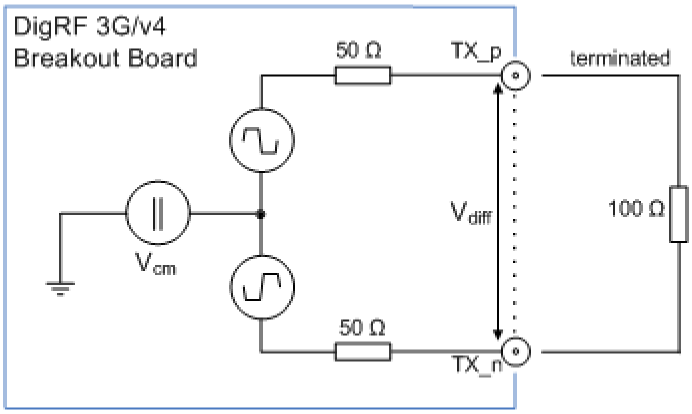


Fig. 7-88: DigRF voltage output configuration

V_{cm} = commom mode voltage
V_{diff} = differential output voltage swing

It is recommended that you perform your measurements in differential mode to avoid incorrect readings due to incorrect termination.

DigRF voltage definitions

The diagram shows the signal voltages, which are calculated according to the following formulas.

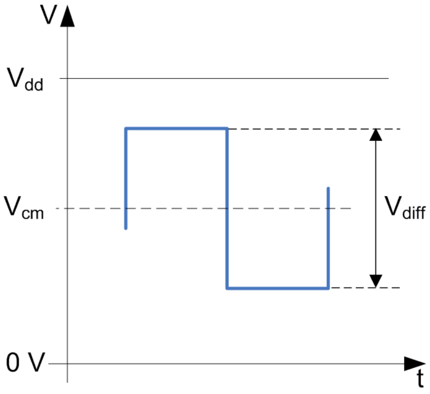


Fig. 7-89: Schematic representation of the voltage levels

V_{dd} = supply voltage of the electronic components
V_{cm} = commom mode voltage
V_{diff} = differential output voltage swing

This figure represents a signal, measured on **one** TX_p or TX_n connector, e.g. with an oscilloscope.

V_{diff} defines the amplitude of the differential output voltage signal:

$$V_{diff} = V_{(TX\_p)} - V_{(TX\_n)}$$

V_{cm} the common mode voltage defines the average of the voltages on the two wires TX_n and TX_p:

$$V_{cm} = \frac{V_{(TX\_p)} + V_{(TX\_n)}}{2}$$

V_{dd} (**d**igital **d**evice) represents the operating voltage of the electronic components.

DigRF 3G voltage levels

DigRF 3G operates LVDS (**L**ow **V**oltage **D**ifferential **S**ignaling) or SLVS (**S**calable **L**ow **V**oltage **S**ignaling) signaling systems, with the following voltage levels.

Table 7-14: DigRF 3G interface standard voltages

Interface Standard	1.8 V LVDS	1.2 V LVDS	1.8 V SLVS	1.2 V SLVS	User
V_{dd}	1.8 V	1.2 V	1.8 V	1.2 V	1.1 ... 1.9 V
V_{cm}	1.2 V	0.6 V	0.2 V	0.2 V	0.1 ... 1.5 V V_{dd} limited
V_{diff}	0.4 V	0.4 V	0.2 V	0.2 V	0.05 ... 0.4 V terminated
	-	-	-	-	0.01 ... 0.8 V unterminated

Since V_{dd} in user mode can be a maximum of 1.9 V, the common mode voltage level is limited accordingly, i.e., $V_{cm\ max}$= V_{dd} - 0.4 V.

DigRF v4 voltage levels

DigRF v4 uses SA (**S**mall **A**mplitude) and LA (**L**ong **A**mplitude) signaling systems, with voltage levels shown in the following table.

Table 7-15: DigRF v4 interface standard voltages

Interface Standard	1.8 V LA	1.2 V LA	1.8 V SA	1.2 V SA	User
V_{dd}	1.8 V	1.2 V	1.8 V	1.2 V	1.1 ... 1.9 V
V_{cm}	0.2 V	0.2 V	0.1 V	0.1 V	0.05 ... 0.4 V
V_{diff}	0.2 V	0.2 V	0.1 V	0.1 V	0.09 ... 0.21 V terminated
	-	-	-	-	0.18 ... 0.42 V unterminated

Slew Rate

The slew rate is defined as the ratio of voltage-difference to time required from the signal to change from low value to high value. The voltage difference is measured at the differential output signal when it passes the step heights, specified in percent.

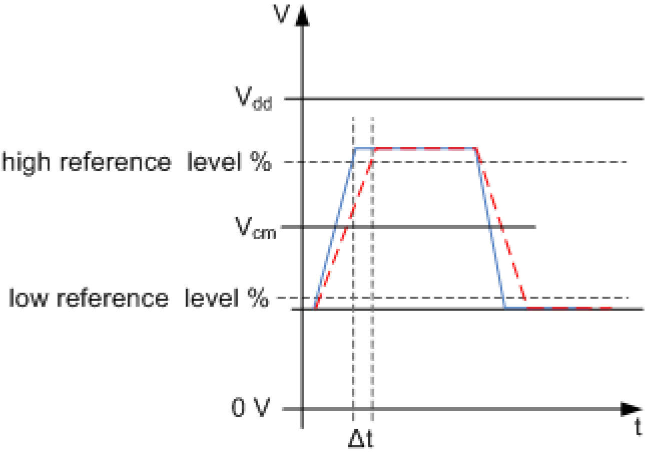


Fig. 7-90: Schematic representation of a signal at a slow slew rate

blue = normal slew rate (continuous line)
red = slow slew rate (dashed line)

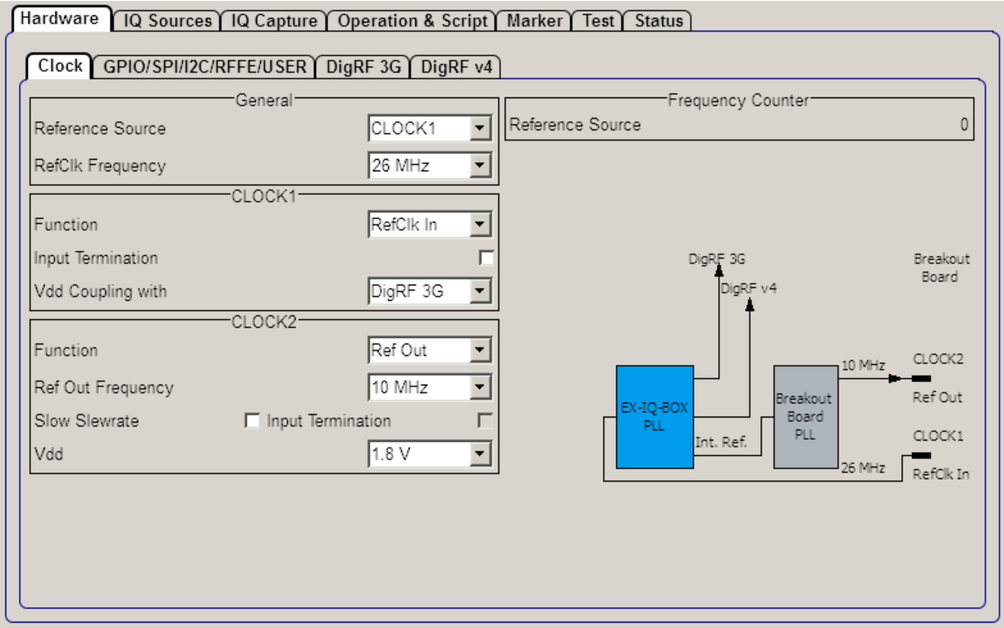
A slow slew rate minimizes EMI, and significantly reduces RF distortions caused by harmonics and non-harmonics.

You can also simulate the effect of a long cable, as it also increases the slew rate of a signal.

7.3.7.3 Clock Settings

Besides of the settings of the reference clock frequency, this tab shows the current signal flow of the clock signals graphically. Refer also to chapter 7.3.7.1, "System Clock", on page 215 for more information on the provided system clock scenarios.

The system clock signal is defined in DigRF 3G as **SysClk**, whereas DigRF v4 uses **RefClk**. In the following description the term **RefClk** is used for both standards.



General
Reference Source CLOCK1
RefClk Frequency 26 MHz

Frequency Counter
Reference Source 0

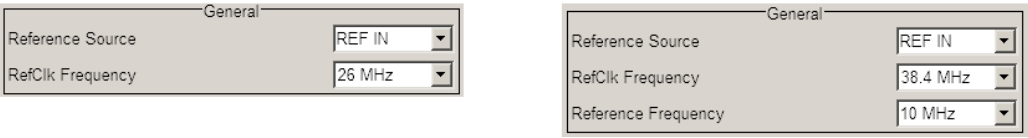
CLOCK1
Function RefClk In
Input Termination ☐
Vdd Coupling with DigRF 3G

CLOCK2
Function Ref Out
Ref Out Frequency 10 MHz
Slow Slewrate ☐ Input Termination ☐
Vdd 1.8 V

Fig. 7-91: DigRF Hardware > Clock dialog box in RF-IC test mode

General Information

In section "General" you can select the reference source and frequency.



RF-IC Test

General
Reference Source REF IN
RefClk Frequency 26 MHz

BB-IC Test

General
Reference Source REF IN
RefClk Frequency 38.4 MHz
Reference Frequency 10 MHz

Fig. 7-92: DigRF Hardware > Clock > General section

Reference Source

Select the system clock source for synchronization. The available signal sources depend on the test mode.

"CLOCK1"	**RF-IC Test** mode. The RF-IC delivers the system clock signal digitally. Assign this signal to the CLOCK1 connector of the DigRF breakout board.

"REF IN"	**RF-IC Test** and **BB-IC Test** mode. The R&S EX-IQ-BOX synchronizes the DigRF communication link with an analog reference clock signal. The signal is fed to the BNC connector REF IN at the rear of the R&S EX-IQ-BOX. It comes directly from the RF-IC, in "RF-IC Test" mode, or, from an R&S instrument in "BB-IC Test" mode.
"Int"	**BB-IC Test** mode. The R&S EX-IQ-BOX generates the system clock frequency with its internal reference oscillator.
"Demo Mode"	For demonstration purposes, you can generate the system clock frequency with the internal reference oscillator of the R&S EX-IQ-BOX, regardless of the test mode.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:RSOUrce` on page 412

RefClk Frequency
Select a DigRF system clock frequency.

The supported frequencies depend on the DigRF standard.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:RCFRequency` on page 411

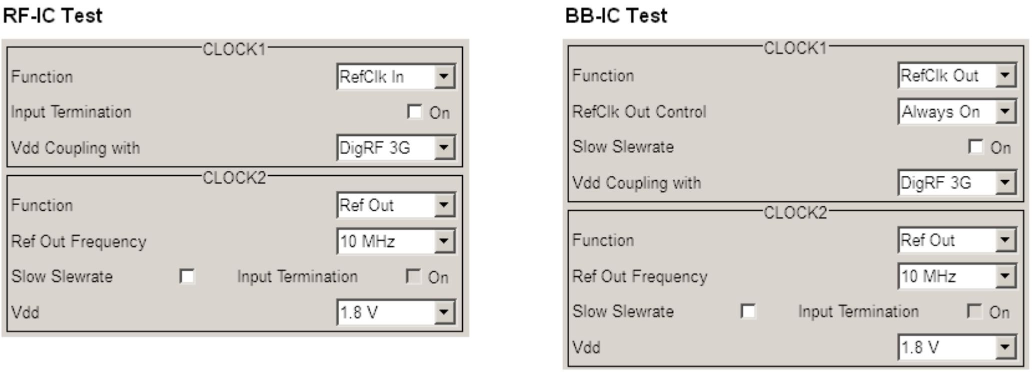
Reference Frequency (BB-IC Test)
Set frequency value that is applied at the REF IN connector of the R&S EX-IQ-BOX.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:RFRequency` on page 411

Clock1 and Clock2

Sections "CLOCK1" and "CLOCK2" contain the parameters of the supported reference signals.

Depending on the test mode and the used reference signal source, the parameters in this section vary.



RF-IC Test

CLOCK1
Function: RefClk In
Input Termination: ☐ On
Vdd Coupling with: DigRF 3G

CLOCK2
Function: Ref Out
Ref Out Frequency: 10 MHz
Slow Slewrate: ☐
Input Termination: ☐ On
Vdd: 1.8 V

BB-IC Test

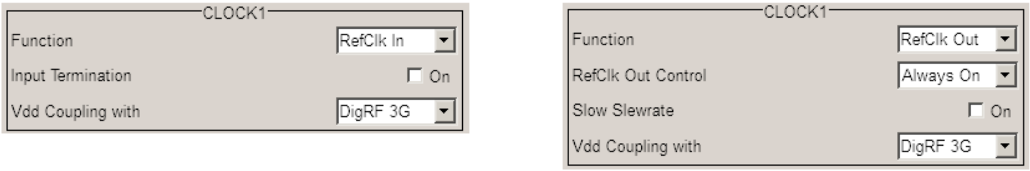
CLOCK1
Function: RefClk Out
RefClk Out Control: Always On
Slow Slewrate: ☐ On
Vdd Coupling with: DigRF 3G

CLOCK2
Function: Ref Out
Ref Out Frequency: 10 MHz
Slow Slewrate: ☐
Input Termination: ☐ On
Vdd: 1.8 V

Fig. 7-93: DigRF Hardware > Clock 1 and Clock 2

Clock1

Sets the parameters of Clock1.



RF-IC Test

CLOCK1

Function	RefClk In
Input Termination	☐ On
Vdd Coupling with	DigRF 3G

BB-IC Test

CLOCK1

Function	RefClk Out
RefClk Out Control	Always On
Slow Slewrate	☐ On
Vdd Coupling with	DigRF 3G

Fig. 7-94: DigRF Hardware > Clock 1

Function ← Clock1

Select the function of the "CLOCK1" signal.

The function of "CLOCK 1" depends on the test mode.

- **BB-IC Test**
  In the BB-IC test, the R&S EX-IQ-BOX provides the reference signal digitally ("RefClk Out").
- **RF-IC Test**
  In the RF-IC test, it additionally depends on the Reference Source:
  - If the reference source is "CLOCK 1" the function automatically switches to signal input ("RefClk IN").
  - If the RF-IC provides an analog signal, i.e. reference source is "REF IN", the reference clock is output digitally. The function switches to "RefClk Out".

"RefClk In"	The R&S EX-IQ-BOX receives the reference frequency digitally from the RF-IC.
"RefClk Out"	The R&S EX-IQ-BOX outputs the signal digitally.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:FUNCtion` on page 409

RefClk Out Control (BB-IC Test) ← Clock1

Sets the output mode of the digital "RefClk Out" in the "BB-IC Test" mode.

"Always On"	Outputs the signal continuously.
"By RefClkEn"	Outputs the signal at the request of the RF-IC.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:RCOC` on page 410

Slow Slew Rate ← Clock1

Activate the slow slewrate of the reference output signal ("RefCLk Out").

This parameter applies to reference source "REF IN".

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:SLEWrate` on page 410

Input Termination ← Clock1

Activate the input termination of the signal reference input signal ("RefCLk In").

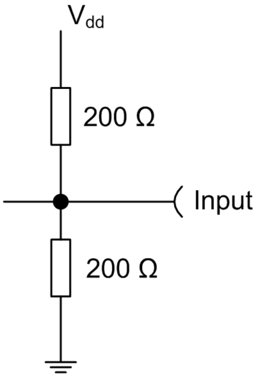


Fig. 7-95: DigRF Hardware > Clock > Input termination resistance

This parameter is active when you derive the reference signal from the DigRF link, i.e. reference source "CLOCK1" and function "Ref Clk In" are selected.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:ITERmination` on page 410

Vdd Coupling with ← Clock1

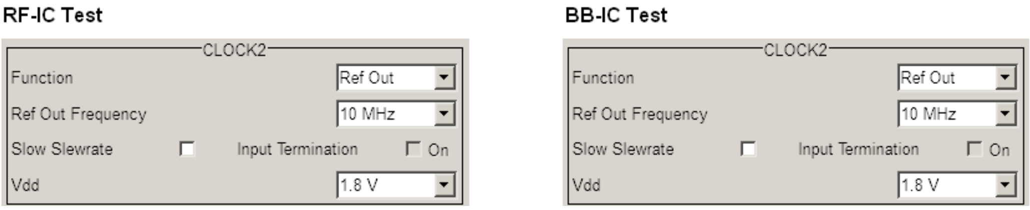
Assign the supply voltage (Vdd) of the DigRF interface to the "CLOCK1" signal.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:VDD` on page 411

Clock2

Sets the parameters of Clock2.



RF-IC Test

CLOCK2

Function: Ref Out

Ref Out Frequency: 10 MHz

Slow Slewrate ☐ Input Termination ☐ On

Vdd: 1.8 V

BB-IC Test

CLOCK2

Function: Ref Out

Ref Out Frequency: 10 MHz

Slow Slewrate ☐ Input Termination ☐ On

Vdd: 1.8 V

Fig. 7-96: DigRF Hardware > Clock 2

Function ← Clock2

Indicates the "CLOCK2" signal function.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:FUNCtion` on page 413

Ref Out Frequency ← Clock2

Select "5 MHz", or "10 MHz" output frequency for the second reference signal "Ref Out".

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:OFRequency` on page 413

Slow Slew Rate ← Clock2
Activate the slow slewrate of the reference output signal ("Ref Out").

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:SLEWrate` on page 413

Input Termination ← Clock2
Activate the input termination of the reference clock signal signal ("RefCLk In").

Note: Currently, the 2nd reference signal is firmly set to "Ref Out", and input termination is inactive. In future extensions the CLOCK 2 interface may be bidirectional. As a result, input termination will be modifiable.

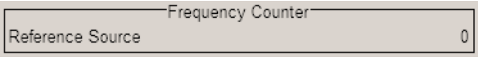
SCPI command:
`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:ITERminate` on page 413

Vdd ← Clock2
Select the supply voltage of the "CLOCK2"signal.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:VDD` on page 414

Frequency Counter

This function counts the reference frequency signal per second at the selected input and indicates the result.



Frequency Counter

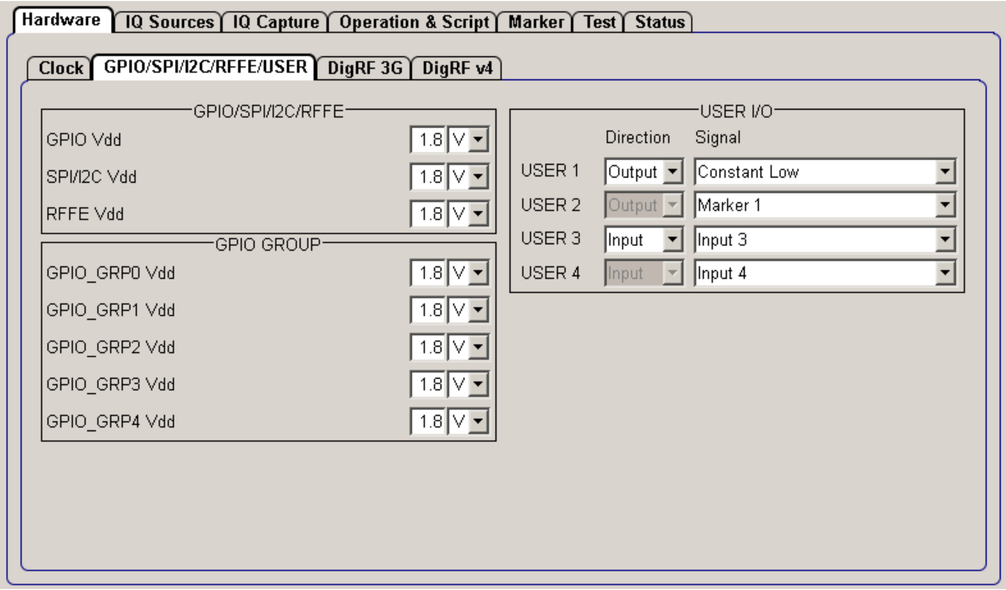
Reference Source 0

Reference Source
Displays the frequency of the reference signal source in MHz.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:RSFRequency` on page 411

7.3.7.4 General Purpose and User Settings

This tab provides the voltage settings for the "GPIO", "SPI/I2C", "RFFE" and "GPIO Group" signals and the configuration of the "USER I/O" signals. These signals are assigned to the three 50-pole SMC connectors at the front of the DigRF breakout board, see "DigRF Control, GPIO / SPI / I2C / RFFE and GPIO Group" on page 212.



GPIO/SPI/I2C/RFFE

GPIO Vdd 1.8 V
SPI/I2C Vdd 1.8 V
RFFE Vdd 1.8 V

GPIO GROUP

GPIO_GRP0 Vdd 1.8 V
GPIO_GRP1 Vdd 1.8 V
GPIO_GRP2 Vdd 1.8 V
GPIO_GRP3 Vdd 1.8 V
GPIO_GRP4 Vdd 1.8 V

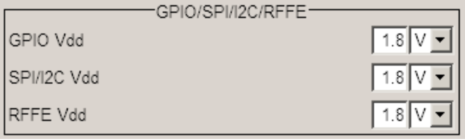
USER I/O

	Direction	Signal
USER 1	Output	Constant Low
USER 2	Output	Marker 1
USER 3	Input	Input 3
USER 4	Input	Input 4

Fig. 7-97: DigRF Hardware > GPIO / SPI / I2C / RFFE / USER dialog box

GPIO / SPI / I2C / RFFE Voltages

In this section, you can set the voltage levels of the general purpose signals GPIO (**G**eneral **P**urpose **I**nput **O**utput Control), SPI (**S**ystem **P**acket **I**nterface), I2C (**I**nter-**I**ntegrated **C**ircuit) or RFFE (**RF** **F**ront **E**nd).



GPIO Vdd 1.8 V
SPI/I2C Vdd 1.8 V
RFFE Vdd 1.8 V

Fig. 7-98: DigRF Hardware > GPIO / SPI / I2C / RFFE

GPIO Vdd

Set the supply voltage of the GPIO signals.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:IO:GPIO:VDD` on page 414

SPI/I2C Vdd

Set the supply voltage of the SPI/I2C signals.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:IO:SPI:VDD` on page 415

RFFE Vdd

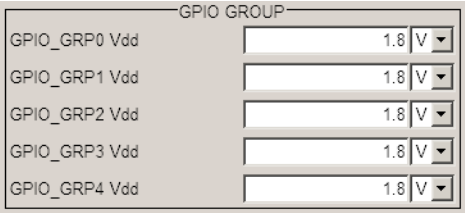
Set the supply voltage of the RFFE signal.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:IO:RFFE:VDD` on page 415

GPIO Group Voltages

In the group voltages section, you can set the voltage levels of the general purpose signals GPIO (**G**eneral **P**urpose **I**nput **O**utput) Group signals.



GPIO GROUP

GPIO_GRP0 Vdd	1.8	V
GPIO_GRP1 Vdd	1.8	V
GPIO_GRP2 Vdd	1.8	V
GPIO_GRP3 Vdd	1.8	V
GPIO_GRP4 Vdd	1.8	V

Fig. 7-99: DigRF Hardware > GPIO GROUP

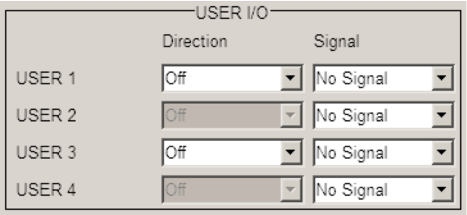
GPIO_GRP0...4 Vdd

Set the supply voltage of the GPIO_GRP0...4 group signals.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:IO:GPIO:GROup<st>:VDD` on page 414

User I/O Settings



USER I/O

	Direction	Signal
USER 1	Off	No Signal
USER 2	Off	No Signal
USER 3	Off	No Signal
USER 4	Off	No Signal

Fig. 7-100: DigRF Hardware > User I/O

Direction <USER1...4>

Select the direction of the signals "USER 1" and "USER 3". "USER 2" and "USER 4" are linked to the "Direction" of "USER 1" and "USER 3" and can not be edited.

"OFF"	Deactivates the USER I/O interface. The corresponding parameter "Signal" is disabled automatically and no signal is provided for selection.
"Output"	Sets the respective USER I/O interface as output, i.e. the R&S EX-IQ-BOX sends a control signal to the external device.
"Input"	Sets the USER I/O interface as input, i.e. the R&S EX-IQ-BOX receives a signal from the external device.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:IO:USER:DIRection<st>` on page 415

Signal

Determine the type of the control signal. You can define separate signals for each of the two interface pairs. The selection list depends on the direction of transmission.

No Signal ← Signal

Deactivated since the user interface is switched off.

Output ← Signal

Select the signal for output at the corresponding USER I/O connector.

"Constant Low / High"	Set the control signal to constant level high or low.
"Marker 1...4"	Use the configured marker for control. Marker settings are made in chapter 7.3.11, "Marker", on page 257.
"Script gpo 20...23"	Use the corresponding script signal for control.

Input ← Signal

Assign the external trigger signal of the corresponding USER I/O connector.

"Input 1...4"	R&S DigIConf automatically assigns the applied signals corresponding to the connectors USER I/O 1 and 2, or USER I/O 3 and 4.

SCPI command:

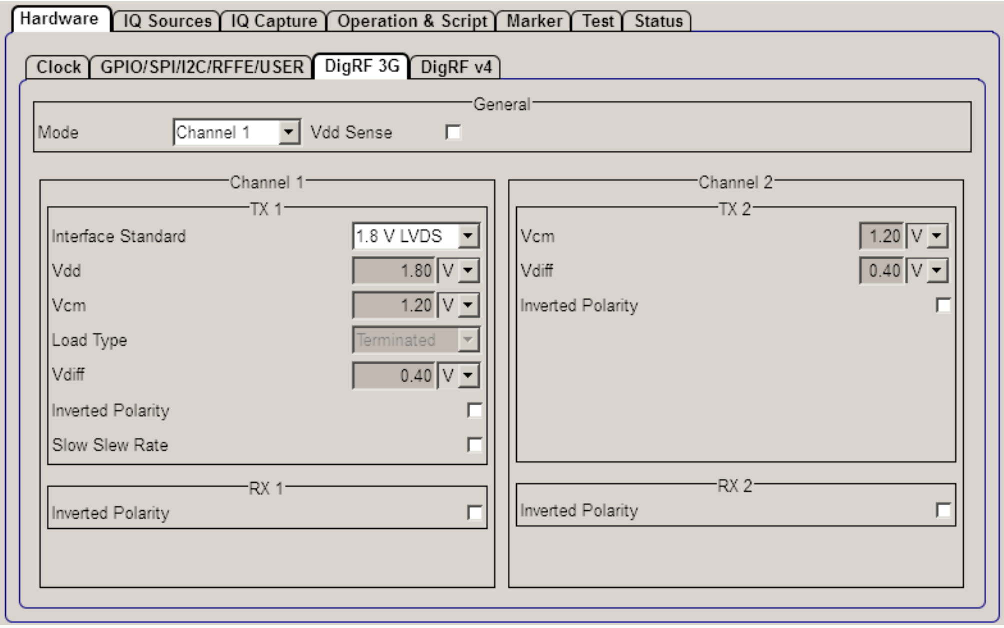
`[:SOURce<hw>]:EBOX:DRF:IO:USER:SIGNal` on page 416

7.3.7.5 DigRF 3G

The DigRF 3G tab comprises the parameters for setting the DigRF 3G interface. These values correspond to the voltages at the DigRF 3G connectors of the breakout board.

Since the voltages to be defined are similar in definition, the description summarizes "Vcm", "Vdiff" and "Inverted Polarity" of both channels (1 and 2).

For detailed information on the voltages used in the standards see chapter 7.3.7.2, "DigRF Electrical Parameter Settings", on page 220.



General

Mode: Channel 1
Vdd Sense ☐

Channel 1

TX 1

Interface Standard: 1.8 V LVDS
Vdd: 1.80 V
Vcm: 1.20 V
Load Type: Terminated
Vdiff: 0.40 V
Inverted Polarity ☐
Slow Slew Rate ☐

RX 1

Inverted Polarity ☐

Channel 2

TX 2

Vcm: 1.20 V
Vdiff: 0.40 V
Inverted Polarity ☐

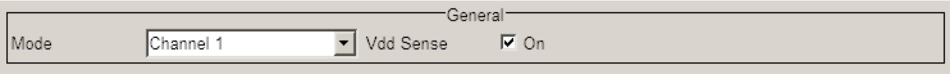
RX 2

Inverted Polarity ☐

Fig. 7-101: DigRF 3G Hardware dialog box

General

In the "General" section of the DigRF 3G hardware tab, you can set the active channel and activate the Vdd sense function.



General

Mode: Channel 1

Vdd Sense: ☑ On

Fig. 7-102: DigRF 3G Hardware > General

Mode
Select the active channel of DigRF.

SCPI command:
[:SOURce<hw>]:EBOX:DRF:D3G|D4V:MODE on page 406

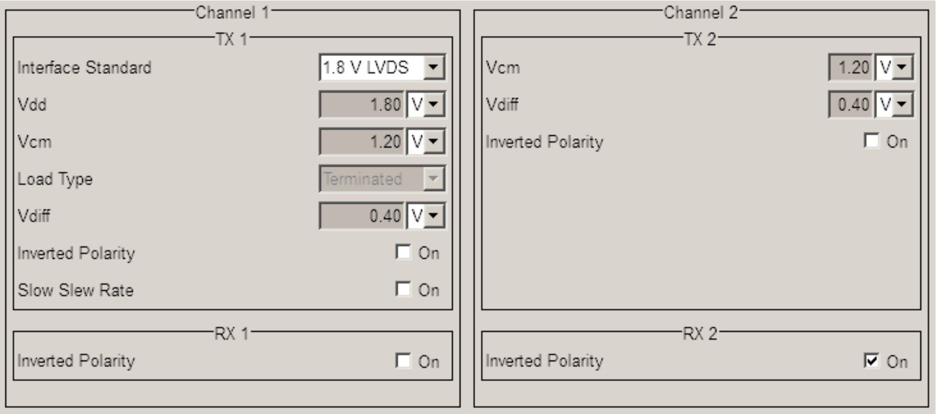
Vdd Sense
Enable the "VDD Sense" function.

The interface is activated when a correct voltage is applied to the sense input.

SCPI command:
[:SOURce<hw>]:EBOX:DRF:D3G|D4V:VDSence on page 406

Channel 1 and Channel 2

Within this section, you can define the electrical parameters of DigRF channel 1. Either select an interface standard from a predefined list, or a user-defined mode.



Channel 1

TX 1

Interface Standard: 1.8 V LVDS

Vdd: 1.80 V

Vcm: 1.20 V

Load Type: Terminated

Vdiff: 0.40 V

Inverted Polarity: ☐ On

Slow Slew Rate: ☐ On

RX 1

Inverted Polarity: ☐ On

Channel 2

TX 2

Vcm: 1.20 V

Vdiff: 0.40 V

Inverted Polarity: ☐ On

RX 2

Inverted Polarity: ☑ On

Fig. 7-103: DigRF 3G Hardware > channels

TX
The "TX" sections contain all settings required for signal output. With an "Interface Standard" selected, R&S DigIConf indicates the respective settings, whereas in "User" defined mode the parameters are editable.

Interface Standard ← TX
Select the interface standard for data transmission.

This function is identical in DigRF 3G and DigRF v4, but the standards operate with different signaling systems and voltage levels. Therefore, the description includes the setting of both standards, as shown in the table below.

For DigRF 3G		For DigRF v4	
Value	**Description**	**Value**	**Description**
1.2 LVDS 1.8 LVDS	Select the appropriate LVDS voltage level to be used in the RX Data and TX Data links (**L**ow **V**oltage **D**ifferential **S**ignaling).	1.2 V LA 1.8 V LA	Select the appropriate LA voltage level (**L**ong **A**mplitude).
1.2 SLVS 1.8 SLVS	Select the appropriate SLVS voltage level (**S**calable **L**ow **V**oltage **S**ignaling).	1.2 SA 1.8 SA	Select the appropriate SA voltage level (**S**mall **A**mplitude).
User	Enable to configure the electrical parameters for transmission manually.	User	Enable to configure the electrical parameters individually.

Refer also to "Vdd, Vcm, and Vdiff" on page 220 for an overview to the voltages of the DigRF standards.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:INTerface`
on page 402

Vdd ← TX
Supply voltage of the DigRF interface. In standard mode the supply voltage is determined by the interface standard. You can set the value in user defined mode.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:VDD` on page 405

Vcm ← TX
The common mode voltage Vcm is defined as the average of the voltages in a TX path (TX_n, TX_p).

For the "Interface Standards", the value is given, and in user-defined mode, you can set Vcm for TX1, as shown in the table below.

Table 7-16: DigRF Vcm

DigRF 3G			DigRF v4		
Interface Standard	**TX1**	**TX2**	**Interface Standard**	**TX1**	**TX2**
1.8 LVDS	1.2 V		1.8 V LA		
1.2 LVDS	0.6 V	1.2 V	1.2 V LA	0.2 V	0.2 V
1.8 SLVS	1.2 V		1.8 SA		
Vcm in TX2 is firmly set			Vcm in TX2 is coupled to TX1		

DigRF 3G			**DigRF v4**		
Interface Standard	**TX1**	**TX2**	**Interface Standard**	**TX1**	**TX2**
1.2 SLVS	0.6 V		1.2 SA	0.1 V	0.1 V
User	Configurable 0.1 ... 1.4 V		User	Configurable 0.05 ... 0.4 V	corresponding to TX1
Vcm in TX2 is firmly set			Vcm in TX2 is coupled to TX1		

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:VCM` on page 404

Load Type ← TX

Set the load type for displaying the differential output voltage of the "TX" signal. With interface standards, the parameter is firmly set to "Terminated".

"Load Type" formats the displayed voltage without modification.

"Terminated"	Vdiff is halved
"Unterminated"	Vdiff is doubled

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:LTYPe` on page 403

Vdiff ← TX

Vdiff represents the difference between maximum and minimum voltage of the differential output signal.

For the "Interface Standards", the value is given, and in user-defined mode, you can set Vdiff for TX1, as shown in the table.

Table 7-17: DigRF Vdiff

DigRF 3G			**DigRF v4**		
Interface Standard	**TX1**	**TX2**	**Interface Standard**	**TX1**	**TX2**
1.8 LVDS	0.4 V	0.4 V	1.8 V LA	0.2 V	0.2 V
1.2 LVDS			1.2 V LA		
1.8 SLVS	0.2 V		1.8 SA	0.1 V	0.1 V
1.2 SLVS			1.2 SA		
User	Configurable 0.05 ... 0.4 V 0.01 .... 0.8 V		User	Configurable 0.09 ... 0.21 V 0.18 ... 0.42 V	corresponding to TX1
Vdiff in TX2 is firmly set			Vdiff in TX2 is coupled to TX1		

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:VDIF` on page 405

Inverted Polarity ← TX
Activate the inverted polarity of the "TX 1" or "TX 2" output signal, respectively.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:IPOLarity`
on page 403

Slow Slew Rate ← TX
Activate the reduced slew rate of the "TX 1" output signal. When activated the slew rate decreases.

See "Slew Rate" on page 222.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:SLEWrate` on page 404

RX
In section "RX" you can invert the polarity of the input signal.

Inverted Polarity ← RX
Activate the inverted polarity of the "RX 1" or "RX 2" input signal, respectively.

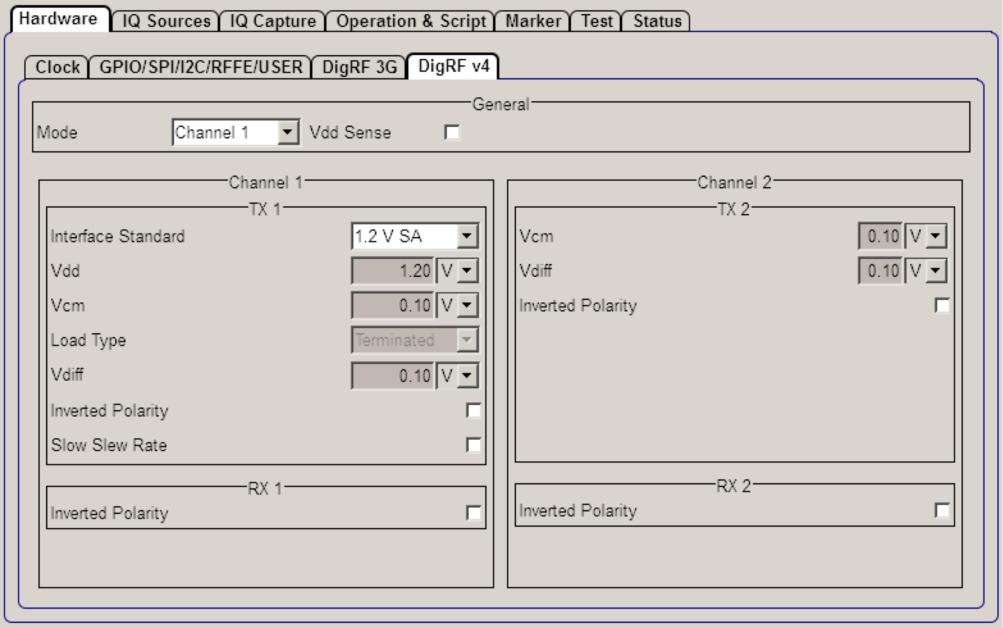
SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:RX:IPOLarity`
on page 402

7.3.7.6 DigRF v4

The DigRF v4 tab comprises the parameters for setting the DigRF v4 interface. These values correspond to the voltages at the DigRF v4 connectors of the breakout board.

Since the voltages to be defined are similar in definition, the description summarizes "Vcm", "Vdiff" and "Inverted Polarity" of both channels (1 and 2).

For detailed information on the voltages used in the standards see chapter 7.3.7.2, "DigRF Electrical Parameter Settings", on page 220.



Mode Channel 1 Vdd Sense ☐

Interface Standard 1.2 V SA
Vdd 1.20 V
Vcm 0.10 V
Load Type Terminated
Vdiff 0.10 V
Inverted Polarity ☐
Slow Slew Rate ☐

Inverted Polarity ☐

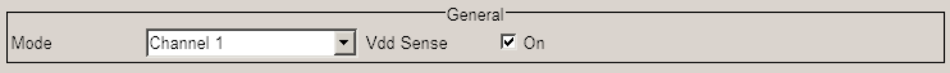
Vcm 0.10 V
Vdiff 0.10 V
Inverted Polarity ☐

Inverted Polarity ☐

Fig. 7-104: DigRF v4 Hardware dialog box

General

In the "General" section of the DigRF v4 hardware tab, you can set the active channel and activate the Vdd sense function.



Mode Channel 1 Vdd Sense ☑ On

Fig. 7-105: DigRF v4 Hardware > General

Mode

Select the active channel of DigRF.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:MODE` on page 406

Vdd Sense

Enable the "VDD Sense" function.

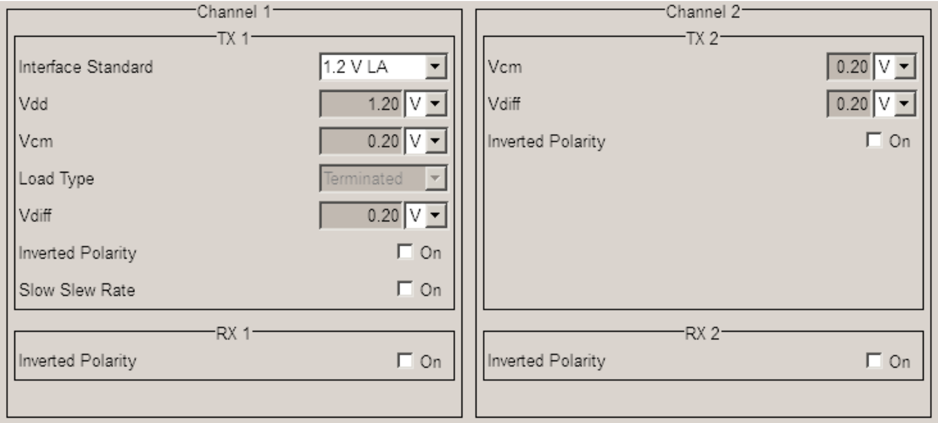
The interface is activated when a correct voltage is applied to the sense input.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:VDSence` on page 406

Channel 1 and Channel 2

Within this section, you can define the transmission parameters of DigRF channel 1. Either select an interface standard from a predefined list, or a user-defined mode.



Channel 1

TX 1

Interface Standard 1.2 V LA

Vdd 1.20 V

Vcm 0.20 V

Load Type Terminated

Vdiff 0.20 V

Inverted Polarity ☐ On

Slow Slew Rate ☐ On

RX 1

Inverted Polarity ☐ On

Channel 2

TX 2

Vcm 0.20 V

Vdiff 0.20 V

Inverted Polarity ☐ On

RX 2

Inverted Polarity ☐ On

Fig. 7-106: DigRF v4 Hardware > channels

TX

The "TX" sections contain all settings required for signal output. With an "Interface Standard" selected, R&S DigIConf indicates the respective settings, whereas in "User" defined mode all parameters are editable.

Interface Standard ← TX

Select the interface standard for data transmission.

This function is identical in DigRF 3G and DigRF v4, but the standards operate with different signaling systems and voltage levels. Therefore, the description includes the setting of both standards, as shown in the table below.

For DigRF 3G		**For DigRF v4**	
Value	**Description**	**Value**	**Description**
1.2 LVDS 1.8 LVDS	Select the appropriate LVDS voltage level to be used in the RX Data and TX Data links (**L**ow **V**oltage **D**ifferential **S**ignaling).	1.2 V LA 1.8 V LA	Select the appropriate LA voltage level (**L**ong **A**mplitude).
1.2 SLVS 1.8 SLVS	Select the appropriate SLVS voltage level (**S**calable **L**ow **V**oltage **S**ignaling).	1.2 SA 1.8 SA	Select the appropriate SA voltage level (**S**mall **A**mplitude).
User	Enable to configure the electrical parameters for transmission manually.	User	Enable to configure the electrical parameters individually.

Refer also to "Vdd, Vcm, and Vdiff" on page 220 for an overview to the voltages of the DigRF standards.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:INTerface`
on page 402

Vdd ← TX
Supply voltage of the DigRF interface. In standard mode the supply voltage is determined by the interface standard. You can set the value in user defined mode.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:VDD` on page 405

Vcm ← TX
The common mode voltage Vcm is defined as the average of the voltages in a TX path (TX_n, TX_p).

For the "Interface Standards", the value is given, and in user-defined mode, you can set Vcm for TX1, as shown in the table below.

Table 7-18: DigRF Vcm

DigRF 3G			**DigRF v4**		
Interface Standard	**TX1**	**TX2**	**Interface Standard**	**TX1**	**TX2**
1.8 LVDS	1.2 V		1.8 V LA		
1.2 LVDS	0.6 V	1.2 V	1.2 V LA	0.2 V	0.2 V
1.8 SLVS	1.2 V		1.8 SA		
1.2 SLVS	0.6 V		1.2 SA	0.1 V	0.1 V
User	Configurable 0.1 ... 1.4 V		User	Configurable 0.05 ... 0.4 V	corresponding to TX1
Vcm in TX2 is firmly set			Vcm in TX2 is coupled to TX1		

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:VCM` on page 404

Load Type ← TX
Set the load type for displaying the differential output voltage of the "TX" signal. With interface standards, the parameter is firmly set to "Terminated".

"Load Type" formats the displayed voltage without modification.

"Terminated"	Vdiff is halved
"Unterminated"	Vdiff is doubled

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:LTYPe` on page 403

Vdiff ← TX
Vdiff represents the difference between maximum and minimum voltage of the differential output signal.

For the "Interface Standards", the value is given, and in user-defined mode, you can set Vdiff for TX1, as shown in the table.

Table 7-19: DigRF Vdiff

DigRF 3G			**DigRF v4**		
Interface Standard	**TX1**	**TX2**	**Interface Standard**	**TX1**	**TX2**
1.8 LVDS	0.4 V	0.4 V	1.8 V LA	0.2 V	0.2 V
1.2 LVDS			1.2 V LA		
1.8 SLVS	0.2 V		1.8 SA	0.1 V	0.1 V
1.2 SLVS			1.2 SA		
User	Configurable 0.05 ... 0.4 V 0.01 .... 0.8 V		User	Configurable 0.09 ... 0.21 V 0.18 ... 0.42 V	corresponding to TX1
Vdiff in TX2 is firmly set			Vdiff in TX2 is coupled to TX1		

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:VDIF` on page 405

Inverted Polarity ← TX

Activate the inverted polarity of the "TX 1" or "TX 2" output signal, respectively.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:IPOLarity`
on page 403

Slow Slew Rate ← TX

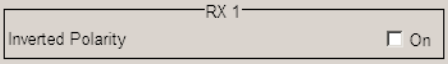
Activate the reduced slew rate of the "TX 1" output signal. When activated the slew rate decreases.

See "Slew Rate" on page 222.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:SLEWrate` on page 404

RX

In section "RX" you can invert the polarity of the input signal.



Inverted Polarity ☐ On

Fig. 7-107: DigRF v4 Hardware > RX 1

Inverted Polarity ← RX

Activate the inverted polarity of the "RX 1" or "RX 2" input signal, respectively.

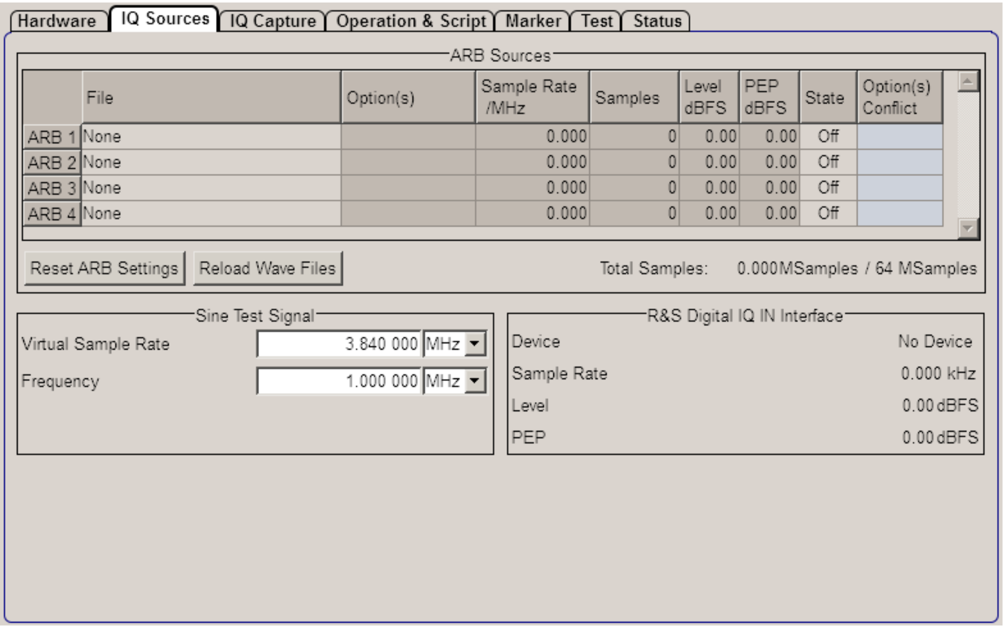
SCPI command:
`[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:RX:IPOLarity`
on page 402

7.3.8 IQ Sources

In the "IQ Sources" tab, you can configure all available I/Q sources such as ARB waveform files, sine test signals or signals that are fed via the digital I/Q interface. The main parameters of a loaded waveform file are displayed.

If you use an external signal source, such as an R&S signal generator, R&S DigIConf shows the connected R&S instrument, and displays the main parameters of the signal in the bottom right section of the dialog.

All signals are available for use in the script.



ARB Sources

	File	Option(s)	Sample Rate /MHz	Samples	Level dBFS	PEP dBFS	State	Option(s) Conflict
ARB 1	None		0.000	0	0.00	0.00	Off	
ARB 2	None		0.000	0	0.00	0.00	Off	
ARB 3	None		0.000	0	0.00	0.00	Off	
ARB 4	None		0.000	0	0.00	0.00	Off	

Total Samples: 0.000MSamples / 64 MSamples

Sine Test Signal

Virtual Sample Rate 3.840 000 MHz

Frequency 1.000 000 MHz

R&S Digital IQ IN Interface

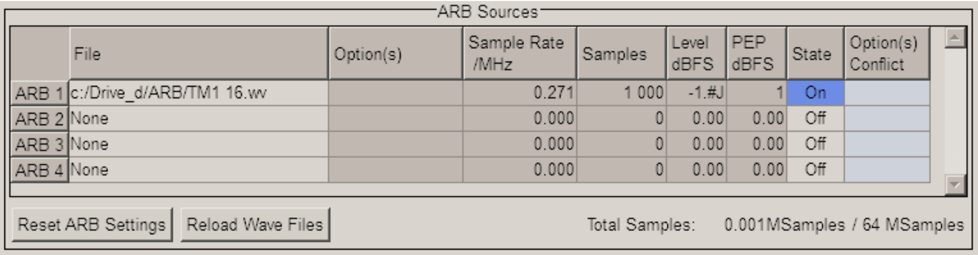
Device	No Device
Sample Rate	0.000 kHz
Level	0.00 dBFS
PEP	0.00 dBFS

Fig. 7-108: DigRF IQ Sources dialog box

Waveform memory and recording memory are provided, when the R&S EX-IQ-BOX is equipped with the respective options. For information on available options refer to chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory ", on page 23.

7.3.8.1 ARB Sources

The **ARB Sources** section displays all fields that are relevant for loading a waveform file in the waveform memory of the R&S EX-IQ-BOX.



ARB Sources

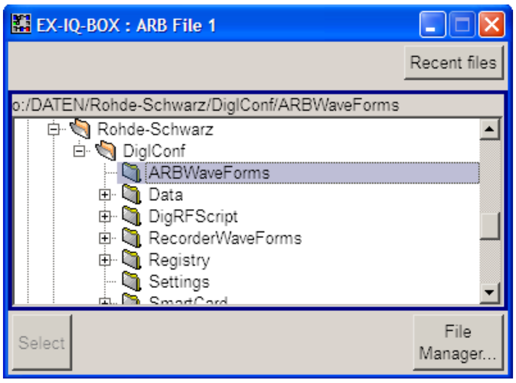
	File	Option(s)	Sample Rate /MHz	Samples	Level dBFS	PEP dBFS	State	Option(s) Conflict
ARB 1	c:/Drive_d/ARB/TM1 16.wv		0.271	1 000	-1.#J	1	On	
ARB 2	None		0.000	0	0.00	0.00	Off	
ARB 3	None		0.000	0	0.00	0.00	Off	
ARB 4	None		0.000	0	0.00	0.00	Off	

Total Samples: 0.001MSamples / 64 MSamples

Fig. 7-109: DigRF IQ Sources > ARB Sources

File

Open a file dialog for loading a waveform file.



The **recent data sets** directory shows the files last used.

Select the directory where waveform files are stored. The available waveform files, identifiable by the file extension *.wv are shown.

The "Select" button loads the marked file and returns to the "IQ Sources" dialog box. The "ARB Sources" table indicates the file name and its path, i.e. the directory where the file is stored.

Note: The "File Manager" button leads to a dialog used to copy, delete and rename files, and to create new directories.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:ARB<ch>:FILE` on page 395

Option(s)

If the wave form file is provided by R&S WinIQSIM2, and is based on a digital standard, R&S DiglConf indicates the name of the option, like e.g., EXBOX-K242, which represents the 3GPP-FDD-Standard. "None" indicates that the loaded waveform file was created with another software, or does not base on a digital standard signal.

Note: Find the list of supported R&S options in chapter 3.2.2.4, "Digital Standards with R&S WinIQSIM2", on page 23.

SCPI command:

Query installed options: `[:SOURce<hw>]:EBOX:OPT` on page 307

`[:SOURce<hw>]:EBOX:OPT` on page 307

Sample Rate (MHz)

Displays the sample rate the waveform is calculated with. The sample rate represents the number of samples per second that are used for digitizing.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:ARB<ch>:SRATe` on page 396

Samples

Indicates the number of samples of a waveform.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:ARB<ch>:SAMPles` on page 395

Level dBFS

Displays the signal level in terms of an rms value, in dBFS (**F**ull **S**cale ratio).

SCPI command:

n.a.

PEP dBFS

Displays the signal level in terms of a peak envelope power value (PEP). The unit of the peak envelope power is dBFS (**F**ull **S**cale ratio).

SCPI command:

n.a.

State

Switch on the ARB. The waveform must be activated for the use as signal source in the script.

To activate signal transmission, assign the signal to the stream in the DigRF script, see `stream_open(... e_stream_scr_dest...)` in the R&S DigRF Script Library. The R&S EX-IQ-BOX then embeds the signal into the DigRF protocol.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:ARB<ch>:STATe` on page 396

Option(s) Conflict

A conflict arises, if a waveform requires an option, that is not installed in the R&S EX-IQ-BOX. A red LED indicates the conflict.

SCPI command:

n.a.

Reset ARB Settings

Erases the ARB table, i.e. all loaded waveform files and their settings.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:ARB:PRESet` on page 394

Reload Wave Files

Update the waveform files, if data has changed. Reload updates all currently assigned files.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:ARB:RELoad` on page 394

Total Samples

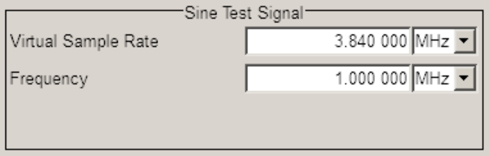
Displays the number of samples of all active signals in the waveform memory.

SCPI command:

`[:SOURce<hw>]:EBOX:CPRI:ARB:SAMPles:TOTal` on page 340

7.3.8.2 Sine Test Signal

Section "Sine Test Signal" provides you to configure a simple sine wave.



Sine Test Signal

Virtual Sample Rate: 3.840 000 MHz

Frequency: 1.000 000 MHz

Fig. 7-110: DigRF IQ Sources > Sine Test Signal

Virtual Sample Rate

Set the virtual sample rate used to generate the test sine signal.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:SINe:SRATe` on page 440

Frequency

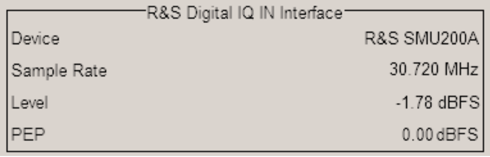
Sets the frequency of the sine test signal. The frequency range is derived with ±40% from the virtual sample rate.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:SINe:FREQuency` on page 440

7.3.8.3 R&S Digital IQ IN Interface

This section shows a connected external R&S signal source and the relevant parameters of the applied signal R&S EX-IQ-BOX.



R&S Digital IQ IN Interface

Device	R&S SMU200A
Sample Rate	30.720 MHz
Level	-1.78 dBFS
PEP	0.00 dBFS

Fig. 7-111: DigRF IQ Sources > digital IQ IN interface

Device

Shows the name of the connected R&S instrument.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:DEVice` on page 407

Sample Rate (MHz)

Displays the sample rate of the externally applied signal.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:SRATe` on page 408

Level dBFS

Displays the signal level in terms of an rms value, in dBFS (**F**ull **S**cale ratio).

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:RMS` on page 408

PEP dBFS

Displays the signal level in terms of a peak envelope power value (PEP). The unit of the peak envelope power is dBFS (**F**ull **S**cale ratio).

SCPI command:

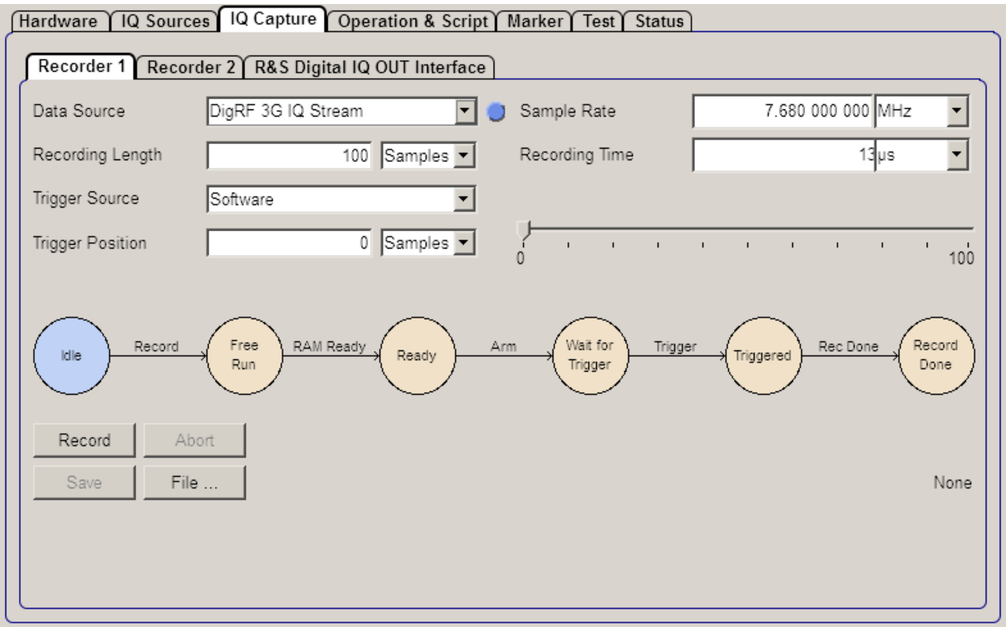
`[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:PEP` on page 407

7.3.9 IQ Capture

Equipped with the corresponding options, the R&S EX-IQ-BOX provides two recorders for recording I/Q or raw data streams of DigRF. Only if an RX stream is active, you can record data. In general, the recording is triggered by the script, but you can also start directly in R&S DigIConf.

Recording via script is executed immediately at startup by default, but it is also possible to start manually with the appropriate trigger settings. If recording is finished, you can store the data and restart any recording.

The tab "R&S Digital IQ OUT Interface" provides information on the data exchange at the digital interface of the R&S EX-IQ-BOX.



Data Source: DigRF 3G IQ Stream

Sample Rate: 7.680 000 000 MHz

Recording Length: 100 Samples

Recording Time: 13 µs

Trigger Source: Software

Trigger Position: 0 Samples

None

Fig. 7-112: DigRF IQ Capture dialog box

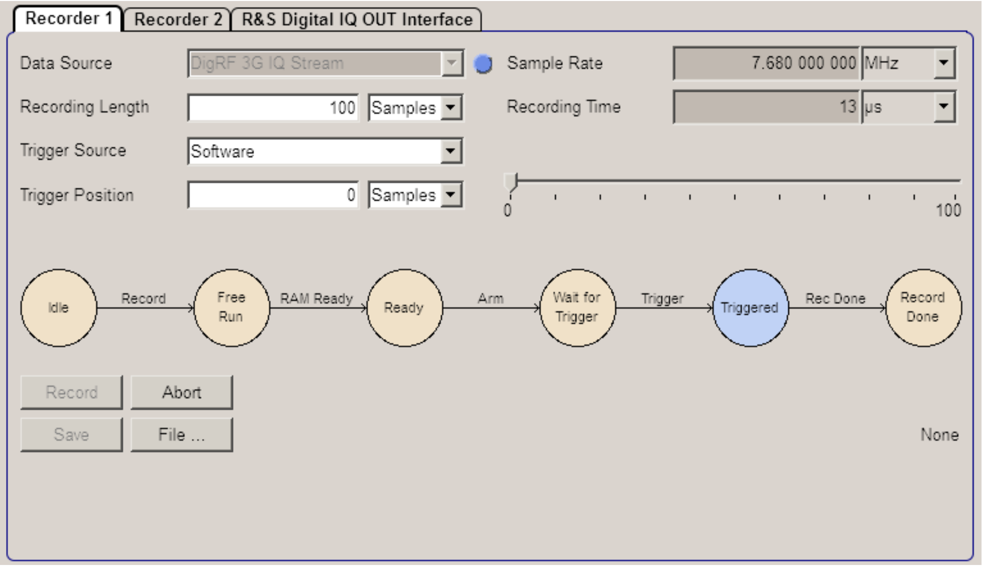
The recorder function applies to receiver mode, when the R&S EX-IQ-BOX is receiving a data signal from the DUT. I.e., it is possible to record a received RF signal, i.e. in DigRF RF-IC test mode or, vice versa, the incoming signal from the baseband in DigRF BB-IC test mode.

Conversely, for operating as transmitter, the R&S EX-IQ-BOX provides a waveform memory, see chapter 7.3.8, "IQ Sources", on page 239. Stored signal data can be replayed and then sent to the DUT.

Waveform Memory and Recording Memory are provided, when the R&S EX-IQ-BOX is equipped with the respective options. For information on available options refer to chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory ", on page 23.

7.3.9.1 Recorder 1 and Recorder 2

The recorders are configured in the "Recorder 1/2" tabs. Select the data source and start recording of manual operation. The data streams and the automatic recording is processed in the script. During the recording R&S DigIConf graphically shows the progress. When completed, you can save the data in a file.



Data Source: DigRF 3G IQ Stream

Sample Rate: 7.680 000 000 MHz

Recording Length: 100 Samples

Recording Time: 13 µs

Trigger Source: Software

Trigger Position: 0 Samples

Fig. 7-113: DigRF IQ Capture > Recorder 1 and 2

Both recorders provide 512 MB memory. As a sample takes 4 bytes of storage, the available recording length is up to 128 MS.

In order to use the maximum record length, the 128 MS can be fully used by one recorder. Alternatively, the two recorders share the memory space, as e.g., each uses 64 MS.

The recording memory provides a predefined resolution of 16 bits, each for I and Q. I.e. recorded I/Q data use always 16 bits in memory, regardless of the resolution of the source.

R&S DigIConf stores recorded I/Q data streams in the standard waveform format `*.wv`, and, raw data streams in the formats `*.drf3` or `*.drf4`. To view raw file formats, Rohde & Schwarz provides the DigRF Viewer as an additional functionality of R&S DigIConf.

Data Source

Selects the data source for recording. Data transmission is controlled by script commands, i.e. the data stream must be configured and started in the script. The LED indicates when a data stream is active.

The LED next to "Data Source" must be blue. It indicates that the selected data stream is active. Otherwise redcording cannot be started.

"DigRF 3G RX"	**..IQ Stream / ..Raw Stream** Select the appropriate DigRF 3G data stream for recording.
"DigRF v4 RX"	**..IQ Stream / ..Raw Stream** Select the appropriate DigRF v4 data stream for recording.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:SOURce:CATalog` on page 435

`[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:SOURce` on page 434

Recording Length

Set the length of data trace in samples.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:RLENgth` on page 434

Trigger Source

Select the trigger source for starting the recording. A trigger event can be initiated by the software itself, by markers or by externally applied trigger signals. The available trigger sources depend on the active markers and the external trigger signals.

"Software"	Recording starts immediately at startup of the script, or when the "Record" button is pressed.
"User 1|2|3|4"	Start recording with a trigger event initiated by the selected user signal in the hardware tab. Depending on these settings the trigger signal is either an internal signal (Marker or Script gpo), or a signal externally applied at the USER I/O connectors, see "User I/O Settings" on page 229.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:RECorder:TRIGger:SOURce` on page 438

Trigger Position

Determine the position of the trigger event in the recorded data stream. The position provides to realize a pre-trigger recording, as well as a post-trigger recording. The value is set in the samples from 0 to "Recording Length"-1.

- **Post-trigger**
  When the trigger position is at the beginning of the data stream, you can evaluate the signal after the trigger event.
- **Pre-trigger**
  The trigger position is at the end of the data stream to evaluate the signal before the trigger event.

The trigger position is graphically displayed on the right.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:RECorder:TRIGger:POSition` on page 437

Sample Rate

Indicates the sample rate of the signal to be recorded.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:SRATe` on page 435

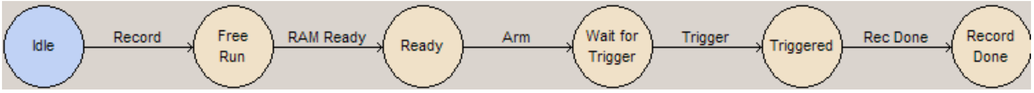
Recording Time

Indicates the duration of recording. The recording time results from the recording length and the sample rate.

SCPI command:

n.a. `[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:DURation` on page 434

Recorder Status Diagram



Displays graphically the current process step of the recording.

"Idle"	The recording process is inactive. Configure the recorder in that state. The recorder remains in Idle state until you start with the "Record" button.
"Free Run"	The recorder records the signal continuously in a ring memory. These data are required for pre-trigger analyzes.
"Ready"	Recording has passed through the ring memory once at least, i.e. it has described the memory completely. At this point the data is valid and R&S DigIConf activates the trigger signal automatically.
"Wait for Trigger"	The recorder continues recording until the trigger event occurs. Then the process switches to the next state. **Note:** If trigger source "Software" is used, the trigger event occurs immediately.
"Triggered"	After the trigger event, only the remaining samples after the trigger position are recorded (post-trigger data).
"Record Done"	If all post-trigger data are recorded, the recording is completed and the recorder stops. The data is available in the memory.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:RECorder:STATus` on page 437

Record
Starts the recording.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:RECorder:EXECute` on page 436

Discard
Stops and cancels recording. The process of recording can be aborted at any time.

After recording (Record Done), the "Abort" button label changes to "Discard" and you can discard the recorded data.

Note: Avoid data loss!. "Discard" erases the recorder memory and turns back to "Idle" state, ready for a new recording. In order to keep the data, save it first by pressing "Save File...".

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:RECorder:ABORt` on page 434

Save
Save the recorded data in a file. Select file name and directory with "Save" on page 247.

Note: R&S DigIConf stores the recorded I/Q data streams in the R&S WinIQSim2 waveform file format with the predefined file extension `*.wv`, and raw data streams in the corresponding formats `*.drf3` and `*.drf4`. File name and the directory are user-selectable.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:RECorder:FILE:CREate` on page 436

File...
Open the file dialog to select directory and file name for storing the recorded data.

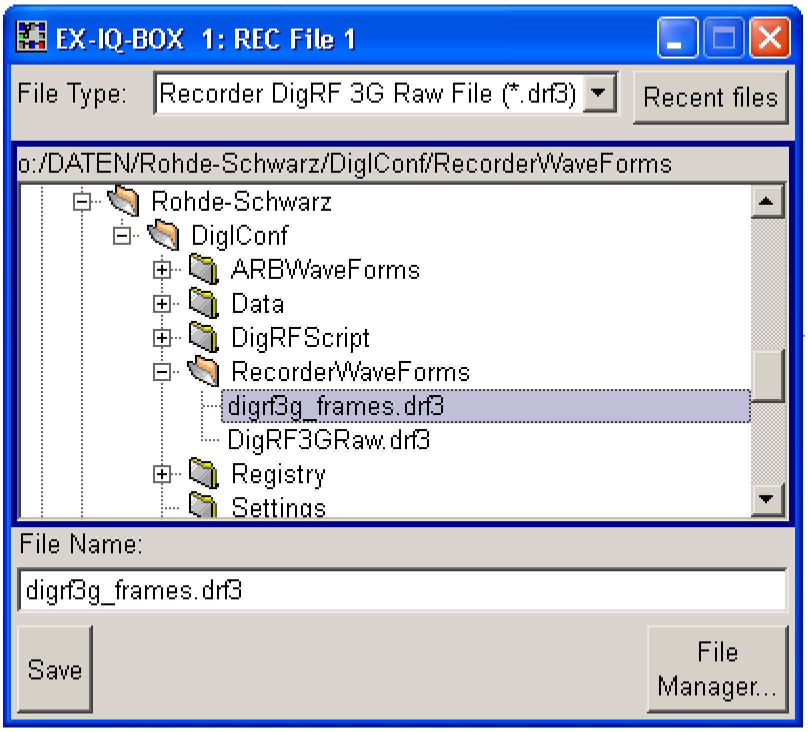


Fig. 7-114: DigRF IQ Capture > File dialog

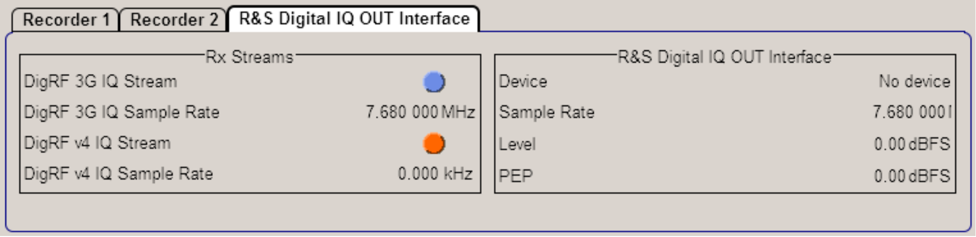
The "Recent Files" directory shows the files last used. Select the directory where recorded files are stored. The available files, identifiable by the file extension `*.wv`, `*.drf3` or `*.drf4` are selected in the file type field.shown. The "Save" button stores the marked file and returns to the "Recorder" dialog box.

The "File Manager" button leads to a dialog used to copy, delete and rename files, and to create new directories.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:RECorder:FILE:SELect` on page 436

7.3.9.2 R&S Digital IQ OUT Interface

This section shows activities on the RX I/Q data streams of the respective DigRF interfaces. It also provides information on the data exchange to a connected external R&S instrument at the "Digital IQ OUT Interface" of the R&S EX-IQ-BOX.



Rx Streams

DigRF 3G IQ Stream	●
DigRF 3G IQ Sample Rate	7.680 000 MHz
DigRF v4 IQ Stream	●
DigRF v4 IQ Sample Rate	0.000 kHz

R&S Digital IQ OUT Interface

Device	No device
Sample Rate	7.680 000 I
Level	0.00 dBFS
PEP	0.00 dBFS

Fig. 7-115: DigRF IQ Capture > R&S Digital IQ OUT interface

Rx Streams

Indicates an active DigRF link, and the corresponding transmission rate of the signal.

"DigRF xx Stream"	The blue LED shows that the link is active, and conversely, when inactive, the LED turns red.
"DigRF xx Sample Rate"	Indicates the sample rate in an active DigRF link.

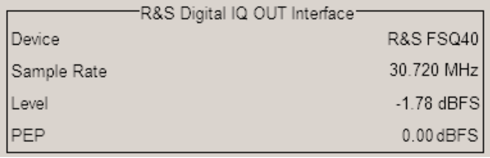
SCPI command:

`[:SOURce<hw>]:EBOX:DRF:DIFC:OUT:D3G:STATe` on page 408

`[:SOURce<hw>]:EBOX:DRF:DIFC:OUT:D3G:SRATe` on page 408

7.3.9.3 R&S Digital IQ OUT interface

This section shows the connected external R&S instrument at the digital IQ OUT interface of the R&S EX-IQ-BOX, and the relevant parameters of the signal.



R&S Digital IQ OUT Interface

Device	R&S FSQ40
Sample Rate	30.720 MHz
Level	-1.78 dBFS
PEP	0.00 dBFS

Fig. 7-116: DigRF IQ Capture > digital IQ OUT interface section

Device

Shows the name of the connected R&S instrument.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:DEVice` on page 407

Sample Rate (MHz)

Displays the sample rate of the outgoing signal. The sample rate represents the number of samples per second that are used for digitizing.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:SRATe` on page 408

Level dBFS

Displays the signal level in terms of an rms value, in dBFS (**F**ull **S**cale ratio).

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:RMS` on page 408

PEP dBFS

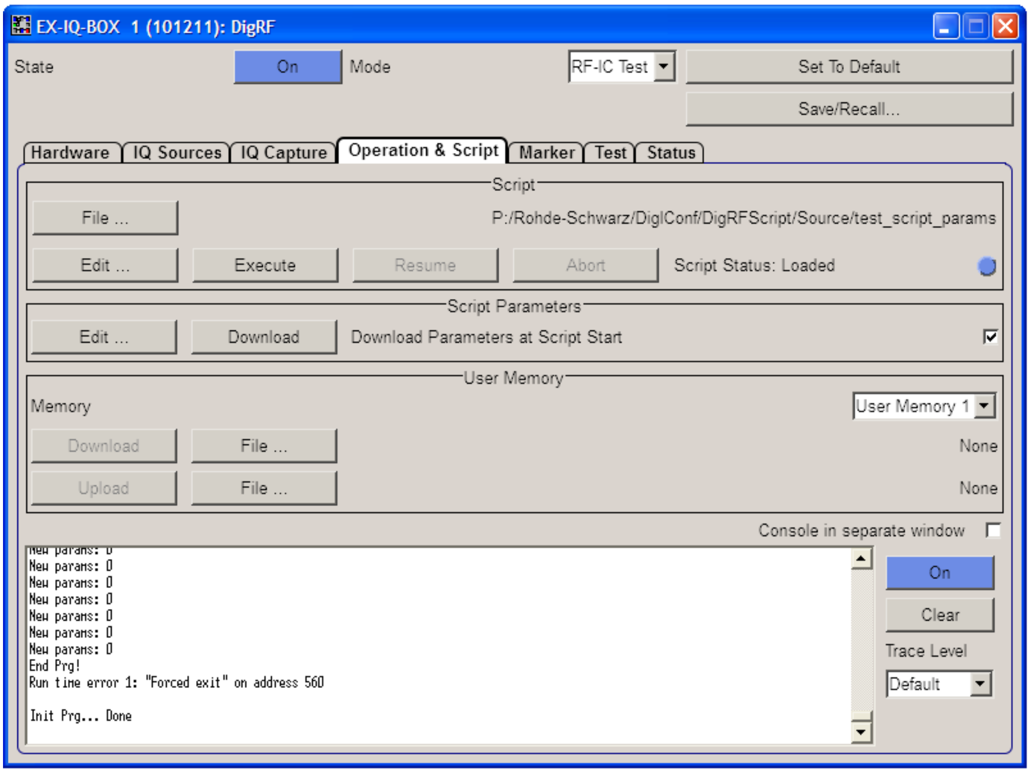
Displays the signal level in terms of a peak envelope power value (PEP). The unit of the peak envelope power is dBFS (**F**ull **S**cale ratio).

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:PEP` on page 407

7.3.10 Operation & Script

This "Operation and Script" tab contains all functions and settings for script execution, including the processing of script parameters and user memory. In the "Script Console", in the bottom section of the dialog, you can display different responses of the measurement.



State: On
Mode: RF-IC Test

P:/Rohde-Schwarz/DiglConf/DigRFScript/Source/test_script_params

Script Status: Loaded

Download Parameters at Script Start ☑

Memory: User Memory 1

None

None

Console in separate window ☐

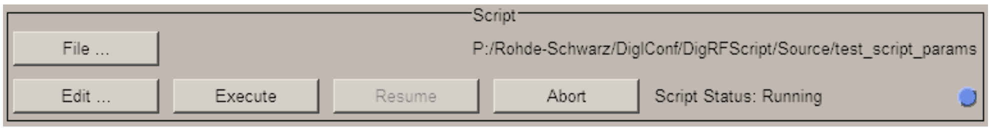
Trace Level: Default

```
New params: 0
New params: 0
New params: 0
New params: 0
New params: 0
New params: 0
New params: 0
End Prg!
Run time error 1: "Forced exit" on address 560

Init Prg... Done
```

Fig. 7-117: DigRF Operation & Script dialog box

7.3.10.1 Script

This section contains all settings and functions for execution of the script.



P:/Rohde-Schwarz/DiglConf/DigRFScript/Source/test_script_params

Script Status: Running

Fig. 7-118: DigRF Operation & Script > Script

If no file is selected, the buttons "Edit", "Execute", "Resume" and "Abort" are inactive. Next to the buttons, you get information on the status of script processing and the error status.

File ...

Open a file dialog for selecting a script file (`*.p`).

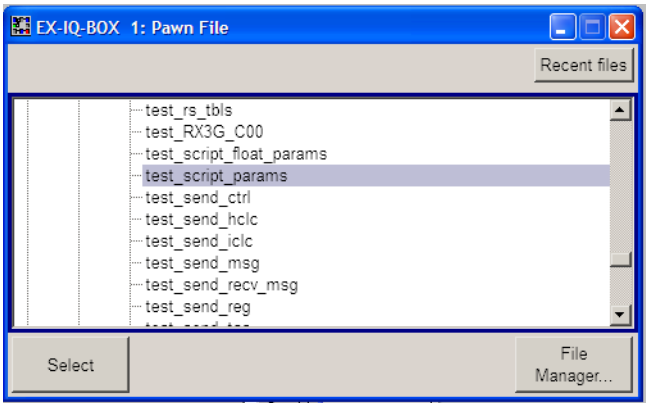


Fig. 7-119: DigRF Operation & Script > Pawn file dialog box

The "Recent Files" directory shows the files last used. Select the directory where script files are stored. The available files, identifiable by the file extension `*.p` are shown.

The "Select" button downloads the selected file and returns to the "Operation & Script" dialog box. In this step, the script file is compiled automatically, provided the checkbox "DigRF Script always recompile" in the chapter 6.1.6.4, "Preferences", on page 71 dialog is set. The compiler translates the script to the executable `*.amx` format.

Note: If "DigRF Script always recompile" is turned off, a script is compiled only if the corresponding compiled (`*.amx`) file does not exist. The feature reduces measurement times by skipping the compilation process.
But keep in mind that interim changes are not taken into account. In case of changes, you can compile the script directly in the editor, see chapter 7.3.4.1, "Brief Overview to the Script Editor", on page 205.

The "File Manager" button leads to a dialog used to copy, delete and rename files, and to create new directories.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:CATalog` on page 427
`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:FILE` on page 429
`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:COMPile` on page 428
`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:DOWNload` on page 428

Edit ...

Open the editor for the selected script file.

As programming environment for the Pawn (`*.p`) script files R&S DigIConf uses an embedded editor with compiler.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:FILE` on page 429

Execute

Starts the currently loaded script file.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:EXECute` on page 429

Resume

Continue the script execution, if halted.

The "Resume" button is active when the script execution is paused, i.e. when Script Status indicates "Halted". Vice versa, "Abort" on page 252 is active when the script is running , i.e. script status indicates "Running".

In addition, you can use the "Resume" function to interactively communicate between the script and the "Resume" button in R&S DigIConf. The command `request_resume` enables you to wait for a resume event, see R&S DigRF Library.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:RESume` on page 431

Abort

Stop the execution of a script. When stopped, it is not possible to continue.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:ABORt` on page 427

Script Status

Displays the status of the script processing. This parameter is read-only and displays the current processing state.

"Compiled"	The indicated scriptfile is compiled.
"Loaded"	The indicated scriptfile is loaded, compiled and is ready to run.
"Running"	R&S DigIConf currently processes the script procedure.
"Halted"	Execution paused.
"Execution complete"	Script execution is completed.
"No script"	No script loaded.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:STATus` on page 431

Error

Status LED indicates (red) when errors occur in the script.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:ERRors:STATe` on page 428

7.3.10.2 Script Parameters

This section provides the settings of the script parameters.

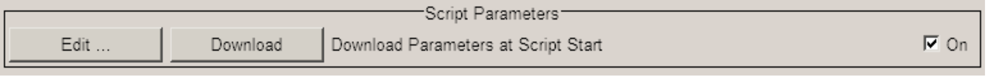


Fig. 7-120: DigRF Operation & Script > Script parameters

Edit...

Open an dialog to edit, load and save script parameters, see chapter 7.3.10.5, "Script Parameters Editor", on page 255.

Download

Load script parameters into the R&S EX-IQ-BOX. The download button is always active, i.e. parameters can be downloaded even during script execution.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams:DOWNload` on page 430

Download Parameters at Script Start

Load the script parameters automatically to the R&S EX-IQ-BOX at start of script execution.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams:DOS` on page 429

7.3.10.3 User Memory

In this section, you can retrieve user-specific data that can be used in the script.

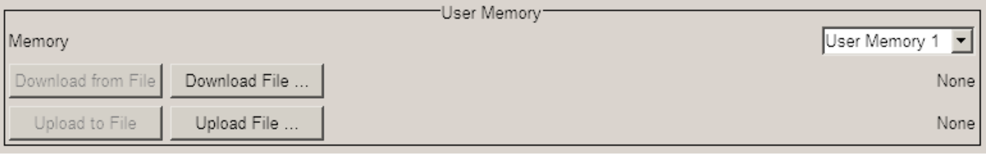


Fig. 7-121: DigRF Operation & Script > User memory

Memory

Select the user memory. R&S EX-IQ-BOX provides two memories, "User Memory 1 / 2" for storing user-specific data.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:SELect` on page 432

Download

Download the data from the (`*.mem`) file into the user memory of the R&S EX-IQ-BOX. To select the file refer to File ... into the user memory.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:DOWNload` on page 432

Upload

Upload the selected user memory data from the R&S EX-IQ-BOX into the destination file. Select the destination file with File ....

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:UPLoad` on page 433

File ...

Open the "EX-IQ-BOX User Memory File" dialog for selecting memory files (`*.mem`).

The "Recent Files" directory shows the files last used. Select the directory where memory files are stored. The available files, identifiable by the file extension `*.mem` are listed.

Select the destination file for download/upload into/from the user memory. The "Select" button loads the marked file and returns to the "Operation & Script" dialog box.

The "File Manager" button leads to a dialog used to copy, delete and rename files, and to create new directories.

SCPI command:

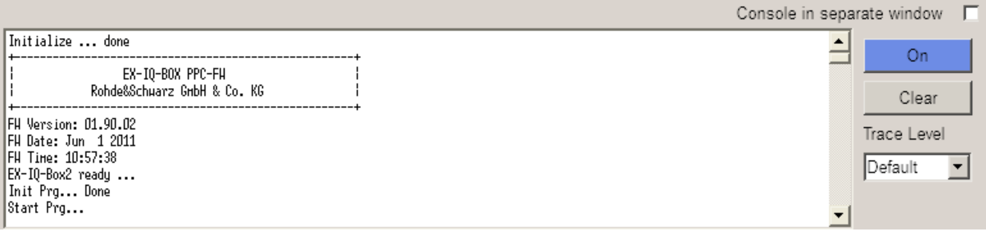
`[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:CATalog` on page 431

`[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:DOWNload:FILE` on page 432

`[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:UPLoad:FILE` on page 433

7.3.10.4 Script Console

In the "Script Console" you can display different responses of the measurement by using the script output command `printf`, but also debug messages and warnings generated by the script interpreter. To zoom in or for optimal arrangement of the "Script Console" section, you can separate it from the DigRF dialog and view it in a separate window.



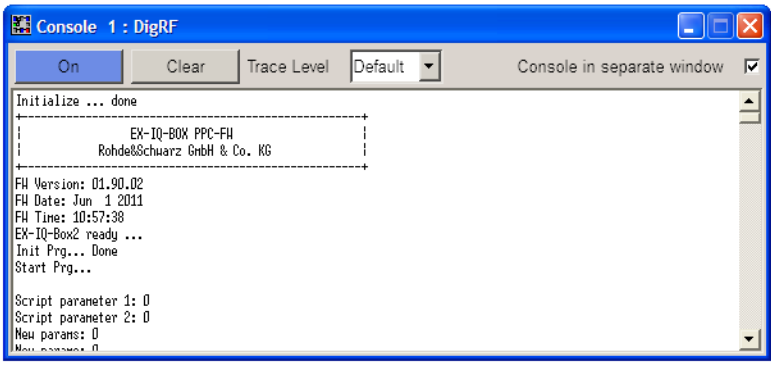
```
Initialize ... done
+--------------------------------------------------+
¦                 EX-IQ-BOX PPC-FW                 ¦
¦             Rohde&Schwarz GmbH & Co. KG          ¦
+--------------------------------------------------+
FW Version: 01.90.02
FW Date: Jun  1 2011
FW Time: 10:57:38
EX-IQ-Box2 ready ...
Init Prg... Done
Start Prg...
```

Fig. 7-122: DigRF Operation & Script > Console

Console in separate window

Disconnect the script console from the "Operation & Script" tab for display in a separate window.

You can embed the console back into the tab, when you deactivate the checkbox, or simply close the window.



```
Initialize ... done
+---------------------------------------------------+
¦                  EX-IQ-BOX PPC-FW                 ¦
¦             Rohde&Schwarz GmbH & Co. KG           ¦
+---------------------------------------------------+
FW Version: 01.90.02
FW Date: Jun  1 2011
FW Time: 10:57:38
EX-IQ-Box2 ready ...
Init Prg... Done
Start Prg...

Script parameter 1: 0
Script parameter 2: 0
New params: 0
```

Fig. 7-123: DigRF script console separated

R&S DigIConf saves and restores the last setting at restart.

State
Switch on the script console.

Clear
Clears the display.

Trace Level
Contains the monitoring level for debug output.

"Default" lists warnings and error messages, and reports all errors occurred in the script.

Note: "Info", "Trace" and "Register" monitoring are protected functions, accessible by enabling the respective protection level.
The debug output is expanding with each level, i.e. it includes the output of the previous level.

7.3.10.5 Script Parameters Editor

The script parameter dialog provides to enter script parameters manually and to save them in a file, or load values from a file.

► To access the editor, open the "Operation & Script" dialgo box of DigRF, and click "Edit..." in section "Script Parameters".

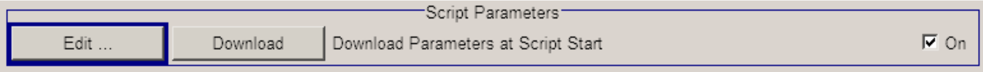
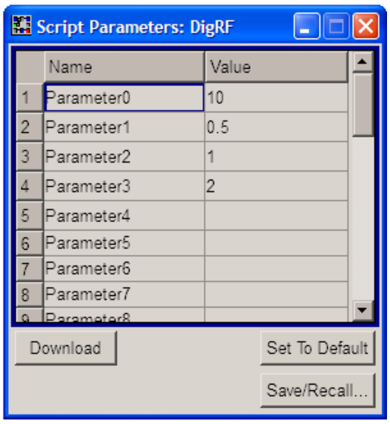


Fig. 7-124: DigRF Operation & Script > Script parameters > Edit

Script Parameters: DigRF
Determine your user specific script parameters. You can also save them for reuse.



	Name	Value
1	Parameter0	10
2	Parameter1	0.5
3	Parameter2	1
4	Parameter3	2
5	Parameter4	
6	Parameter5	
7	Parameter6	
8	Parameter7	
9	Parameter8	

Fig. 7-125: DigRF Operation & Script > Script parameters editor

The editor represents up to 32 parameters with name and value. With the provided keys you can load parameter files for editing, download a parameter file for use in the script and save your settings.

Name

Enter the parameter name. The maximum length of the name is 12 characters. Default name is "Parameter x" with x numbered in ascending order.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams<ch>:NAMe`
on page 430

Value

Enter the value of the parameter. Valid formats for a value are hexadecimal format (0x), decimal format and floating point.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams<ch>:VALues`
on page 430

Download

Load script parameters into the R&S EX-IQ-BOX, see "Download" on page 253.

Set To Default

Set the parameter names to default and clear all values.

Save / Recall

Provides access to additional dialogs, either to save or load DigRF script parameter settings, or to the file manager dialog.

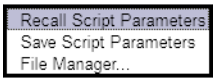


Fig. 7-126: DigRF Save / Recall script parameters menu

R&S DigIConf stores the script parameter settings of DigRF in a file with the predefined file extension `*.par`. You can specify the file name and directory.

The "Recent Files" directory shows the last used script parameter files. The "Select" button loads the marked file and returns to the "Script Parameters: DigRF" dialog box.

"Recall Script Parameters"	Open the file "Recall Script Parameters" dialog to load a previously saved DigRF script parameter file.
"Save Script Parameters"	Open the "Recall Script Parameters" dialog to save the current DigRF parameters. Determine the file name and save the settings.
"File Manager"	Calls the file manager dialog. A DigRF settings file `*.par` is preset in the "File Type" entry field. You can use the file manager to copy, delete, and rename files and to create new directories.

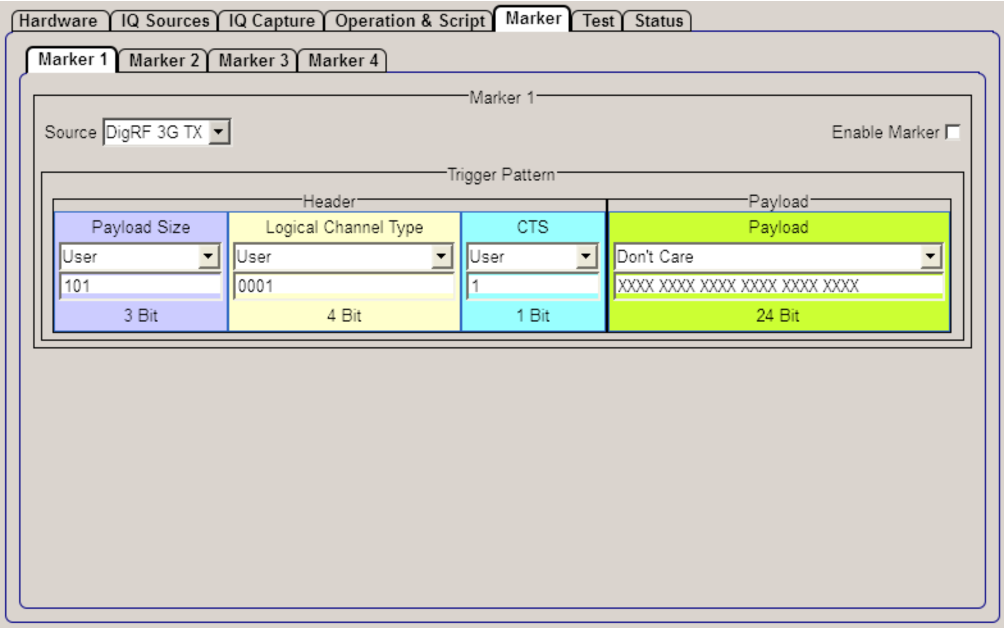
SCPI command:

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams:CATalog` on page 429

`[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams:RECall|SAVe` on page 430

7.3.11 Marker

The "Marker" tab contains four subtabs, one each to configure a marker signal. Marker signals are applied to the USER I/O connectors and can be referenced as a trigger for the recorder. All markers provide the same functionality determined by the selected source and the trigger parameters.



Source DigRF 3G TX

Enable Marker ☐

Header			Payload
Payload Size	Logical Channel Type	CTS	Payload
User	User	User	Don't Care
101	0001	1	XXXX XXXX XXXX XXXX XXXX XXXX
3 Bit	4 Bit	1 Bit	24 Bit

Fig. 7-127: DigRF Marker dialog box

The marker function generates a signal when a specific trigger pattern is detected at the beginning of a DigRF frame. The trigger pattern is 32 bits long (8 header bits and 24 bits payload) and can be specified for each of the 4 available markers individually.

7.3.11.1 Activating the Marker Signal

In each of the subtabs "Marker 1 ... 4", you can configure and activate a marker signal, select the signal source and determine a designated trigger pattern according to your test purposes.

Source
Select the DigRF data stream for the marker generator.

With the source you select both, the DigRF standard as well as the direction of the current data stream to be evaluated.

"DigRF 3G TX, DigRF 3G RX"	Select the appropriate DigRF 3G TX or RX stream for the marker generator.
"DigRF v4 TX, DigRF v4 RX"	Select the appropriate DigRF v4 TX or RX stream for the marker generator.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:MARKer:SOURce` on page 426

Enable
Activate the marker generator.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:MARKer:ENABle` on page 422

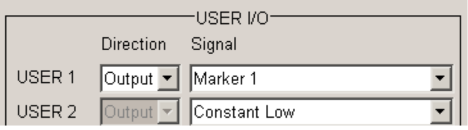
7.3.11.2 Trigger Pattern

In this section, you can configure a trigger pattern for evaluation, in order to generate a marker signal. The trigger pattern corresponds to the respective DigRF standard (3G/v4) and consists of the 8 header bits and 24 bits of payload data, divided into functional blocks. You can specify the pattern of each block separately, but you can also not evaluate the information of a block.

The R&S EX-IQ-BOX generates the marker signal only, when the currently transmitted DigRF frame contains all information specified in the trigger pattern. Additionally, "Enable Marker" must be activated.

To view and analyze the signal, e.g. with an oscilloscope, the R&S EX-IQ-BOX outputs the signal at one of the USER I/O connector of the DigRF breakout board.

See the "Hardware" tab, section "User I/O" for assigning the corresponding signal to the connector ("User I/O Settings" on page 229).



USER I/O

	Direction	Signal
USER 1	Output	Marker 1
USER 2	Output	Constant Low

Fig. 7-128: DigRF 3G Marker > Marker assignment

General explanation to the structure and the settings of the Trigger Pattern

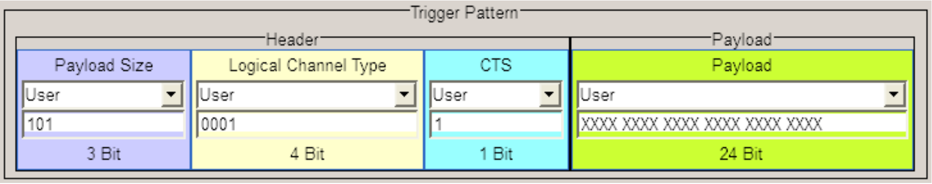


Fig. 7-129: DigRF 3G Marker > Trigger pattern

The following example shows the "Payload Size Block" blocks of a DigRF 3G frame, and briefly explains the possibilites for the individual setting of the trigger pattern. It is representative of all the blocks.

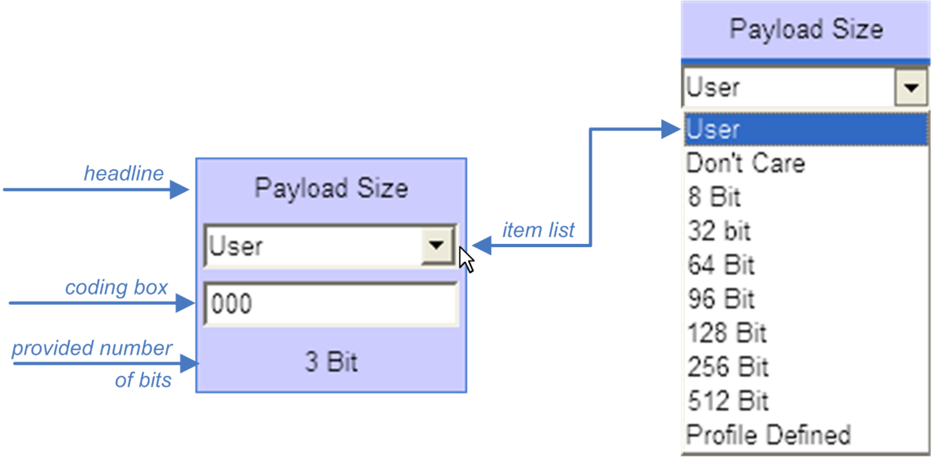


Fig. 7-130: DigRF Marker > Trigger pattern > block structure

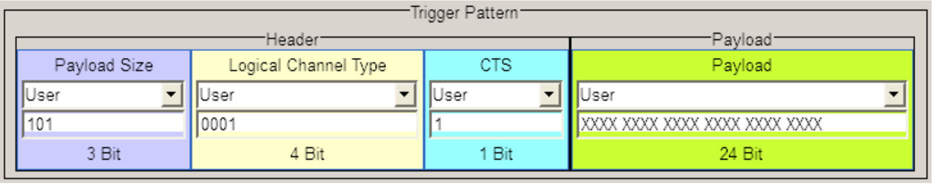
Block components:

- "headline"
  Shows the functionality of the information in the frame.
- **item list**
  Offers selection of possible values from a list.
  - "User"
    Set the coding individually. The coding box is editable.
  - "Don't Care"
    These bits are not evaluated, i.e. there is no condition specified. The coding box indicates "XXX... ".
  - "<predefined entries>"
    Selects the entry. The coding box indicates the encoding of the bits in read-only mode.
- **coding box**
  Contains the number bits provided for the binary encoding of the field parameter.
- **provided number of bits**
  Shows the number of bits provided.

Refer to chapter 7.3.3, "DigRF 3G Transmission Protocol", on page 199 for more detail on the structure, bit assignments and coding, as well as to the coresponding MIPI Alliance Specification of the respective standard.

7.3.11.3 DigRF 3G Trigger Pattern

The following section explains the trigger pattern a DigRF 3G marker signal is composed of. The information contained within a DigRF 3G frame vary, depending on the transmission path. Accordingly, you can set the trigger pattern.



Payload Size	Logical Channel Type	CTS	Payload
User	User	User	User
101	0001	1	XXXX XXXX XXXX XXXX XXXX XXXX
3 Bit	4 Bit	1 Bit	24 Bit

Fig. 7-131: DigRF 3G Marker > Trigger pattern

Payload Size

Sets the payload size in the trigger pattern.

You can either select a predefined value from DigRF 3G or configure the size manually.

In case of "Profile-Defined" the size is RF-IC-specific.

Refer also to table 7-9 for coding.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:MARKer:PSIZe` on page 424

`[:SOURce<hw>]:EBOX:DRF:MARKer:PSIZe:PATTern` on page 425

Logical Channel Type

Select the logical channel type in the trigger pattern.

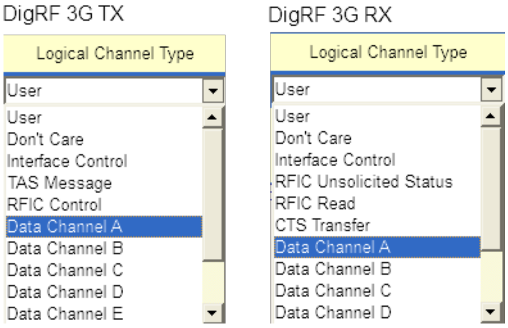


Fig. 7-132: DigRF Logical channel type selection

Refer to chapter 7.3.3.3, "Logical Channel Types", on page 202 for description and coding in detail.

The information in a logical channel varies according to the selected transmission path, i.e. the source, as reported in the table.

Value	Description	Source
"User / Don't Care..."	These bits are not evaluated, see chapter 7.3.11.2, "Trigger Pattern", on page 258.	
"Interface Control"	Covers all interface related control information. This setting is generally coded with 0000.	
"TAS Message"	TAS (**T**ime **A**ccurate **S**trobe) provides exact timing reference.	DigRF 3G TX
"RFIC Control"	Provides control information from the BBIC to the RFIC.	DigRF 3G TX
"RFIC Unsolicited Status"	RFIC Unsolicited Status is used to accommodate unsolicited frames in the BB-IC hardware interface, and to handle such frames in the RF-IC driver software correctly.	DigRF 3G RX
"RFIC Read"	Provides responses to the RFIC Control Logical Channel.	DigRF 3G RX
"CTS Transfer"	The CTS bit supports the control on the transmission data buffer.	DigRF 3G RX
"Data Channel A...H"	Transfers various types of data, e.g. primary or diversity, specified in the profile of each defined combination of data.	

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:MARKer:LCT` on page 423

`[:SOURce<hw>]:EBOX:DRF:MARKer:LCT:PATTern` on page 424

CTS

Activate the evaluation of the (**C**lear **T**o **S**end) bit for the marker signal generation.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:MARKer:CTS` on page 421

`[:SOURce<hw>]:EBOX:DRF:MARKer:CTS:PATTern` on page 421

Payload

Define the payload of DigRF 3G in the trigger pattern for evaluation.

The payload field contains I/Q data or control information. The payload size of the marker trigger pattern is 24 Bit.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:MARKer:G3PL` on page 422

`[:SOURce<hw>]:EBOX:DRF:MARKer:G3PL:PATTern` on page 422

7.3.11.4 DigRF v4 Trigger Pattern

The following section explains the trigger pattern a DigRF v4 marker signal is composed of. The information contained within a DigRF v4 frame vary, depending on the transmission path. Accordingly, you can set the trigger pattern.

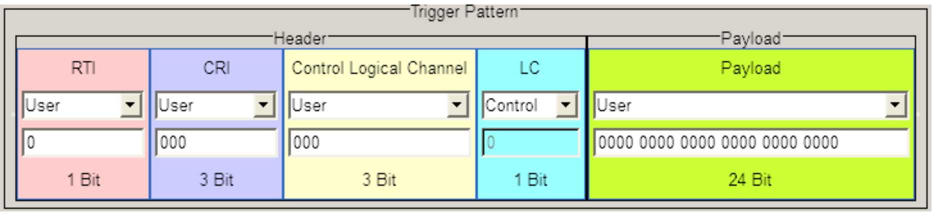


Fig. 7-133: DigRF v4 Marker > Trigger pattern

RTI

Activate the evaluation of the RTI (**R**e**T**ransmission **I**ndicator) bit in the trigger pattern. RTI distinguishes between ordinary and retransmitted frames.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:MARKer:RTI` on page 425

`[:SOURce<hw>]:EBOX:DRF:MARKer:RTI:PATTern` on page 425

CRI

Select the CRI (**C**yclic **R**unning **I**ndex) mode in the trigger pattern.

CRI identifies the frame order and potentially lost frames in the ARQ scheme.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:MARKer:CRI` on page 421

`[:SOURce<hw>]:EBOX:DRF:MARKer:CRI:PATTern` on page 421

Logical Channel Types

Select the logical channel type to be detected for the marker signal.

DigRF v4 distinguishes two logical channel types, CLC (**C**ontrol **L**ogical **C**hannels) and DLC (**D**ATA **L**ogical **C**hannel). The logical channel type is defined by the LC bit in the header of the frame. Additionally three bits are used for logical channel identification.

Control Logical Channel ← Logical Channel Types

Select the mode of the control logical channel type in the trigger pattern. R&S DigIConf displays the "Control Logical Channel" block when logical channel "LC" is selected.

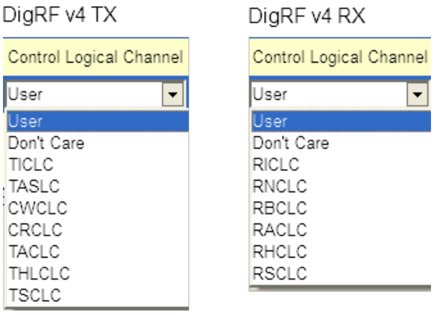


Fig. 7-134: DigRF v4 Marker > TX / RX Control Logical Channel (CLC)

The information in a control logical channel varies according to the selected transmission path, i.e. the source, as reported in the table.

Value	Description	Source
"User / Don't Care..."	These bits are not evaluated, see chapter 7.3.11.2, "Trigger Pattern", on page 258.	
"TICLC"	Assign **TX** **I**nterface **C**ontrol **L**ogical **C**hannel	DigRF v4 TX
"TASLC"	**TAS** **L**ogical **C**hannel	DigRF v4 TX
"CWCIC"	**C**onfiguration **W**rite **C**ontrol **L**ogical **C**hannel	DigRF v4 TX
"CRCLC"	**C**onfiguration **R**ead **C**ontrol **L**ogical **C**hannel	DigRF v4 TX
"TACLC"	**T**X not **A**cknowledge **C**ontrol **L**ogical **C**hannel	DigRF v4 TX
"THCLC"	**T**X **H**igh **L**evel **C**ontrol **L**ogical **C**hannel	DigRF v4 TX
"TSCLC"	**T**X **S**ub **C**ontrol **L**ogical **C**hannel	DigRF v4 TX
"RICLC"	Assign **R**X **I**nterface **C**ontrol **L**ogical **C**hannel	DigRF v4 RX
"RNCLC"	**R**X informatio**N** **C**ontrol **L**ogical **C**hannel	DigRF v4 RX
"RBCLC"	**R**ead **B**ack **C**ontrol **L**ogical **C**hannel	DigRF v4 RX
"RACLC"	**R**X not **A**cknowledge **C**ontrol **L**ogical **C**hannel	DigRF v4 RX
"RHCLC"	**R**X **H**igh **L**evel **C**ontrol **L**ogical **C**hannel	DigRF v4 RX
"RSCLC"	**R**X **S**ub **C**ontrol **L**ogical **C**hannel	DigRF v4 RX

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:MARKer:SOURce` on page 426

`[:SOURce<hw>]:EBOX:DRF:MARKer:LC` on page 422

`[:SOURce<hw>]:EBOX:DRF:MARKer:CLC` on page 418

`[:SOURce<hw>]:EBOX:DRF:MARKer:CLC:PATTern` on page 420

Data Logical Channel ← Logical Channel Types

Select the mode of the data logical channel type.

R&S DigIConf displays the "Data Logical Channel" block when logical channel "Data" is set.

For simultaneous or alternating transmission of different data streams eight configurable data logical channels DLC are defined.

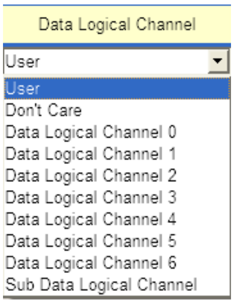


Fig. 7-135: DigRF v4 Marker > Trigger pattern > DLC select

"Data Logical Channel 0 ... 6"	Select a channel.
"SDLC"	Used for further sub-data logical channels or I/Q data compression (**S**ub **D**ata **L**ogical **C**hannel).

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:MARKer:SOURce` on page 426
`[:SOURce<hw>]:EBOX:DRF:MARKer:LC` on page 422
`[:SOURce<hw>]:EBOX:DRF:MARKer:CLC` on page 418
`[:SOURce<hw>]:EBOX:DRF:MARKer:CLC:PATTern` on page 420

LC
Select the logical channel type in the trigger pattern. The LC bit is defined by the LSB of the header.

"Control"	Select control logical channel. The corresponding coding is "0".
"Data"	Select data logical channel, i.e. coding is "1".

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:MARKer:LC` on page 422
`[:SOURce<hw>]:EBOX:DRF:MARKer:LC:PATTern` on page 423

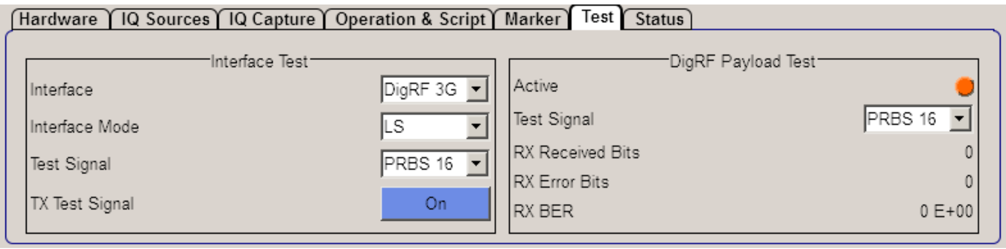
Payload
Define the payload of DigRF v4 in the trigger pattern for evaluation.

The payload field transports the actual data, either control or data, depending on the frame type. The payload size is 24 Bit.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:MARKer:V4PL` on page 426
`[:SOURce<hw>]:EBOX:DRF:MARKer:V4PL:PATTern` on page 426

7.3.12 Test

The **Test** tab comprises diagnostics settings in order to evaluate signal transmission. Interface parameters as well as payload test parameters are available for monitoring the interface and signal transmission.



Interface Test
Interface: DigRF 3G
Interface Mode: LS
Test Signal: PRBS 16
TX Test Signal: On

DigRF Payload Test
Active: ●
Test Signal: PRBS 16
RX Received Bits: 0
RX Error Bits: 0
RX BER: 0 E+00

Fig. 7-136: DigRF Test dialog box

Basic functionalities of the two Tests are:

- "Interface Test"

With the "Interface Test" you can configure a TX test signal, for example to check the signal level,e.g. on an oscilloscope. Connection to the DUT is not required.

- "DigRF Payload Test"
  This tester fills the payload of a DigRF frame with PRBS data to evaluate it. Therefor you need to activate the data source and data sink in the script.
  Perform this test accordingly with a frame loopback, i.e. with connected DUT. It is important that the DUT is also working in loopback mode.

Interface Test
Generates a test signal to analyze the TX output without DUT connected.

Interface ← Interface Test
Select the DigRF interface for testing.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:BER:IFC` on page 397

Interface Mode ← Interface Test
Select the mode, i.e. the line rate for the interface test. The available modes depend on the selected interface.

Inteface DigRF 3G		**Interface DigRF v4**	
Mode	**Description**	**Mode**	**Description**
LS	Test at the **L**ow **S**peed line rate, which corresponds to the used reference frequency.	LS	Test at the **L**ow **S**peed line rate, which corresponds to the used reference frequency.
HS	Use the **H**igh **S**peed line rate, which corresponds to the used reference frequency.	H1SP	Test at **H**igh **S**peed **P**rimary interface frequency.
		HS1S	Test at the **H**igh **S**peed **S**econdary interface frequency.

SCPI command:
`[:SOURce<hw>]:EBOX:DRF:BER:IFC:MODE` on page 397

Test Signal ← Interface Test
Select the test signal.

"PRBS"	Select a PRBS16 sequence as test pattern. The length of the test pattern is defined as 2^{16}-1=65535 bits.
"Pattern"	**Interface Test** Define a test pattern manually. The 16 bit test signal is provided for interface test only.

"Counter"	**Payload Test** Use a counter for the number of bits/blocks and the number of error bits. Test signal provided for payload test only.

SCPI command:

Interface test: `[:SOURce<hw>]:EBOX:DRF:BER:IFC:SIGNal` on page 398

Payload test: `[:SOURce<hw>]:EBOX:DRF:BER:PL:SIGNal` on page 399

Pattern ← Interface Test

Define a user-specific bit pattern with a maximum length of 16 bits for the interface test.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:BER:IFC:PATTern` on page 398

TX Test Signal ← Interface Test

Switch on the interface test signal.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:BER:IFC:SIGNal:STATe` on page 398

DigRF Payload Test

Generates PRBS payload data of a DigRF frame for RX BER measurement. The response from the DUT is evaluated.

Active (LED) ← DigRF Payload Test

Indicates the state of the payload test. The blue LED indicates that the payload test is active, and vice versa, when inactive, it turns red.

Note: To perform the test, you must activate the data source and data sink in the script.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:BER:PL:STATe` on page 400

Test Signal ← DigRF Payload Test

Select the test signal.

"PRBS"	Select a PRBS16 sequence as test pattern. The length of the test pattern is defined as 2^{16}-1=65535 bits.
"Pattern"	**Interface Test** Define a test pattern manually. The 16 bit test signal is provided for interface test only.
"Counter"	**Payload Test** Use a counter for the number of bits/blocks and the number of error bits. Test signal provided for payload test only.

SCPI command:

Interface test: `[:SOURce<hw>]:EBOX:DRF:BER:IFC:SIGNal` on page 398

Payload test: `[:SOURce<hw>]:EBOX:DRF:BER:PL:SIGNal` on page 399

RX Received Bits ← DigRF Payload Test

Indicates the total number of received bits. The function always starts counting from 0 at the start of the BER measurement.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:BER:IFC|PL:RXBits` on page 399

RX Error Bits ← DigRF Payload Test

Displays the number of received bits that are incorrect. The function always starts counting from 0 at the start of the BER measurement.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:BER:IFC|PL:RXERrors` on page 399

RX BER ← DigRF Payload Test

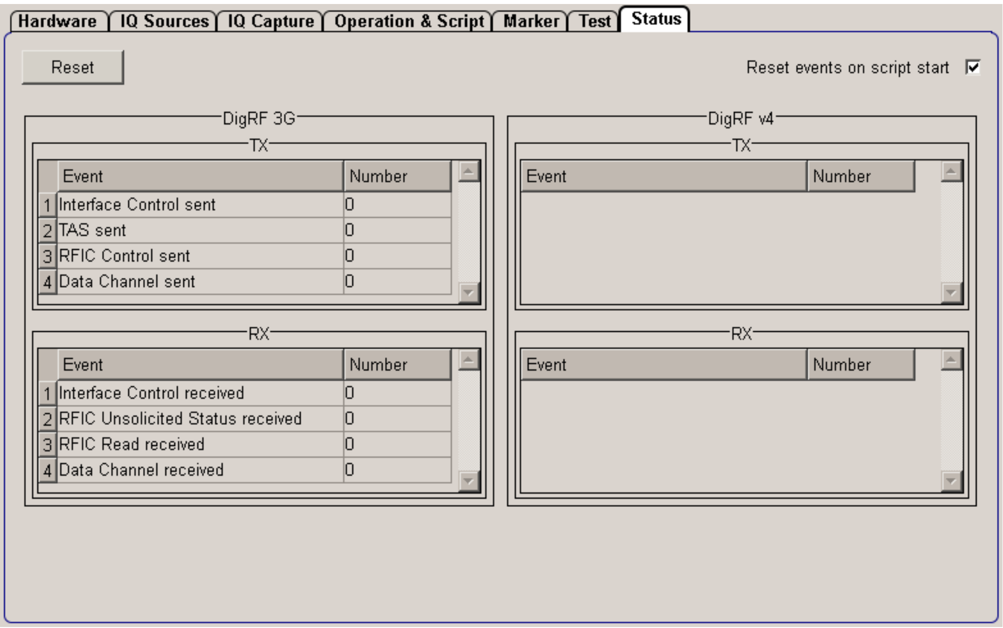
Displays the bit error rate. The BER result is the ratio, which is calculated by dividing the number of error bits by the total number of bits (RX Error Bits/RX Received Bits).

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:BER:IFC|PL:BER` on page 398

7.3.13 Status

This tab displays the statistics of the activities in the DigRF communication links.



Reset events on script start ☑

DigRF 3G – TX

	Event	Number
1	Interface Control sent	0
2	TAS sent	0
3	RFIC Control sent	0
4	Data Channel sent	0

DigRF 3G – RX

	Event	Number
1	Interface Control received	0
2	RFIC Unsolicited Status received	0
3	RFIC Read received	0
4	Data Channel received	0

DigRF v4 – TX

Event	Number

DigRF v4 – RX

Event	Number

Fig. 7-137: DigRF Status dialog box

Currently R&S DigIConf provides the events of DigRF 3G, DigRF v4 will be implemented in a later release.

Reset

Reset all events.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:CSTatus:EVENts:RESet` on page 401

Reset events on script start

Resets all events at startup of a script.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:CSTatus:EVENts:SRESet` on page 401

Events

Displays the individual events of the corresponding DigRF standard.

TX Events ← Events

Shows the events in the transmitter path, and how often an event occurred during transmission.

"Interface Control sent"	Number of sent interface control data frames.
"TAS sent"	Number of sent TAS frames (**T**ime **A**ccurate **S**trobe).
"RFIC Control sent"	Number of sent RFIC frames (**R**adio **F**requency **I**ntegrated **C**ircuit).
"Data Channel sent"	Number of sent data frames.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:CSTatus:D3G|D4V:TX:EVENts<st>` on page 401

RX Events ← Events

Lists the individual events in the receiver path. The column at the right shows the number of occurred events.

"Interface Control received"	Number of received interface control data frames.
" RFIC Unsolicited Status received"	Number of received unsolicited status messages.
" RFIC Read received"	Number of received of RFIC frames (**R**adio **F**requency **I**ntegrated **C**ircuit).
" Data Channel received"	Number of received data frames.

SCPI command:

`[:SOURce<hw>]:EBOX:DRF:CSTatus:D3G|D4V:RX:EVENts<st>` on page 401

8 Remote Control Basics

This chapter provides basic information on operating R&S DigIConf via remote control.

Information on used term for R&S DigIConf

Throughout this description, the term “instrument” is used to indicate R&S DigIConf; the terms “instrument”, “software” and R&S DigIConf are used interchangeably.

8.1 Remote Control Interfaces and Protocols

R&S DigIConf supports a LAN (**L**ocal **A**rea **N**etwork) interface for remote control, using socket communication protocol, i.e. Raw Socket (simple telnet). The interface is based on TCP/IP with VISA resource string composed of:

TCPIP::<ipaddr>::<port>::SOCKET

No VISA installation is necessary to remote control while using socket communication.

For a description of the protocol refer to chapter 8.1.2, "LAN interface", on page 270.

SCPI (Standard Commands for Programmable Instruments)

SCPI commands - messages - are used for remote control. Commands that are not taken from the SCPI standard follow the SCPI syntax rules. R&S DigIConf supports the SCPI version 1999. The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers. The tutorial "Automatic Measurement Control - A tutorial on SCPI and IEEE 488.2" from John M. Pieper (R&S order number 0002.3536.00) offers detailed information on concepts and definitions of SCPI.

Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers.

8.1.1 Messages

There are different types of instrument messages, depending on the direction they are sent:

- Commands
- Responses

Structure and syntax of messages are described in chapter 8.2, "SCPI Command Structure", on page 278. A detailed description of all messages available for R&S DigIConf is provided in chapter 9, "Remote Control Commands", on page 292.

Commands

Commands (program messages) are messages the controller sends to R&S DigIConf. They operate functions and request information.

The commands are subdivided according to two criteria:

- According to the effect they have on the instrument:
  - **Setting commands** cause instrument settings such as a reset of the instrument or setting the frequency.
  - **Queries** cause data to be provided for remote control, e.g. for identification of the instrument or polling a parameter value. Queries are formed by directly appending a question mark to the command header.
- According to their definition in standards:
  - **Common commands:** their function and syntax are precisely defined in standard IEEE 488.2. They are employed identically on all instruments (if implemented). They refer to functions such as management of the standardized status registers, reset and self test.
  - **Instrument control commands** refer to functions depending on the features of the instrument such as frequency settings. Many of these commands have also been standardized by the SCPI committee. These commands are marked as "SCPI compliant" in the command reference chapters. Commands without this SCPI label are device-specific, however, their syntax follows SCPI rules as permitted by the standard.

Instrument responses

Instrument responses (response messages and service requests) are messages the R&S EX-IQ-BOX sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status.

8.1.2 LAN interface

For remote control via a network, the controller and the PC on that the R&S DigIConf is installed (if not the same) must be connected via the LAN interface to a common network with TCP/IP network protocol. They are connected using a commercial RJ-45 cable.

Software for remote control must be installed on the controller.

IP address

Only the IP address or the computer name (LAN device name) is required to set up the connection. The IP address/computer name is part of the "visa resource string" used by the programs to identify and control the instrument. The visa resource string has the form:

`TCPIP::host address::[LAN device name]::[SOCKET]`, where:

- **TCPIP** designates the network protoccol
- **host address** is the IP address
- **LAN device name** is the computer name of the control device (alternative to IP address)
- **SOCKET** indicates that the socket protocol is used

In case the R&S DigIConf and the controller are installed on the same PC, the IP address *127.0.0.1* or *Local Host* is used. Hence the valid visa resource string is:

```
TCPIP::127.0.0.1::INSTR
```

Identifying instruments in a network

If several instruments are connected in a network, each instrument has its own IP address and associated resource string. The controller identifies these instruments by means of the resource string.

Socket communication

An alternative way for remote control of the software is to establish a simple network communication using sockets. The socket communication, also referred as “Raw Ethernet communication” or "Raw socket", does not require a VISA installation on the remote controller side. Connection can also be performed with "Win Socket" communication.

An alternative way to establish a socket communication is to use a build-in telnet program. The telnet program is part of every operating system and supports a communication with the software on a command-by-command basis. For better utilization and to enable automation by means of programs, user defined sockets can be programmed.

Socket connections are established on a specially defined port. The socket address is a combination of the IP address or the host name of the instrument and the number of the port configured for remote-control. R&S DigIConf uses port number 5026 for this purpose by default, but can be set. The port is configured for communication on a command-to-command basis and for remote control from a program.

8.1.3 Starting a Remote Control Session

The instrument and the controller have to be connected with the suitable cable and switched on.

A remote control program must open a connection to R&S DigIConf (using Raw socket or VISA functionality), before it can send commands to and receive device responses from R&S DigIConf.

Refer to chapter 8.1.5, "Examples", on page 272 for practical examples on setting up of a remote control link and starting of a remote control session.

8.1.4 Switching to Remote Control

When it is started, the software is always in the manual operating state and can be operated via the block diagram.

Starting remote control

Send a command from a controller to the signal generation software.

The software is in a remote control state as soon as it receives a command from the controller.

8.1.5 Examples

These sections provides examples for setting up of remote control connection and starting a remote control session over LAN interface.

This section assumes basic knowledge of programming and operation of the controller. A description of the interface commands can be obtained from the relevant manuals.

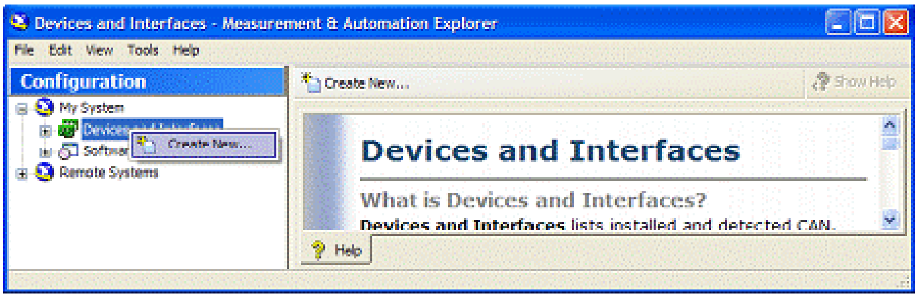
8.1.5.1 Remote Control Over LAN Using Socket Protocol

Through the examples in this section, the program 'Measurement & Automation Explorer' from National Instruments under Windows operating system is used for setting up a LAN remote control link and starting a remote control session.

Configuring the controller

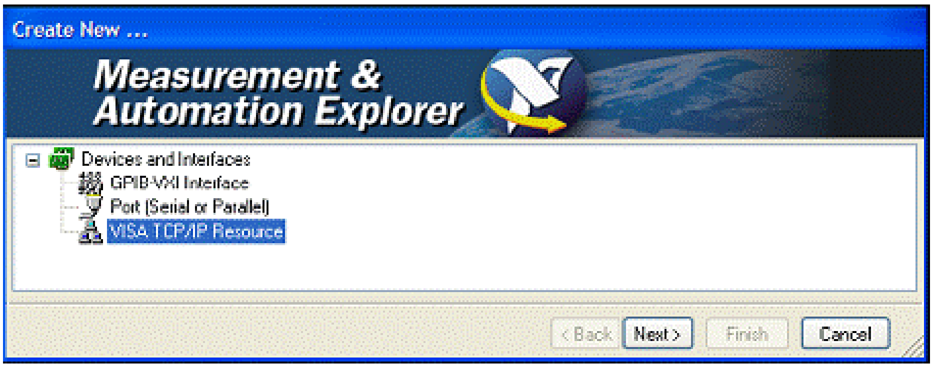
To enable the external controller to communicate with the software via TCP/IP protocol, set up a remote control link as follow:

1. Connect the controller and the instrument to the network (network cable) and switch them on.
2. Start the 'Measurement & Automation Control' program on the controller.
3. Select "Devices and Interfaces > Create New".

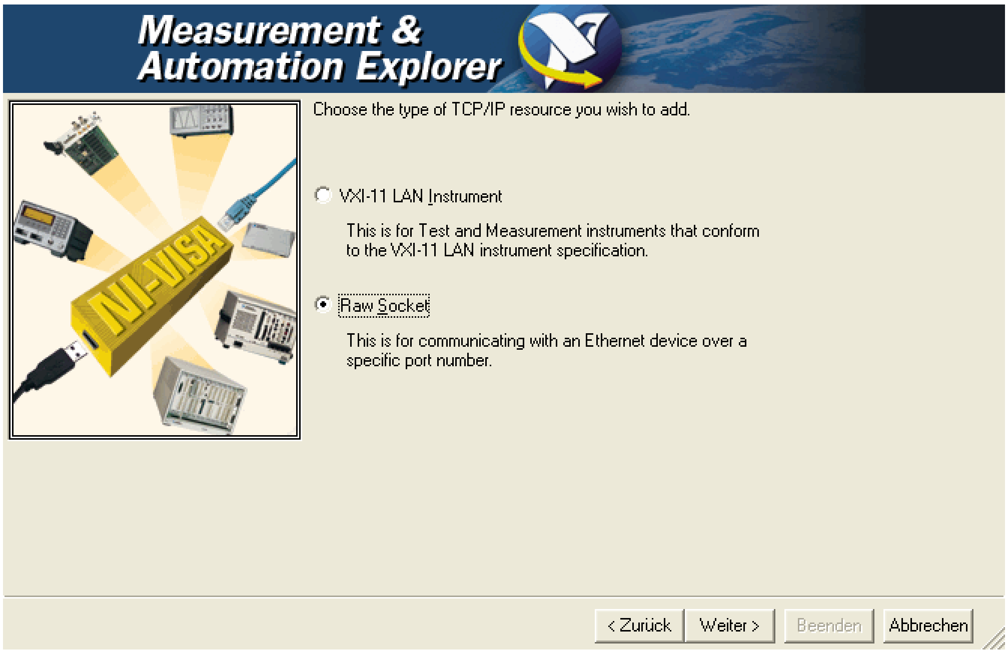


Devices and Interfaces lists installed and detected CAN,

4. Select "VISA TCP/IP Resource" and confirm with "Next".



5. Choose the type of TCP/IP resource you wish to add and select "Next".



Choose the type of TCP/IP resource you wish to add.

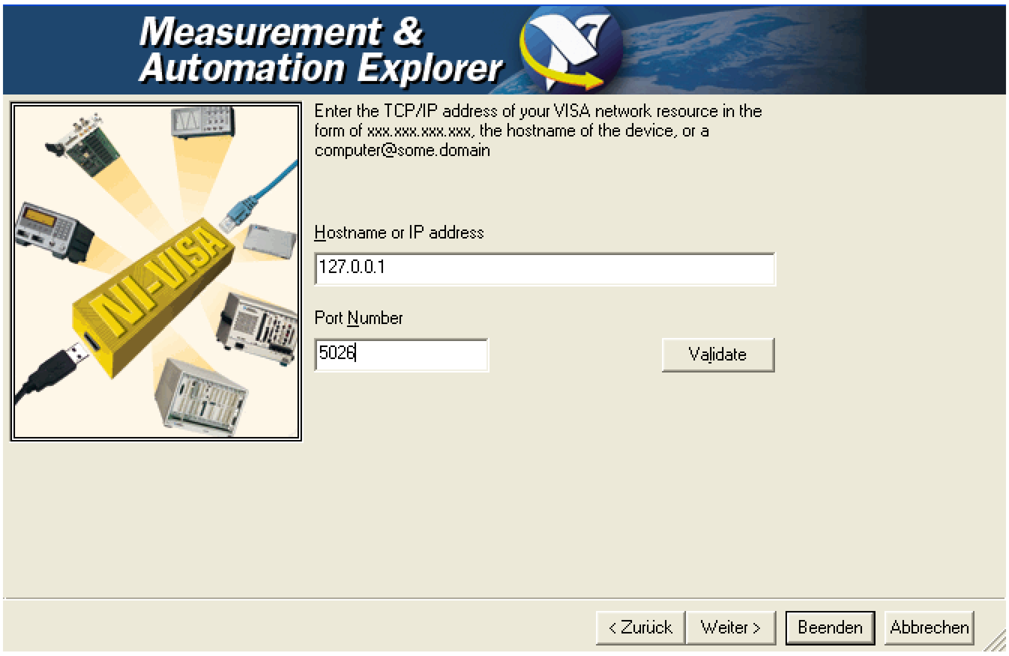
○ VXI-11 LAN Instrument

This is for Test and Measurement instruments that conform to the VXI-11 LAN instrument specification.

● Raw Socket

This is for communicating with an Ethernet device over a specific port number.

6. Enter the IP address or the host name of R&S DigIConf and select "Next".

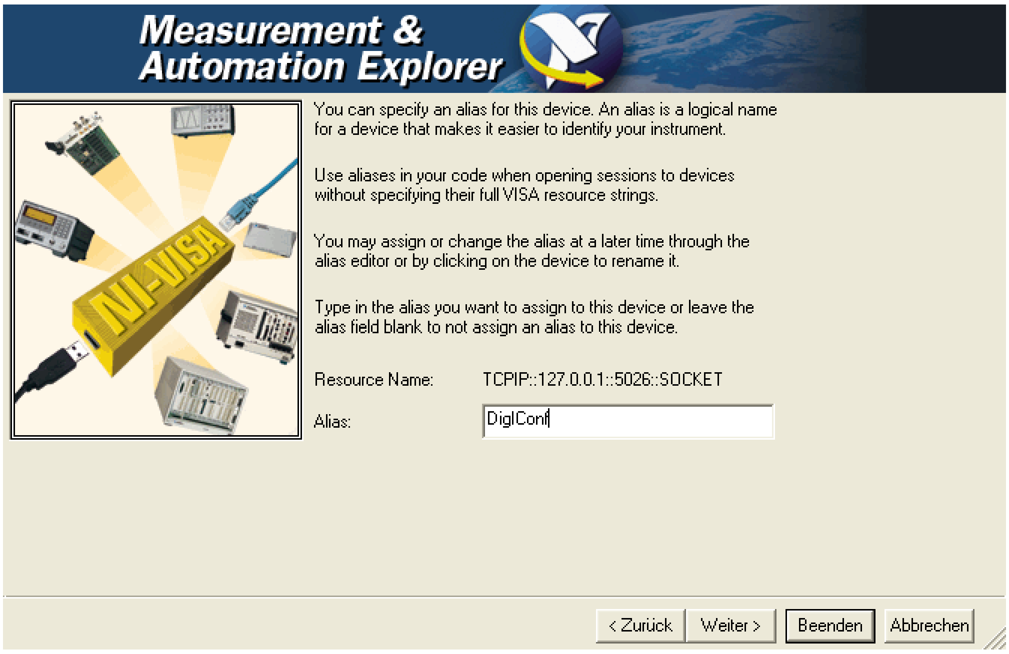


Enter the TCP/IP address of your VISA network resource in the form of xxx.xxx.xxx.xxx, the hostname of the device, or a computer@some.domain

Hostname or IP address: 127.0.0.1

Port Number: 5026

7. Enter the alias name if required.



You can specify an alias for this device. An alias is a logical name for a device that makes it easier to identify your instrument.

Use aliases in your code when opening sessions to devices without specifying their full VISA resource strings.

You may assign or change the alias at a later time through the alias editor or by clicking on the device to rename it.

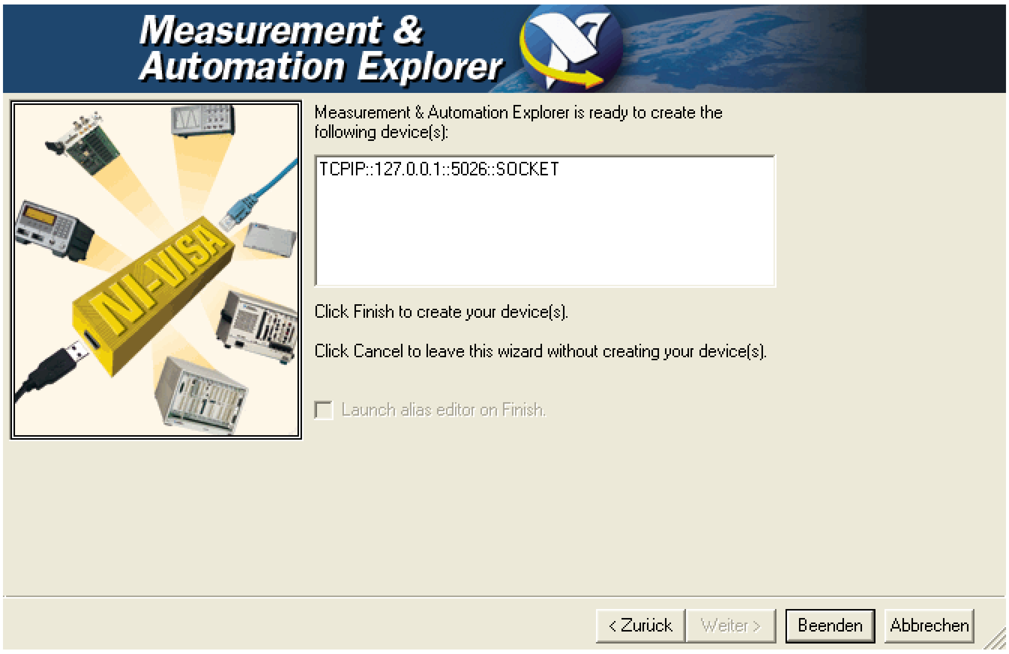
Type in the alias you want to assign to this device or leave the alias field blank to not assign an alias to this device.

Resource Name: TCPIP::127.0.0.1::5026::SOCKET

Alias: DiglConf

The alias name must not be mistaken for the computer name. It is only used for instrument identification within the program and displayed in the menu as an option in case of an Ethernet link.

8. Confirm the settings with "Finish".



Measurement & Automation Explorer is ready to create the following device(s):

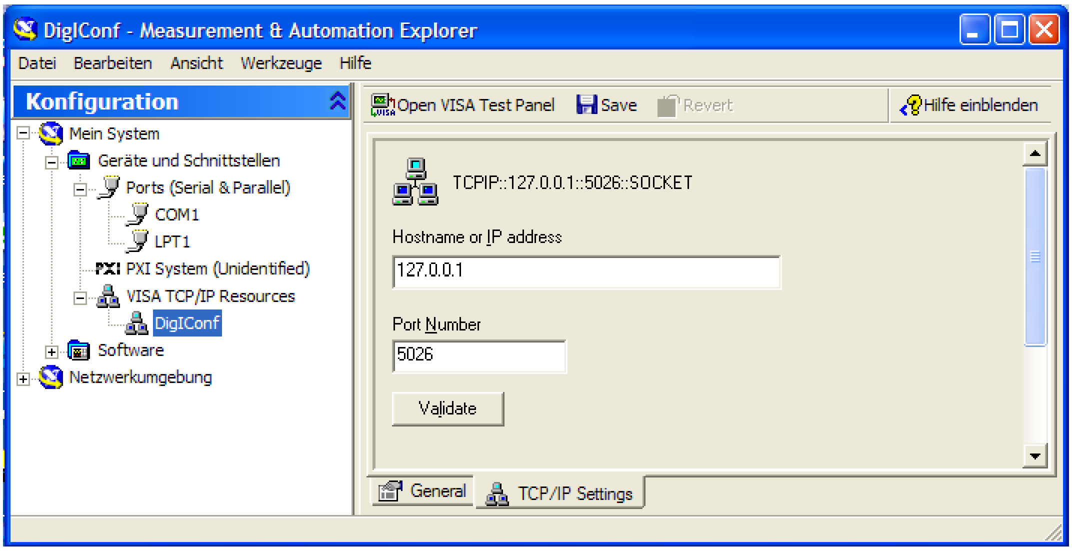
TCPIP::127.0.0.1::5026::SOCKET

Click Finish to create your device(s).

Click Cancel to leave this wizard without creating your device(s).

☐ Launch alias editor on Finish.

The instrument is configured and the settings are displayed in the "TCP/IP Settings" tab.

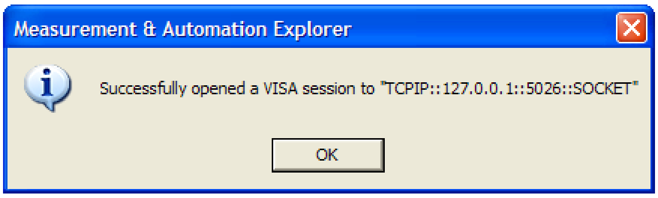


TCPIP::127.0.0.1::5026::SOCKET

Hostname or IP address: 127.0.0.1

Port Number: 5026

9. To test the connection, select "Validate".

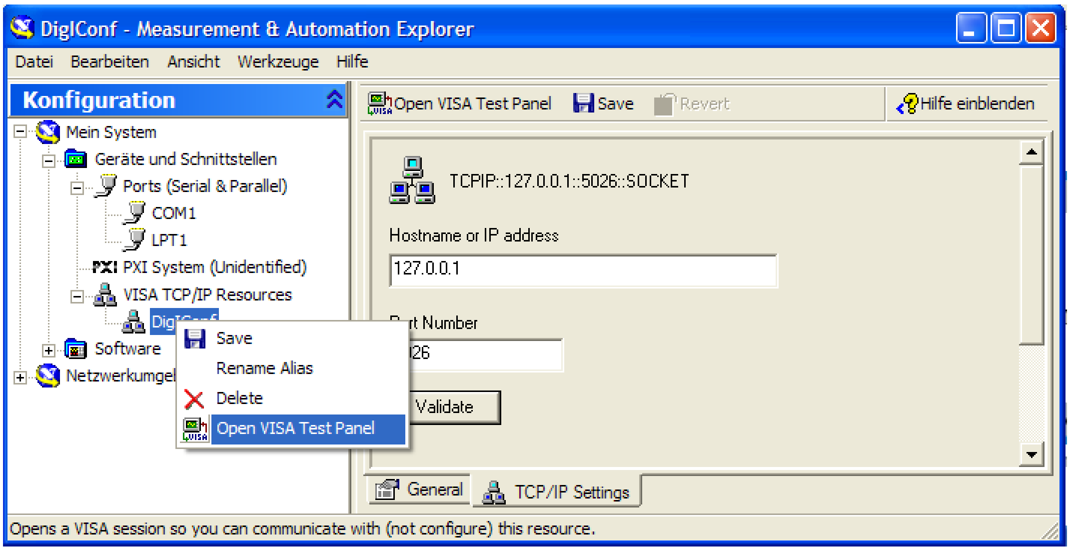


Successfully opened a VISA session to "TCPIP::127.0.0.1::5026::SOCKET"

A message indicates whether the link to the instrument can be set up or not.
If a connection cannot be set up, check whether the controller and the instrument are connected to the network (network cable) and switched on. Correct spelling of the IP address or the computer name can also be checked. For further error location, inform the network administrator. In large networks, specification of additional addresses may be required for link setup, e.g. gateway and subnet mask, which are known to the network administrator.
R&S DigIConf is now registered in the program and can be addressed via the resource string or alias name.

Starting a remote control over LAN

1. Start the 'Measurement & Automation Explorer' on the controller.
2. In the "Configuration" window, select "Device and Interfaces > VISA TCP/IP Resources", select the required instrument and select "Open VISA Test Panel".



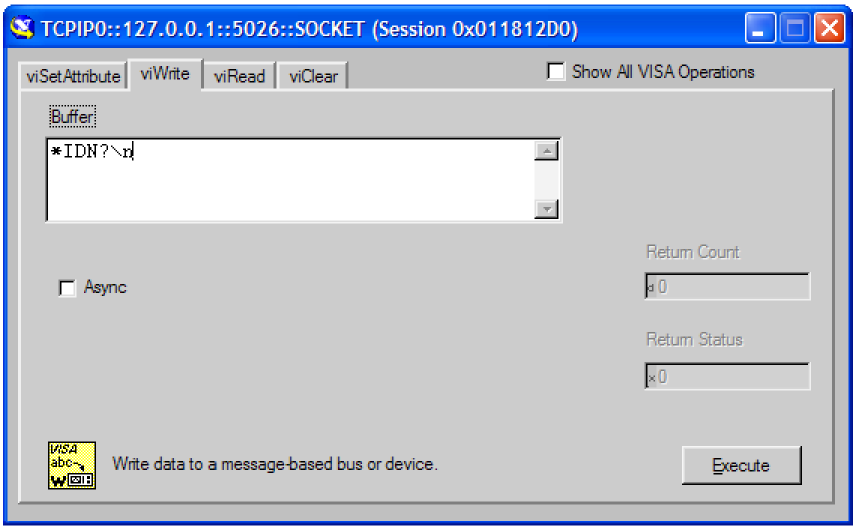
TCPIP::127.0.0.1::5026::SOCKET

Hostname or IP address: 127.0.0.1

P rt Number: 26

Opens a VISA session so you can communicate with (not configure) this resource.

3. In the "viWrite" tab, write the command to be send to the instrument and select "Execute".



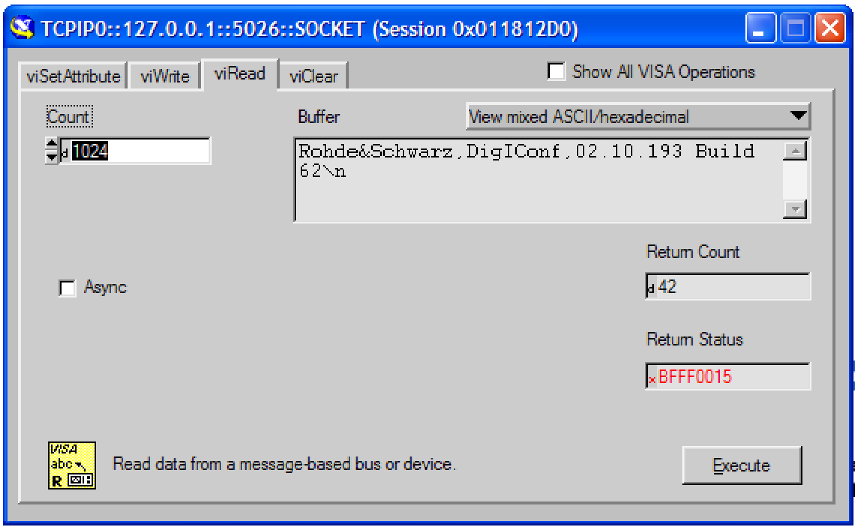
Buffer: *IDN?\n

Return Count: 0

Return Status: 0

Write data to a message-based bus or device.

Instrument responses are displayed on the "viRead" tab.



Count: 1024

```
Rohde&Schwarz,DigIConf,02.10.193 Build
62\n
```

☐ Async

Return Count: 42

Return Status: BFFF0015

Read data from a message-based bus or device.

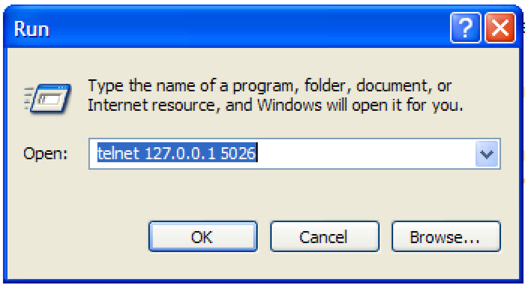
For further program operation refer to the online help of the program.

Setting up a Telnet Connection

This chapter provides an example on how to establish a remote control connection over telnet protocol and a simple sockets-based program example that can be further developed.

To control the software, only a telnet program is required. The telnet program is part of every operating system.

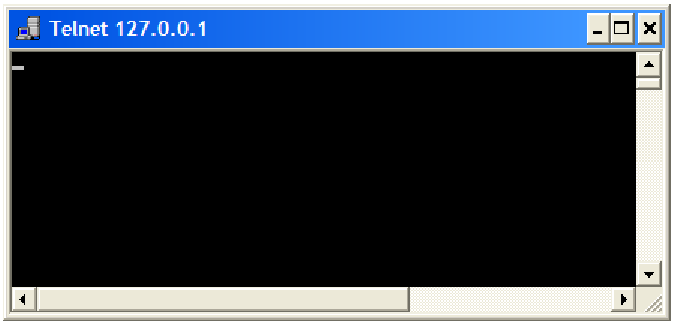
1. To establish a Telnet connection with R&S DigIConf, start the telnet program and enter the socket address.
   The socket address is a combination of the IP address or the host name of the R&S DigIConf and the number of the port configured for remote-control via telnet.
   Tip:
   R&S DigIConf uses the port number 5026 for remote connection via Telnet.



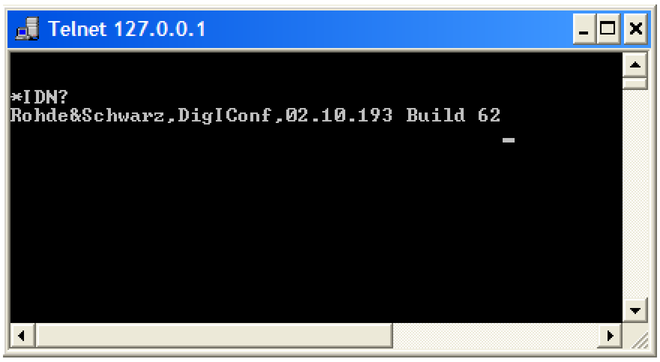
Type the name of a program, folder, document, or Internet resource, and Windows will open it for you.

Open: telnet 127.0.0.1 5026

The connection to the instrument is set up and remote-control commands can be sent.

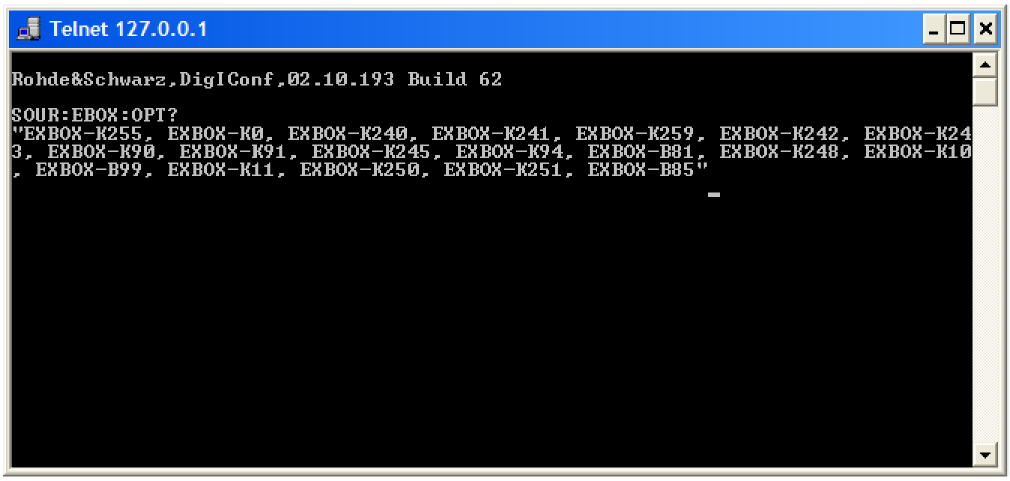


2. Even if the cursor is not visible on the screen, enter blind a remote-control command and confirm with Enter.



```
*IDN?
Rohde&Schwarz,DigIConf,02.10.193 Build 62
```

After the first remote-control command had been send, R&S DigIConf is in remote-controlled state.



```
Rohde&Schwarz,DigIConf,02.10.193 Build 62

SOUR:EBOX:OPT?
"EXBOX-K255, EXBOX-K0, EXBOX-K240, EXBOX-K241, EXBOX-K259, EXBOX-K242, EXBOX-K24
3, EXBOX-K90, EXBOX-K91, EXBOX-K245, EXBOX-K94, EXBOX-B81, EXBOX-K248, EXBOX-K10
, EXBOX-B99, EXBOX-K11, EXBOX-K250, EXBOX-K251, EXBOX-B85"
```

Instrument response is displayed after the command has been sent.

8.2 SCPI Command Structure

SCPI commands consist of a so-called header and, in most cases, one or more parameters. The header and the parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several mnemonics (keywords). Queries are formed by appending a question mark directly to the header.

The commands can be either device-specific or device-independent (common commands). Common and device-specific commands differ in their syntax.

Restrictions in the use of SCPI commands in R&S DigIConf

R&S DigIConf does not support the entire functionality of the SCPI commands. Note the following restrictions:

- 2 commands entered in a row are not provided (usually divided by a semicolon)
- only a limited subset of Common Commands is available
- no status reporting system

8.2.1 Syntax for Common Commands

Common (=device-independent) commands consist of a header preceded by an asterisk (*) and possibly one or more parameters.

Example:

*RST	RESET	Resets the instrument.
*IDN?	IDENTIFICATION QUERY	Queries the instrument identification string.
*OPT?	OPTION IDENTIFICATION QUERY	Queries the options included in the instrument.

8.2.2 Syntax of Device-Specific Commands

Optional note heading

Not all commands used in the following examples are necessarily implemented in the instrument.

For demonstration purposes only, assume the existence of the following commands for this section:

- `DISPlay[:WINDow<1...4>]:MAXimize <Boolean>`
- `FORMat:READings:DATA <type>[,<length>]`
- `HardCOPy:DEVice:COLor <Boolean>`
- `HardCOPy:DEVice:CMAP:COLor:RGB <red>,<green>,<blue>`
- `HardCOPy[:IMMediate]`
- `HardCOPy:ITEM:ALL`
- `HardCOPy:ITEM:LABel <string>`
- `HardCOPy:PAGE:DIMensions:QUADrant[<N>]`
- `HardCOPy:PAGE:ORIentation LANDscape | PORTrait`
- `HardCOPy:PAGE:SCALe <numeric value>`
- `MMEMory:COPY <file_source>,<file_destination>`
- `SENSE:BANDwidth|BWIDth[:RESolution] <numeric_value>`
- `SENSe:FREQuency:STOP <numeric value>`
- `SENSe:LIST:FREQuency <numeric_value>{,<numeric_value>}`

Long and short form

The mnemonics feature a long form and a short form. The short form is marked by upper case letters, the long form corresponds to the complete word. Either the short form or the long form can be entered; other abbreviations are not permitted.

Example:

`HardCOPy:DEVice:COLor ON` is equivalent to `HCOP:DEV:COL ON`

Case sensitivity

Upper case and lower case notation only serves to distinguish the two forms in the manual, the instrument itself is case-insensitive.

Numeric suffixes

If a command can be applied to multiple instances of an object, e.g. specific channels or sources, the required instances can be specified by a suffix added to the command.

Numeric suffixes are indicated by angular brackets (<1...4>, <n>, <i>) and are replaced by a single value in the command. Entries without a suffix are interpreted as having the suffix 1.

Example:

Definition: `HardCOPy:PAGE:DIMensions:QUADrant[<N>]`

Command: `HCOP:PAGE:DIM:QUAD2`

This command refers to the quadrant 2.

Different numbering in remote control

For remote control, the suffix may differ from the number of the corresponding selection used in manual operation. SCPI prescribes that suffix counting starts with 1. Suffix 1 is the default state and used when no specific suffix is specified.

Some standards define a fixed numbering, starting with 0. With GSM, for instance, slots are counted from 0 to 7. In remote control, the slots are selected using the suffixes 1 to 8. If the numbering differs in manual operation and remote control, it is indicated for the corresponding command.

Optional mnemonics

Some command systems permit certain mnemonics to be inserted into the header or omitted. These mnemonics are marked by square brackets in the description. The instrument must recognize the long command to comply with the SCPI standard. Some commands are considerably shortened by these optional mnemonics.

Example:

Definition: `HardCOPy[:IMMediate]`

Command: `HCOP:IMM` is equivalent to `HCOP`

Optional mnemonics with numeric suffixes

Do not omit an optional mnemonic if it includes a numeric suffix that is relevant for the effect of the command.

Example:

Definition: `DISPlay[:WINDow<1...4>]:MAXimize <Boolean>`

Command: `DISP:MAX ON` refers to window 1.

In order to refer to a window other than 1, you must include the optional `WINDow` parameter with the suffix for the required window.

`DISP:WIND2:MAX ON` refers to window 2.

Parameters

Parameters must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma (,). For a description of the parameter types, refer to chapter 8.2.3, "SCPI Parameters", on page 282.

Example:

Definition: `HardCOPy:DEVice:CMAP:COLor:RGB <red>,<green>,<blue>`

Command: `HCOP:DEV:CMAP:COL:RGB 3,32,44`

Special characters

|	**Parameters** A vertical stroke in parameter definitions indicates alternative possibilities in the sense of "or". The effect of the command differs, depending on which parameter is used. **Example:** Definition: `HardCOPy:PAGE:ORIentation LANDscape | PORTrait` Command: `HCOP:PAGE:ORI LAND` specifies landscape orientation Command: `HCOP:PAGE:ORI PORT` specifies portrait orientation **Mnemonics** A selection of mnemonics with an identical effect exists for several commands. These mnemonics are indicated in the same line; they are separated by a vertical stroke. Only one of these mnemonics needs to be included in the header of the command. The effect of the command is independent of which of the mnemonics is used. **Example:** Definition: `SENSE:BANDwidth|BWIDth[:RESolution] <numeric_value>` The two following commands with identical meaning can be created: Command: `SENS:BAND:RES 1` Command: `SENS:BWID:RES 1`
[ ]	mnemonics in square brackets are optional and may be inserted into the header or omitted. **Example:** Command: **HardCOPy[:IMMediate]** Command: `HCOP:IMM` is equivalent to `HCOP`
{ }	Parameters in curly brackets are optional and can be inserted once or several times, or omitted. **Example:** Definition: `SENSe:LIST:FREQuency <numeric_value>{,<numeric_value>}` The following are valid commands: Command: `SENS:LIST:FREQ 10` Command: `SENS:LIST:FREQ 10,20` Command: `SENS:LIST:FREQ 10,20,30,40`

8.2.3 SCPI Parameters

Many commands are supplemented by a parameter or a list of parameters. The parameters must be separated from the header by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank).

Allowed parameters are:

- Numeric values
- Special numeric values
- Boolean parameters
- Text
- Character strings
- Block data

The parameters required for each command and the allowed range of values are specified in the command description.

Numeric values

Numeric values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not allowed. In the case of physical quantities, the unit can be entered. Allowed unit prefixes are G (giga), MA (mega), MOHM and MHZ are also allowed), K (kilo), M (milli), U (micro) and N (nano). If the unit is missing, the basic unit is used.

Example:

`SENSe:FREQ:STOP 1.5GHz = SENSe:FREQ:STOP 1.5E9`

Units

For physical quantities, the unit can be entered. Allowed unit prefixes are:

- G (giga)
- MA (mega), MOHM, MHZ
- K (kilo)
- M (milli)
- U (micro)
- N (nano)

If the unit is missing, the basic unit is used.

Example:

`SENSe:FREQ:STOP 1.5GHz = SENSe:FREQ:STOP 1.5E9`

Some settings allow relative values to be stated in percent. According to SCPI, this unit is represented by the PCT string.

Example:

`HCOP:PAGE:SCAL 90PCT`

Special numeric values

The texts listed below are interpreted as special numeric values. In the case of a query, the numeric value is provided.

- **MIN/MAX**
- MINimum and MAXimum denote the minimum and maximum value.
- **DEF**
- DEFault denotes a preset value which has been stored in the EPROM. This value conforms to the default setting, as it is called by the `*RST` command.
- **UP/DOWN**

- UP, DOWN increases or reduces the numeric value by one step. The step width can be specified via an allocated step command for each parameter which can be set via UP, DOWN.
- **INF/NINF**
- INFinity, Negative INFinity (NINF) represent the numeric values 9.9E37 or -9.9E37, respectively. INF and NINF are only sent as instrument responses.
- **NAN**
- Not A Number (NAN) represents the value 9.91E37. NAN is only sent as a instrument response. This value is not defined. Possible causes are the division of zero by zero, the subtraction of infinite from infinite and the representation of missing values.

Example:

Setting command: `SENSe:LIST:FREQ MAXimum`

Query: `SENS:LIST:FREQ?`, Response: `3.5E9`

Queries for special numeric values

The numeric values associated to MAXimum/MINimum/DEFault can be queried by adding the corresponding mnemonics to the command. They must be entered following the quotation mark.

Example:

`SENSe:LIST:FREQ? MAXimum`

Returns the maximum numeric value as a result.

Boolean Parameters

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0. The numeric values are provided as the response for a query.

Example:

Setting command: `HCOPy:DEV:COL ON`

Query: `HCOPy:DEV:COL?`

Response: 1

Text parameters

Text parameters observe the syntactic rules for mnemonics, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

Example:

Setting command: `HardCOPy:PAGE:ORIentation LANDscape`

Query: `HCOP:PAGE:ORI?`

Response: `LAND`

Character strings

Strings must always be entered in quotation marks (' or ").

Example:

`HCOP:ITEM:LABel "Test1"` or `HCOP:ITEM:LABel 'Test1'`

Block data

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

Example:

`FORMat:READings:DATA #45168xxxxxxxx`

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted.

#0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

8.2.3.1 Overview of Syntax Elements

The following table provides an overview of the syntax elements:

:	The colon separates the mnemonics of a command. In a command line the separating semicolon marks the uppermost command level.
;	The semicolon separates two commands of a command line. It does not alter the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*	The asterisk marks a common command.
"	Quotation marks introduce a string and terminate it.
#	The hash symbol introduces binary, octal, hexadecimal and block data. • Binary: #B10110 • Octal: #O7612 • Hexa: #HF3A7 • Block: #21312
	A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates the header from the parameters.

8.2.3.2 Structure of a Command Line

A command line may consist of one or several commands. It is terminated by one of the following:

- a <New Line>
- a <New Line> with EOI
- an EOI together with the last data byte

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

Example:

```
MMEM:COPY "Test1","MeasurementXY";:HCOP:ITEM ALL
```

This command line contains two commands. The first command belongs to the MMEM system, the second command belongs to the HCOP system.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels. The colon following the semicolon must be omitted in this case.

Example:

```
HCOP:ITEM ALL; HCOP:IMM
```

This command line is represented in its full length and contains two commands separated from each other by the semicolon. Both commands are part of the HCOP command system, i.e. they have one level in common.

When abbreviating the command line, the second command begins with the level below HCOP. The colon after the semicolon is omitted. The abbreviated form of the command line reads as follows:

```
HCOP:ITEM ALL;IMM
```

However, a new command line always begins with the complete path.

Example:

```
HCOP:ITEM ALL
HCOP:IMM
```

8.2.3.3 Responses to Queries

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

- The requested parameter is transmitted without a header.
  Example:
  `HCOP:PAGE:ORI?`, Response: `LAND`
- Maximum values, minimum values and all other quantities that are requested via a special text parameter are returned as numeric values.

Example:
`SENSe:FREQuency:STOP? MAX`, Response: `3.5E9`

- Numeric values are output without a unit. Physical quantities are referred to the basic units or to the units set using the Unit command. The response 3.5E9 in the previous example stands for 3.5 GHz.
- Truth values (Boolean values) are returned as 0 (for OFF) and 1 (for ON).
  Example:
  Setting command: `HCOPy:DEV:COL ON`
  Query: `HCOPy:DEV:COL?`
  Response: `1`
- Text (character data) is returned in a short form.
  Example:
  Setting command: `HardCOPy:PAGE:ORIentation LANDscape`
  Query: `HCOP:PAGE:ORI?`
  Response: `LAND`

8.3 Command Sequence and Synchronization

IEEE 488.2 defines a distinction between overlapped and sequential commands:

- A sequential command is one which finishes executing before the next command starts executing. Commands that are processed quickly are usually implemented as sequential commands. Sequential commands are not implemented in the instrument, however the execution time of most commands is so short that they act as sequential commands when sent in different command lines.
- An overlapping command is one which does not automatically finish executing before the next command starts executing. Usually, overlapping commands take longer to process and allow the program to do other tasks while being executed. If overlapping commands do have to be executed in a defined order, e.g. in order to avoid wrong measurement results, they must be serviced sequentially. This is called synchronization between the controller and the instrument.

Setting commands within one command line, even though they may be implemented as sequential commands, are not necessarily serviced in the order in which they have been received. In order to make sure that commands are actually carried out in a certain order, each command must be sent in a separate command line.

Example:

Commands and queries in one message

The response to a query combined in a program message with commands that affect the queried value is not predictable.

The following commands always return the specified result:

`:FREQ:STAR 1GHZ;SPAN 100 :FREQ:STAR?`

Result:

`1000000000 (1 GHz)`

Whereas the result for the following commands is not specified by SCPI:

`:FREQ:STAR 1GHz;STAR?;SPAN 1000000`

The result could be the value of `STARt` before the command was sent since the instrument might defer executing the individual commands until a program message terminator is received. The result could also be 1 GHz if the instrument executes commands as they are received.

As a general rule, send commands and queries in different program messages.

Example:

Overlapping command with *OPC

The instrument implements `INITiate[:IMMediate]` as an overlapped command. Assuming that `INITiate[:IMMediate]` takes longer to execute than `*OPC`, sending the following command sequence results in initiating a sweep and, after some time, setting the OPC bit in the ESR:

`INIT; *OPC`

Sending the following commands still initiates a sweep:

`INIT; *OPC; *CLS`

However, since the operation is still pending when the instrument executes `*CLS`, forcing it into the "Operation Complete Command Idle" State (OCIS), `*OPC` is effectively skipped. The OPC bit is not set until the instrument executes another `*OPC` command.

Example:

Overlapped command followed by non-conflicting commands

Suppose that the instrument is switched on to provide a real time test signal that requires some calculation time. At the same time some settings for the configuration of a different signal are made which do not interact with the generated signal (e.g. the signal may be used later on). The signal generation and the signal configuration are independent from each other, so none of the following overlapped commands needs to be synchronized:

```
SOUR:BB:3GPP:STAT ON
SOUR:BB:GSM:FORM FSK2
```

8.3.1 Preventing Overlapping Execution

To prevent an overlapping execution of commands, one of the commands `*OPC`, `*OPC?` or `*WAI` can be used. All three commands cause a certain action only to be carried out after the hardware has been set. By suitable programming, the controller can be forced to wait for the corresponding action to occur.

Command	Action	Programming the controller
*OPC	Sets the Operation Complete bit in the ESR after all previous commands have been executed.	Setting bit 0 in the ESE Setting bit 5 in the SRE Waiting for service request (SRQ)
*OPC?	Stops command processing until 1 is returned. This is only the case after the Operation Complete bit has been set in the ESR. This bit indicates that the previous setting has been completed.	Sending *OPC? directly after the command whose processing should be terminated before other commands can be executed.
*WAI	Stops further command processing until all commands sent before *WAI have been executed.	Sending *WAI directly after the command whose processing should be terminated before other commands are executed.

Command synchronization using `*WAI` or `*OPC?` appended to an overlapped command is a good choice if the overlapped command takes only little time to process. The two synchronization techniques simply block overlapped execution of the command.

For time consuming overlapped commands it is usually desirable to allow the controller or the instrument to do other useful work while waiting for command execution. Use one of the following methods:

***OPC with a service request**

1. Set the OPC mask bit (bit no. 0) in the ESE: `*ESE 1`
2. Set bit no. 5 in the SRE: `*SRE 32` to enable ESB service request.
3. Send the overlapped command with `*OPC`
4. Wait for a service request

   The service request indicates that the overlapped command has finished.

***OPC? with a service request**

1. Set bit no. 4 in the SRE: `*SRE 16` to enable MAV service request.
2. Send the overlapped command with `*OPC?`
3. Wait for a service request

   The service request indicates that the overlapped command has finished.

Event Status Register (ESE)

1. Set the OPC mask bit (bit no. 0) in the ESE: `*ESE 1`
2. Send the overlapped command without `*OPC`, `*OPC?` or `*WAI`
3. Poll the operation complete state periodically (by means of a timer) using the sequence: `*OPC`; `*ESR?`

   A return value (LSB) of 1 indicates that the overlapped command has finished.

***OPC? with short timeout**

1. Send the overlapped command without `*OPC`,`*OPC?` or `*WAI`
2. Poll the operation complete state periodically (by means of a timer) using the sequence: <short timeout>; `*OPC?`
3. A return value (LSB) of 1 indicates that the overlapped command has finished. In case of a timeout, the operation is ongoing.
4. Reset timeout to former value
5. Clear the error queue with `SYStem:ERRor?` to remove the "-410, Query interrupted" entries.

Using several threads in the controller application

As an alternative, provided the programming environment of the controller application supports threads, separate threads can be used for the application GUI and for controlling the instrument(s) via SCPI.

A thread waiting for a `*OPC?` thus will not block the GUI or the communication with other instruments.

8.4 General Programming Recommendations

Initial instrument status before changing settings

Manual operation is designed for maximum possible operating convenience. In contrast, the priority of remote control is the "predictability" of the instrument status. Thus, when a command attempts to define incompatible settings, the command is ignored and the instrument status remains unchanged, i.e. other settings are not automatically adapted. Therefore, control programs should always define an initial instrument status (e.g. using the *RST command) and then implement the required settings.

Command sequence

As a general rule, send commands and queries in different program messages. Otherwise, the result of the query may vary depending on which operation is performed first (see also Preventing Overlapping Execution).

Reacting to malfunctions

The service request is the only possibility for the instrument to become active on its own. Each controller program should instruct the instrument to initiate a service request in case of malfunction. The program should react appropriately to the service request.

Error queues

The error queue should be queried after every service request in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

9 Remote Control Commands

In the following, all remote-control commands are presented in detail with their parameters and the ranges of numerical values.

Commands to the respective transmission protocols are described in separate chapters:

- User Defined chapter 9.3, "User Defined - Remote Control Commands", on page 313
- chapter 9.4, "CPRI Remote Control Commands", on page 339
- chapter 9.5, "DigRF - Remote Control Commands", on page 394

For an introduction to remote control, refer to chapter 8, "Remote Control Basics", on page 269.

The remote-control commands are structured in subsystems according to the SCPI syntax, and then listed in alphabetical order.

Addditionally, find a list of all commands for the R&S EX-IQ-BOX at the end of the manual, see "Alphabetical List of Commands".

9.1 Common Commands

Common commands are described in the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect and are employed in the same way on different devices. The headers of these commands consist of "*" followed by three letters. Many common commands are related to the Status Reporting System.

Available common commands:

***CLS** <*cls>

CLear Status

Sets the status byte (STB), the standard event register (ESR) and the `EVENt` part of the `QUEStionable` and the `OPERation` registers to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

Setting parameters:

<*cls>	string

Usage: Setting only

***IDN?**

IDeNtification query.

Queries the identificaion of the R&S EX-IQ-BOX.

The query returns "Rohde&Schwarz,<device type>,<serial number>,<firmware version>". The information is returned at fixed positions in a comma-separated string.

Return values:

<*idn >	string

Example:	`*IDN?`
	query instrument identification.
	`Rohde&Schwarz,<EX-IQ-BOX>,<101211>,`
	`<000.00.01-0>`

Usage:	Query only

***OPC** <*opc >

OPeration Complete

Sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request. The query form writes a "1" into the output buffer as soon as all preceding commands have been executed. This is used for command synchronization.

Parameters:

<*opc >	string

***OPT?**

OPTion identification query.

Queries the options included in the R&S EX-IQ-BOX. For a list of all available options and their description refer to chapter 3.2.2, "Options", on page 22 or the R&S website of the R&S EX-IQ-BOX: http://www.rohde-schwarz.com/product/EX-IQ-Box.html.

Return values:

<*opt >	string The query returns a list of options. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed.

Example:	`*OPT ?`
	query installed options.
	`EXBOX-B85,EXBOX-K90,EXBOX-K91,EXBOX-K94,`
	`EXBOX-K240`

Usage:	Query only

***RCL** <*rcl>

ReCaLl calls up the instrument settings from an intermediate memory identified by the specified number. The instrument settings can be stored to this memory using the command `*SAV` on page 294 with the associated number.

It also activates the instrument settings which are stored in a file and loaded using the `MMEMory:LOAD <number>, <file_name.extension>` command.

Setting parameters:

<*rcl>	string
Usage:	Setting only

***RST** <*rst>

ReSeT

Sets the R&S EX-IQ-BOX to a defined default status. It is equivalent to `SYSTem:PRESet`. The default settings are indicated in the description of commands.

Setting parameters:

<*rst>	string
Usage:	Setting only

***SAV** <*sav>

SAVe stores the current instrument settings under the specified number in an intermediate memory. The settings can be recalled using the command `*RCL` with the associated number.

To transfer the stored instrument settings in a file, use the command `MMEMory:STORe:STATe`.

Setting parameters:

<*sav>	string
Usage:	Setting only

ERR?

Return values:

<Err >	string **0** `No error`, i.e the error queue is empty. **positive value** Positive error numbers denote device-specific errors. **negative value** Negative error numbers denote error messages defined by SCPI.

Example:	`ERR?` queries all entries in the error queue. Response: `0, no error` no errors have occurred since the error queue was last read out.
Usage:	Query only

9.2 R&S EX-IQ-BOX - Remote Control Commands

The following subsystems relate to the R&S EX-IQ-BOX and R&S instruments, as well as some general functions. The specific commands are described in the associated subsystems.

9.2.1 Device Subsystem

The `DEVice` subsystem contains remote control commands of the device manager dialog of R&S DigIConf.

[:SOURce<hw>]:EBOX:DEVice:CATalog?

The command queries the R&S EX-IQ-BOXes operated by R&S DigIConf. The query returns the serial numbers in a comma-separated string.

Return values:

<Catalog>	string

Example:	`SOUR:EBOX:CAT?`
	list the connected R&S EX-IQ-BOXes.
	Response:
	`900002, 900010`
	currently the R&S EX-IQ-BOXes `90002` and **90010** are connected.

Usage:	Query only

[:SOURce<hw>]:EBOX:DEVice:CONTroller?

The command queries the controller type the R&S EX-IQ-BOX is equipped with.

Return values:

<cnt>	string
Example:	`SOUR:EBOX:DEV:CONT?` shows the controller type of the R&S EX-IQ-BOX.
Usage:	Query only

[:SOURce<hw>]:EBOX:DEVice:CPLD?

The command queries the version of CPLD (**C**omplex **P**rogrammable **L**ogic **D**evice). This command is model specific and applies to R&S EX-IQ-BOX1409.5505.02.

Return values:

<cpld>	string
Example:	`SOUR:EBOX:DEV:CPLD?` query the CPLD of the R&S EX-IQ-BOX.
Usage:	Query only

[:SOURce<hw>]:EBOX:DEVice:FPG:BASe?

The command queries the version of the FPGA (**F**ield **P**rogrammable **G**ate **A**rray) basic design of the R&S EX-IQ-BOX.

Return values:

<base>	string
Example:	`SOUR:EBOX:DEV:FPG:BAS?` query the FPGA version of the R&S EX-IQ-BOX.
Usage:	Query only

[:SOURce<hw>]:EBOX:DEVice:FPG:BOB?

The command queries the FPGA (**F**ield **P**rogrammable **G**ate **A**rray) version of the breakout board connected to the R&S EX-IQ-BOX.

Return values:

<bob>	string
Example:	`SOURce:EBOX:DEV:FPG:BOB?` query the FPGA of the breakout board.
Usage:	Query only

[:SOURce<hw>]:EBOX:DEVice:FPG:DIGio?

The command queries the version of the digital interface standard. This command is model specific and applies to R&S EX-IQ-BOX 1409.5505K04.

Return values:

<fpga>	string
Example:	`SOUR:EBOX:DEV:FPG:DIG?` query the digital interface standard.
Usage:	Query only

[:SOURce<hw>]:EBOX:DEVice:PART <part>

The command queries the part number of the R&S EX-IQ-BOX.

Parameters:

<part>	string

Example:	`SOUR:EBOX:DEV:PART?`
	query the part number of the selected R&S EX-IQ-BOX.
	Response:
	`101211`
	currently the R&S EX-IQ-BOX with part number `101211` is connected.

[:SOURce<hw>]:EBOX:DEVice:PPCVersion?

The command queries the R&S EX-IQ-BOX PPC firmware version, i.e. the version of the built-in power PC.

Return values:

<ver>	string
Example:	`SOUR:EBOX:DEV:PPCV?` query version of the PPC.
Usage:	Query only

[:SOURce]:EBOX:DEVice:BOARd:PART?

The command queries the part number of the R&S EX-IQ-BOX´s internal board.

Return values:

<pn>	string

Example: `SOUR:EBOX:DEV:BOAR:PART?`
query the part number.

Usage: Query only

[:SOURce]:EBOX:DEVice:BOARd:REVision?

The command queries the revision number of the R&S EX-IQ-BOX´s internal board.

Return values:

<rev>	string

Example: `SOUR:EBOX:DEV:BOAR:REV?`
query the board revision number.

Usage: Query only

[:SOURce]:EBOX:DEVice:BOARd:SERial?

The command queries the serial number of the R&S EX-IQ-BOX´s internal board.

Return values:

<serial>	string

Example: `SOUR:EBOX:DEV:BOAR:SER?`
query the board serial number.

Usage: Query only

[:SOURce]:EBOX:DEVice:BOB:REVision?

The command queries the revision number of the connected breakout baord.

Return values:

<rev>	string

Example: `SOUR:EBOX:DEV:BOB:REV?`
query the breakout board revision number.

Usage: Query only

[:SOURce]:EBOX:DEVice:BOB:SERial?

The command queries the serial number of the connected breakout board.

Return values:

<sn>	string

Example: `SOUR:EBOX:DEV:BOB:SER?`
query the breakout board serial number.

Usage: Query only

[:SOURce]:EBOX:DEVice:BOB:TYPe?

The command queries the type of the connected breakout board.

Return values:

<typ>	string
Example:	`SOUR:EBOX:DEV:BOB:TYP?` query the breakpout board type.
Usage:	Query only

[:SOURce]:BBIN:EXTernal:FIRMware:SUPPorted?
[:SOURce<hw>]:IQ:OUTPut:EXTernal:FIRMware:SUPPorted?
[:SOURce<hw>]:EBOX:USER:FIRMware:SUPPorted?
[:SOURce]:EBOX:DEVice:FIRMware:SUPPorted?

The command queries the firmware available for the R&S EX-IQ-BOX 1407.5505.02.

Return values:

<Supported>	string
Example:	`SOUR:EBOX:DEV:FIRM:SUPP?` check the supported firmware.
Usage:	Query only

[:SOURce<hw>]:EBOX:DEVice:SELect <Select>

Select a currently connected R&S EX-IQ-BOX by means of its serial number.

Parameters:

<Select>	float
Example:	`SOUR:EBOX:DEV:SELect 100112` select the connected R&S EX-IQ-BOX with serial number `'10112`

[:SOURce]:EBOX:DEVice:SERial?

The command queries the serial number of the R&S EX-IQ-BOX.

Return values:

<serial>	string
Example:	`SOUR:EBOX:DEV:SER?` query the R&S EX-IQ-BOX serial number.
Usage:	Query only

9.2.2 Diagnostic Subsystem

The `DIAGnostic` subsystem contains the commands used for instrument diagnosis and servicing. SCPI does not define any `DIAGnostic` commands; the commands listed here are all device-specific. `DIAGnostic` commands are query commands which are not influenced by `*RST`.

:DIAGnostic:EBOX:CATalog?

The command queries the R&S EX-IQ-BOX instruments operated by R&S DigIConf. The query returns the serial numbers in a comma-separated string.

Return values:

<Catalog>	string

Example:	`DIAG:EBOX:CAT?`
	list the connected R&S EX-IQ-BOXes.
	Response:
	`900002, 900010`
	R&S DigIConf currently operates with the R&S EX-IQ-BOXes `90002` and `90010`

Usage:	Query only

:DIAGnostic:EBOX:CPRI:EXECute

The command starts the CPRI test for service purposes, see `:DIAGnostic:EBOX:CPRI:TEST` on page 301 .

Example: `DIAG:EBOX:CPRI:EXEC?`
executes the CPRI diagnostic test.
Response:
`running, finished`

Usage: Event

:DIAGnostic:EBOX:CPRI:TEST?

The command checks the CPRI communication link for service purposes.

Return values:

<Test> 0 | 1 | OFF | ON

*RST: 1

Example: `DIAG:EBOX:CPRI:TEST?`
query the test result of the CPRI link.
Response: `0` = passed, `1` = failed

Usage: Query only

:DIAGnostic:EBOX:CPRI:TEST:STORe <Store>

Saves the test report of the CPRI diagnostic test in a log file. This function is protected and used for service purposes.

Setting parameters:

<Store> string

Example: `MMEM:CDIR "d:/user/diagnostic"`
set the default directory to `d:/user/diagnostic`
`DIAG:EBOX:CPRI:TEST:STOR "CPRITest.log"`
saves the test report in the default directory with file name `CPRITest.log`.

Usage: Setting only

:DIAGnostic:EBOX:LEDTest <state>

The command tests the LEDs of the DigRF breakout board. This function is protected and used for service purposes.

Parameters:

<state> ON | OFF

*RST: OFF

Example: `DIAG:EBOX:LEDT`
start LED test of the R&S EX-IQ-BOX.

:DIAGnostic:EBOX:LVDS:BER?

The command checks the LVDS interface. This function is protected and used for service purposes.

Return values:

<ber>	float
Example:	`DIAG:EBOX:LVDS:BER?` query the results of the LVDS test. Response: `0` = passed, `1` = failed
Usage:	Query only

:DIAGnostic:EBOX:LVDS:DCM?

The command checks the LVDS DCM lock state. This function is protected and used for service purposes.

Return values:

<dcm>	ON | OFF *RST: OFF
Example:	`DIAG:EBOX:LVDS:DCM?` query the state DCM. Response: `0` = locked, `1` = unlocked
Usage:	Query only

:DIAGnostic:EBOX:LVDS:ERRors?

The queries the number of errors in LVDS test. This function is protected and used for service purposes.

Return values:

<err>	float
Example:	`DIAG:EBOX:LVDS:ERR?` counts the errors occured during LVDS test.
Usage:	Query only

:DIAGnostic:EBOX:LVDS:NDATa?

The command zeroes the received bit for the LVDS test. This function is protected and used for service purposes.

Return values:

<dat>	ON | OFF *RST: OFF
Example:	`DIAG:EBOX:LVDS:NDAT?`
Usage:	Query only

:DIAGnostic:EBOX:LVDS:PLL?

The command checks the PLL lock state during LVDS test. This function is protected and used for service purposes.

Return values:

<pll>	ON | OFF
Example:	`DIAG:EBOX:LVDS:PLL?` query the state of the PLL.
Usage:	Query only

:DIAGnostic:EBOX:LVDS:RCV?

The command checks the number of received bits.

Return values:

<received>	float
Example:	`DIAG:EBOX:LVDS:RCV?` count the number of received bits.
Usage:	Query only

:DIAGnostic:EBOX:LVDS:RX|TX:SOURce <source>

The command selects LVDS test source. This function is protected and used for service purposes.

Parameters:

<source>	PRBS | COUNTER
Example:	`DIAG:EBOX:LVDS:TX:SOUR PRBS` test the TX channel with the PRBS signal pattern.

:DIAGnostic:EBOX:LVDS:RX|TX:STATe <state>

The command starts the LVDS test. This function is protected and used for service purposes.

Parameters:

<state>	ON | OFF *RST: OFF
Example:	`DIAG:EBOX:LVDS:TX:STAT ON` start the LVDS test in the TX channel.

:DIAGnostic:EBOX:POINt <point>

The command selects the diagnostic points. This function is protected and used for service purposes.

Parameters:

<point>	UI | U2V5 | AVTT | AVCC_PLL | AVCC_MGT | U1V8 | U24V | GND | VIN | COM3V3 | AUX2V5 | DIV3V3 | CORE1V0 | VCO | GND1 | PPC_VCC_INT | PPC_TEMP | PPC_VCC_AUX

Example: `DIAG:EBOX:POIN UI`

:DIAGnostic:EBOX:POINt:DRF <drfpoint>

The command selects diagnostic points of the DigRF breakout board. This function is protected and used for service purposes.

Parameters:

<drfpoint>	U5VN | U5V | U3V3 | U2V5 | U1V2 | LIN3V5 | LIN2V0N | LIN2V5N | GPIOG0 | GPIOG1 | GPIOG2 | GPIOG3 | GPIOG4 | PLL1 | PLL2 | DIAGV4GTX | USER_SPI | GPIO_EX | DRF112 | DRF3SE | DRF4SE | SYSCLK1 | SYSCLK2 | TEMP | DIAGV3TX1P | DIAGV3TX1N | V3DIFF_TX_VCM | V3DIFF_TX_OFFS | DIAGV4TX1P | DIAGV4TX1N | REF2V5 | GND

Example: `DIAG:EBOX:POIN:DRF SYSCLK1`
selects the CLOCK 1 interface for testing.

:DIAGnostic:EBOX:POINt:DRF:VALue?

The command queries the voltage value at the selected diagnostic point of the DigRF breakout board.

Return values:

<val>	string

Example: `DIAG:EBOX:POIN:DRF:VAL?`
query the voltage value at the diagnostic point.

Usage: Query only

:DIAGnostic:EBOX:POINt:STATe <state>

The command activates the test at the diagnostic points of the R&S EX-IQ-BOX and the DigRF breakout board.

Parameters:

<state>	ON | OFF	
	*RST:	OFF

Example: `DIAG:EBOX:POIN:STAT ON`
starts the test at the diagnostic points.

:DIAGnostic:EBOX:POINt:VALue?

The command queries the voltage value at the selected diagnostic point of the R&S EX-IQ-BOX.

Return values:

<val>	string
Example:	`DIAG:EBOX:POIN:VAL?` query the voltage value at the diagnostic point.
Usage:	Query only

:DIAGnostic:EBOX:SELect <Select>

Select a currently connected R&S EX-IQ-BOX in the chapter 6.1.6.1, "EX-IQ-BOX Device Manager", on page 66 dialog by means of its serial number. This function is protected and used for service purposes.

Parameters:

<Select>	float
Example:	`DIAG:EBOX:SEL 100112` select the connected R&S EX-IQ-BOX with serial number '10112'.

9.2.3 EBOX Subsystem

The `EBOX` subsystem describes all remote-control commands regarding the configuration of the R&S EX-IQ-BOX. Configuration parameters are set via the configuration software R&S DigIConf.

R&S DigIConf may handle up to four R&S EX-IQ-BOX devices simultaneously. Therefore, all commands regarding to the R&S EX-IQ-BOX start with `[:SOURce<hw>:]` in order to select a device.

The numeric suffix `<hw>` to `SOURce` distinguishes the selected R&S EX-IQ-BOX [:SOURce<[1]|2|3|4>:]....

- SOURce[1] = R&S EX-IQ-BOX 1
  If only one R&S EX-IQ-BOX is connected the keyword `SOURce` is optional and can be omitted.
- SOURce2 = R&S EX-IQ-BOX 2 (up to four are possible simultaneously)
  If you work with more devices, the keyword is mandatory, i.e. the command must contain the keyword with suffix.

[:SOURce<hw>]:EBOX:ARB:CATalog?

The command queries the available waveform files in the specified default directory. Only files with the file extension `*.wv` will be listed.

Return values:

<Catalog>	string

Example:	`MMEM:CDIR "d:/user/waveform"`
	set the default directory to `d:/user/waveform`.
	`SOUR:EBOX:ARB:CAT?`
	list out all waveform files in the default directory.
	Response:
	`wav1, wav2`
	the directory contains the configuration files `wav1.wv` and `wav2.wv`.

Usage:	Query only

[:SOURce<hw>]:EBOX:ARB:DELete <Delete>

The command removes a waveform file from the specified directory. Determine the file by adding directory, file name and extension of the file.

Setting parameters:

<Delete>	<file_name> String parameter to specify the name and directory of the file to be removed.
Example:	`SOUR:EBOX:ARB:DEL "D:/USER/wav1.wv"` delete the file `wav1.wv` in the `USER` directory on drive `d:/`.
Usage:	Setting only

[:SOURce<hw>]:EBOX:CATalog?

The command queries the R&S EX-IQ-BOXes operated by R&S DigIConf. The query returns the serial numbers in a comma-separated string.

Return values:

<Catalog>	string

Example:	`SOUR:EBOX:CAT?`
	list the connected R&S EX-IQ-BOXes.
	Response:
	`Undefined, 900002, 900010`
	R&S DigIConf currently operates with the R&S EX-IQ-BOXes `90002` and `90010`.

Usage:	Query only

[:SOURce<hw>]:EBOX:COUNt <Count>

The command queries / sets the number of connected R&S EX-IQ-BOXes.

Parameters:

<Count>	integer Range: 1 to 4

Example: `SOUR:EBOX:COUN?`
Response: `2`
currently two devices are connected.

[:SOURce<hw>]:EBOX:OPT <Opt>

The command queries the options installed on the R&S EX-IQ-BOX. The query returns a list of options in a comma-separated string.

Parameters:

<Opt>	string

Example: `SOUR:EBOX:OPT?`
check the installed options.
Response: `EXBOX-B85, EXBOX-K10, EXBOX-K11, EXBOX-K90, EXBOX-K242, ...`

[:SOURce<hw>]:EBOX:SELect <Select>

Select a currently connected R&S EX-IQ-BOX by means of its serial number.

Parameters:

<Select>	float

Example: `SOUR:EBOX:DEV:SELect 100112`
select the connected R&S EX-IQ-BOX with serial number `10112`.

[:SOURce<hw>]:EBOX:STATe?

Queries the current state of the R&S EX-IQ-BOX. The state can only be activated with commands switching on a transmission protocol, e.g. `EBOX:USER:STAT ON`.

Return values:

<State>	OFF | ON *RST: OFF

Example: `SOUR1:EBOX:STAT?`
check whether a standard is active.

Usage: Query only

9.2.4 INSTrument Subsystem

The `INStrument` subsystem contains remote control commands to query the interface and identity of connected R&S instruments.

The numeric suffix `INST<ch>` distinguishes between the instruments connected to the R&S EX-IQ-BOX. If only one R&S instrument is connected the suffix `INST[1]` is optional and can be omitted.

[:SOURce<hw>]:EBOX:INST<ch>:NAME?

Queries type and serial number of an R&S instrument connected to the R&S EX-IQ-BOX.

Return values:

<Name>	string
Example:	`SOUR2:EBOX:INST1:NAME?` query the symbolic name of the connected instrument. Response: `AMU 200A (100201)` the second connected instrument is an `R&S AMU200A` with serial number `100201`.
Usage:	Query only

[:SOURce<hw>]:EBOX:INST<ch>:PORT?

Queries the instrument's port the R&S EX-IQ-BOX is connected to. The response differs depending on the connected instrument type. In a two-path instrument the path is also given.

Return values:

<Port>	string
Example:	`SOUR2:EBOX:INST2:PORT?` query the digital interface of the instrument to which the R&S EX-IQ-BOX is connected. Response: `In`, `Out A`
Usage:	Query only

[:SOURce<hw>]:EBOX:INST<ch>:SERial?

Queries serial number of the R&S instrument connected to the R&S EX-IQ-BOX.

Return values:

<Serial>	string
Example:	`SOUR1:EBOX:INST1:TYPE?` query the serial number of the instrument connected the R&S EX-IQ-BOX. Response: `100201` the serial number of the first connected instrument is `100201`.

Usage: Query only

[:SOURce<hw>]:EBOX:INST<ch>:TYPE?

Queries the type of an R&S instrument connected to the R&S EX-IQ-BOX.

Return values:

<Type>	string

Example: `SOUR1:EBOX:INST1:TYPE?`
query the type of the connected instrument.
Response: `AMU 200A`
the first connected instrument is an `R&S AMU200A`.

Usage: Query only

9.2.5 MMEMory Subsystem

The MMEMory subsystem (Mass Memory) contains the commands for managing files and directories as well as for loading and storing complete instrument settings in files.

The various drives can be selected using the "mass storage unit specifier " <msus>. The internal hard disk is selected with `D:\`, and a memory stick which is inserted at the USB interface is selected with `E:\`. The resources of a network can also be selected with <msus> in the syntax of the respective network, e.g. using the UNC format (Universal Naming Convention): `\\server\share`.

The default drive is determined using the command `MMEMory:MSIS <msus>`.

The `C:` drive is a protected system drive. This drive should not be accessed. Reconstruction of the system partition will not be possible without loss of data..

9.2.5.1 File Naming Conventions

To enable files in different file systems to be used, the following file naming conventions should be observed.

The file name can be of any length and no distinction is made between uppercase and lowercase letters. The file and the optional file extension are separated by a dot. All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the file name). Where possible, special characters should not be used. Use of the slashes "\" and "/" should be avoided since they are used in file paths. A number of names are reserved by the operating system, e.g. CLOCK$, CON, AUX, COM1...COM4,

LPT1...LPT3, NUL and PRN.

In the R&S DigIConf all files in which lists and settings are stored are given a characteristic extension.

The extension is separated from the actual file name by a dot (see chapter 9.2.5.2, "Extensions for User Files", on page 310 for an overview the file types).

The two characters `*` and `?` function as wildcards, i.e. they are used for selecting several files. The `?` character represents exactly one character, while the `*` character represents all characters up to the end of the file name. `*.*` therefore stands for all the files in a directory.

When used in conjunction with the commands, the parameter `<file_name>` is specified as a string parameter with quotation marks. It can contain either the complete path including the drive, only the path and file name, or only the file name. The file name must include the file extension. The same applies for the parameters `<directory_name>` and `<path>`.

Depending on how much information is provided, either the values specified in the parameter or the values specified with the commands `MMEM:MSIS` (default drive) and `MMEM:CDIR` (default directory) are used for the path and drive setting in the commands.

Before the instrument settings can be stored in a file, they have to be stored in an intermediate memory using common command *SAV <number>. The specified number is subsequently used in the `MMEM:STOR:STATe<number>`, `<file>` command. Also, subsequently to loading a file with instrument settings with command `MMEM:LOAD:STAT <number>`, `<file>`, these settings have to be activated with the common command `*RCL <number>`.

Example:

In this example, the current instrument setting is always stored in the file `test1.savrcl` in the directory `user` on the internal hard disk.

```
*SAV 4
```

```
MMEM:STOR:STAT 4,"d:\user\test1.savrcl"
```

If the complete path including the drive letter is specified, the file is stored in the specified path.

```
MMEM:MSIS 'D:'*SAV 4
```

```
MMEM:STOR:STAT 4,"\user\test1.savrcl"
```

If the parameter only contains the path and file name, the default drive set with the `MMEM:MSIS` command is effective.

9.2.5.2 Extensions for User Files

The following table list all available file extensions for user files. The currently available files on the instrument depend on the installed options.

Table 9-1: List of the automatically assigned file extensions in R&S DiglConf

Function/Digital Standard	List type	Contents	File suffix
CPRI	Settings	CPRI configuration, vendor data included Instrument settings	`*.cpri`
	Waveform	Waveforms and multi segment waveforms	`*.wv`

Function/Digital Standard	List type	Contents	File suffix
DigRF	Settings	DigRF configuration	`*.digrf`
	Data streams	I/Q data streams	`*.wv`
		Raw data streams	`*.drf3` `*.drf4`
	Scripts	DigRF scipts files	`*.p`
		compiled script files	`*.amx`
		script parameters	`*.par`
		user memory data	`*.mem`
User Defined	Settings	User Defined Protocol configuration	`*.iqbox`
Configuration Software	Settings	R&S DigIConf settings	`*.savrcl`

9.2.5.3 Remote Control Commands

MMEMory:CATalog?

Returns the content of the current or a specified directory.

Return values:

<Catalog>	string String parameter to specify the directory. If the direcory is omitted, the command queries the content of the current directory, queried with `MMEM:CDIR` command.
<path>	<used_memory>,<free_memory>,<file_name>,<file_entry>,... **<used_memory>** Total amount of storage currently used in the directory, in bytes. **<free_memory>** Total amount of storage available in the directory, in bytes. **<file_entry>** All files of the directory are listed with their file name, format and size in bytes.

Example: `MMEM:CAT?`

Usage: Query only

MMEMory:CDIRectory <Cdirectory>

Changes the default directory for mass memory storage. The directory is used for all subsequent `MMEM` commands if no path is specified with them. It is also possible to change to a higher directory using two dots '..' .

Setting parameters:

<Cdirectory>	<directory_name>
Example:	`MMEM:CDIR  'var/user'*SAV 4`
Usage:	Setting only

MMEMory:DELete <Delete>

Removes a file from the specified directory.

Parameters:

<Delete>	<file_name> String parameter to specify the name and directry of the file to be removed.
Example:	`MMEM:DEL "c:/temp/test"`

MMEMory:LOAD:STATe <State>

Loads the specified file stored under the specified name in an internal memory.

After the file has been loaded, the instrument setting must be activated using an `*RCL` command.

Parameters:

<sav_rcl_state_number>	Determines to the specific <number> to be used with the `*RCL` command, e.g. `*RCL 4`.
<file_name>	String parameter to specify the file name with extension `*.savrcl`.

Setting parameters:

<State>	string
Example:	`MMEM:STOR:STAT 4,"test.savrcl"`
Usage:	Setting only

MMEMory:MDIRectory <Mdirectory>

Creates a new subdirectory for mass memory storage in the specified directory. If no directory is specified, a subdirectory is created in the default directory. This command can also be used to create a directory tree.

Setting parameters:

<Mdirectory>	string

Example:	`MMEM:MDIR "d:/test"`
Usage:	Setting only

MMEMory:RDIRectory <Rdirectory>

Removes an existing directory from the mass memory storage system. If no directory is specified, the subdirectory with the specified name is deleted in the default directory.

Setting parameters:

<Rdirectory>	string String parameter to specify the directory to be deleted.
Example:	`MMEM:RDIR "d:/test"`
Usage:	Setting only

MMEMory:STORe:STATe <State>

Stores the current instrument setting in the specified file.

The instrument setting must first be stored in an internal memory with the same number using the common command `*SAV`.

Parameters:

<sav_rcl_state_number>	Corresponds to the specific <number> defined with the `*SAV` command, e.g. `*SAV 4`.
<file_name>	String parameter to specify the file name with extension `*.savrcl`.

Setting parameters:

<State>	string String parameter to specify the file name with extension `*.savrcl`.
Example:	`MMEM:STOR:STAT 4,"d:\user\test.savrcl"`
Usage:	Setting only

9.3 User Defined - Remote Control Commands

This chapter describes all remote-control commands for user defined applications, including their parameters and value ranges.

Based on the R&S DigIConf commands, the description is structured according to the SCPI subsystems. Within each chapter, the order is alphabetical.

As a special feature you can find most of the commands summarized in a set of commands. This is required for test setups of the R&S EX-IQ-BOX, modell 1409.5505.02, when not controlled by R&S DigIConf.

A command set defines first the commands of the R&S instruments. See also chapter 9.3.1, "Explanation to the Device Specific SCPI Syntax", on page 314 for more details.

Specific properties that relate to a particular instrument, are clearly expressed.

The command for R&S DigIConf is always listed as last command, thus directly with the explanation.

9.3.1 Explanation to the Device Specific SCPI Syntax

This chapter briefly describes the variants in SCPI notation, depending on the controlling device.

Basically, if you run an R&S EX-IQ-BOX, model 1409.5505.02 directly with an R&S instrument, you have to set the same parameters as if controlled by R&S DigIConf. Since the devices communicate directly with each other, however, the transmission direction must be determined within the command. I.e. there are separate commands defined for the transmission and the receiver mode.

The following example shows you the notation to use, according to the controlling device.

The `<placeholder>` represents the variants in notation.

Example:

`<placeholder>:LOGic:TYPE`

The command in this example selects the digital signaling system used for transmitting the baseband signal from or to the DUT.

Table 9-2: Command Variants

SCPI	used with ...	Transmission path
`[:SOURce<hw>]:EBOX:USER:LOGic[:TYPE]`	R&S DigIConf	determined by a separate command
`[SOURce<[1]|2>:]BBIN:EXTernal:LOGic[:TYPE]`	R&S Signal Generators	digital IQ IN (BBIN)
`[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:LOGic[:TYPE]`	R&S Signal Generators	digital IQ OUT (IQ OUT)
`[SOURce:]RECeiver:LOGic[:TYPE]`	R&S Signal Analyzer	digital IQ IN (receiver)
`[SOURce:]TRANsmitter:LOGic[:TYPE]`	R&S Signal Analyzer	digital IQ OUT (transmitter)

9.3.2 User Defined - Main Control Commands

The **main controls** commands provide the selection of the transmission "Direction", and commands as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading previously defined settings.

[:SOURce]:BBIN:EXTernal:DIRection <Direction>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DIRection <Direction>
[:SOURce<hw>]:EBOX:USER:DIRection <Direction>

Note: This command applies to R&S Signal Generators and R&S DigIConf. Setting the direction of transmission for analyzers, refer to `[:SOURce]:RECeiver:SENDto` on page 317 or `SOURce:TRANsmitter:SENDto` on page 317.

The command determines the direction of signal transmission from the DUT to the R&S EX-IQ-BOXor vice versa.

Setting direction and activating transmission depends on the R&S Device:

- **R&S DigIConf**
  Signal direction is selected in the "Direction" field of the R&S EX-IQ-BOX "User Defined" settings dialog. Select "Transmitter/Receiver" in the list.
  The transmission is activated by switching On the "State" button.
- R&S signal analyzers
  Signal direction is selected in the "Select Type" field of the "EXIQ-Box Settings" dialog. Select "Transmitter/Receiver" in the drop down list, as described in chapter 6.1.1.6, "Dialogs", on page 58
- R&S signal generators
  The direction of signal transmission is determined by the connection at the interface, either DIGITAL IQ IN or OUT. The parameters are provided respectively in the "EX-IQ-BOX BBIN" and "EX-IQ-BOX BBOUT" dialogs. Therefore, the "Direction" field is not needed.

Signal transmission is activated with "State".

Parameters:

<Direction>	RECeiver | TRANsmitter **RECeiver** The connected R&S EX-IQ-BOX receives the signal from the DUT and forwards it to an R&S instrument. **TRANsmitter (Output)** The R&S EX-IQ-BOX receives data from an R&S instrument and sends it to the DUT. The baseband signal is transmitted in Single Data Rate (SDR) mode from the DUT to the R&S EX-IQ-BOX or vice versa. The data transmission is triggered by the rising edge of the data clock.

Example:

```
EBOX:USER:DIR TRAN
```

set the R&S EX-IQ-BOX to transmit the data to the DUT.

[:SOURce]:BBIN:EXTernal:LOGic[:TYPE] <Type>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:LOGic[:TYPE] <Type>
SOURce:TRANsmitter:LOGictype <Type>
SOURce:RECeiver:LOGictype <Type>
[:SOURce<hw>]:EBOX:USER:LOGic[:TYPE] <Type>

Selects the signaling system used from the DUT for the baseband signal.

Note:

Avoid connector overload

The type of the electrical signals are based on various logic types (TTL or CMOS standard) performing different logic levels. The logic type of the DUT connected must be compatible to the logic type of the R&S EX-IQ-BOX. Inappropriate logic types may cause damage to the R&S EX-IQ-BOX and/or to the DUT.

Note: SCPI notation varies

The SCPI notation varies, when you remotely control the R&S EX-IQ-BOX on R&S EX-IQ-BOX or R&S signal generators and R&S signal analyzers, as described below.

Parameters:

<Type>	LVDS | LVTTL | CMOS33 | CMOS25 | CMOS18 | CMOS15 | CMOS12, or LVDS | LVTTL | CM33 | CM25 | CM18 | CM15 | CM12, respectively | SSI12 | SI18 *RST: CMOS33
CMOS33...	Enter the respective string, if you run R&S DigIConf or R&S signal generators.
CM33...	Select the logic type as shown, when you remotely control R&S signal analyzers. **LVDS** The signal is transmitted by using the signaling system LVDS (**L**ow **V**oltage **D**ifferential **S**ignaling). **LVTTL** The signal is transmitted in LVTTL technology (**L**ow **V**oltage **Tr**ansistor **T**ransistor **L**ogic) with 3.3 V voltage level. **CMOSxx / CMxx** The signal is transmitted by using the CMOS technology (**C**omplementary **M**etal **O**xide **S**emiconductor technology). xx represents the according voltage values. Available level values: 3.3 V, 2.5 V, 1.8 V, 1.5 V, 1.2 V. SSIxx (R&S instruments only) The signal is transmitted by using the SSI technology (**S**erial **S**ynchronuos **I**nterface). **Note:** SSI signal are only supported by R&S signal generators and R&S signal analyzers. Due to the very specific application, it is listed here for completeness, but not described explicitly. Voltage levels are 1.5 V and 1.8 V.

[:SOURce<hw>]:EBOX:USER:PRESet

Set all parameters to default values. Refer to table Preset - User defined default settings which contains an overview of the most important default settings.

Example: `SOUR1:EBOX:USER:PRES`
setup all User Defined parameters to the default value.

Usage: Event

[:SOURce]:RECeiver:SENDto
SOURce:TRANsmitter:SENDto

The command determines the direction of signal transmission from the R&S EX-IQ-BOX to the DUT.

Example: `SOUR:TRAN:SEND`
The connected R&S EX-IQ-BOX receives data from an R&S signal analyzer and transmits this data to the DUT.

[:SOURce<hw>]:EBOX:USER:STATe <State>

Activates signal transmission.

This function applies to R&S DigIConf, since R&S signal generators and analyzers start signal transmission directly in the instrument.

Note: Data transmission requires that the respective breakout board is connected.

Parameters:
<State> OFF | ON
*RST: OFF

Example: `EBOX:USER:STAT ON`
switch on signal data transmission.

9.3.3 Settings Subsystem

The `USER:SETTings` subsystem contains the commands for loading and storing application settings in files.

[:SOURce<hw>]:EBOX:USER:SETTing:CATalog?

Queries the available settings files in the specified directory. Settings files are used to store current application settings. Only files with the file extension `*.iqbox` will be listed. Access to the files via remote is possible using the commands of the `MEMM` subsystem.

Return values:

<Catalog>	string String parameter to select the directory where settings files are stored.

Example:	`MEMM:CDIR "d:\DigIConf\Settings\User"`
	Set the default directory and path to `d:\DigIConf\Settings\User`.
	`SOUR1:EBOX:USER:SETT:CAT?`
	read out all settings files of the `DigIConf\Settings\User` directory on drive `d:`

Usage:	Query only

[:SOURce<hw>]:EBOX:USER:SETTing:DELete <Delete>

The command removes a settings file from the specified directory. Determine the file by adding directory, file name and extension of the file.

Setting parameters:

<Delete>	<directory>, <file_name>, <ext> Determine the file to be deleted by adding directory, file name and the file extension (`*.iqbox`).
Example:	`SOUR1:EBOX:USER:SETT:DEL "d:\DigIConf\Settings\User\converter_test.iqbox"` delete the file `converter_test.iqbox`.
Usage:	Setting only

[:SOURce<hw>]:EBOX:USER:SETTing:LOAD <Load>

The command loads a previously saved user defined configuration. Define directory and file name, R&S DigIConf automatically assigns the file extension `*.iqbox`.

Setting parameters:

<Load>	<directory>, <file_name> String parameter to determine the target directory and the file-name for loading the settings file.
Example:	`SOUR1:EBOX:USER:SETT:LOAD "d:\DigIConf\Settings\User\converter_test"` load the settings file `converter_test.iqbox` from the directory `d:\DigIConf\Settings\User`.
Usage:	Setting only

[:SOURce<hw>]:EBOX:USER:SETTing:STORe <Store>

Saves the current signal configuration of user defined mode. Specify the directory and file name. R&S DigIConf automatically assigns the file extension `*.iqbox` to user defined configuration files.

Setting parameters:

<Store>	<directory>, <file_name> String parameter to determine the target directory and the filename for storing the settings file.
Example:	`SOUR1:EBOX:USER:SETT:STOR "d:\DigIConf\Settings\User\converter_test"` save the settings in the file `converter_test.iqbox` in the directory `d:\DigIConf\Settings\User`.
Usage:	Setting only

9.3.4 Protocol Commands

This section contains the commands for setting the parameters of user defined transmission protocols.

[:SOURce]:BBIN:EXTernal:DRATe <Drate>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DRATe <Drate>
SOURce:TRANsmitter:DRATe <Drate>

SOURce:RECeiver:DRATe <Drate>
[:SOURce<hw>]:EBOX:USER:DRATe <Drate>

Sets the data rate mode of the R&S EX-IQ-BOX for receiving/sending a baseband signal from/to an external device (DUT).

Parameters:

<Drate>	SDR | DDR **SDR** Transmits the baseband signal in **S**ingle **D**ata **R**ate (SDR) mode from the DUT to the R&S EX-IQ-BOX or vice versa. The rising eddge of the clock signal triggers data transmisison. **DDR** Transmits the baseband signal in **D**ouble **D**ata **R**ate (SDR) mode from the DUT to the R&S EX-IQ-BOX or vice versa. The rising and the falling edge of the clock signal trigger data transmission (double speed transfer). *RST: SDR

Example: `SOUR1:EBOX:USER:DRAT SDR`
sets the data rate mode to "Single".

[:SOURce]:BBIN:EXTernal:FORMat <Format>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:FORMat <Format>
SOURce:TRANsmitter:FORMat <Format>
SOURce:RECeiver:FORMat <Format>
[:SOURce<hw>]:EBOX:USER:FORMat <Format>

Sets the signal transmission protocol of the R&S EX-IQ-BOX for receiving/sending a baseband signal from/to an external device (DUT) via the user interface of the R&S EX-IQ-BOX.

Parameters:

<Format>	SERial | PARallel **SERial** Transmits each sample serially, i.e. "bitwise" from the DUT to the R&S EX-IQ-BOX or vice vera. In sereial mode, I and Q data are sent via the input and output pins IO and QO, respectively. **PARallel** Transmits parallel, i.e. "wordwise" from the DUT to the R&S EX-IQ-BOX or vice versa. The input and output pin assignment depends on the bits alignment and the bit order settings. *RST: PARallel

Example: `SOUR1:EBOX:USER:FORM SER`
sets the transmission protocol of the R&S EX-IQ-BOX to "serial".

[:SOURce]:BBIN:EXTernal:ILEaving <Ileaving>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:ILEaving <Ileaving>

SOURce:TRANsmitter:ILEaving
SOURce:RECeiver:ILEaving
[:SOURce<hw>]:EBOX:USER:ILEaving <Ileaving>

Switches on interleaving and selects the interleaving mode.

Depending on the interleaving settings, the baseband signal is either sent simultaneously or in I/Q or Q/I order from the DUT to the R&S EX-IQ-BOX or vice versa.

Parameters:

<Ileaving> OFF | IQ | QI

OFF
Transmits the baseband signal without not Interleaved on the I and Q data lines.

IQ
Transtmits the baseband signal on the I data line starting with I data, i.e. "I/Q Interleaved".
Serial transmission, SDR: The strobe signal UI_RES1 lasts for 2 clock cycles. The first clock cycle triggers the I data, the second the Q data.
Serial transmission, DDR: The strobe signal (UI_Res1) lasts for 1 clock cycle. The rising edge triggers the I data, the falling edge triggers the Q data.
Parallel transmission, SDR: The I marker output at the Reserved1 pin UI_RES1 of the user interface marks the I data.
Parallel transmission, DDR: The rising edge of the clock signal triggers the I data, the falling edge the Q data.

QI
Transmits the baseband signal on the I data line starting with Q data, i.e. "Q/I Interleaved". With interchanged order of the I and Q data the I/Q signal is transferred similarly as described under I/Q Interleaved.

*RST: OFF

Example: `SOUR1:EBOX:USER:ILE IQ`
sets the interleaving mode to "IQ".

[:SOURce]:BBIN:EXTernal:SRATe?
[:SOURce<hw>]:IQ:OUTPut:EXTernal:SRATe?
SOURce:TRANsmitter:SRATe
SOURce:RECeiver:SRATe
[:SOURce<hw>]:EBOX:USER:SRATe?

Note: This command refers to R&S DigIConf and R&S Signal Generators.

This command queries the current sample rate of the external digital baseband signal.

Return values:

<Srate> float

Example: `SOUR1:EBOX:USER:SRAT?`

queries the "sample rate" of the externally applied baseband signal.

Usage: Query only

9.3.5 Clock Subsystem

The `USER:CLOCk` subsystem contains the commands for configuration of the clock signal, and the corresponding output and input connectors.

[:SOURce]:BBIN:EXTernal:CLOCk:PHASe <Phase>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:CLOCk:PHASe <Phase>
SOURce:TRANsmitter:CLOCk:PHASe <Phase>
SOURce:RECeiver:CLOCk:PHASe <Phase>
[:SOURce<hw>]:EBOX:USER:CLOCk:PHASe <Phase>

Sets a phase shift of the active clock edge in 90° steps related to the data bits.

Note: SCPI notation varies

The SCPI notation differs between the commands of R&S generators, R&S DigIConf and the R&S analyzers, as described below.

Parameters:

<Phase>	0 | 90 | 180 | 270, or P0 | P90 | P180 | P270, respectively *RST: 0
0 | 90 | 180 | 270	Enter the value for the phase shift of the clock signal, if you remotely control R&S DigIConf or R&S signal generators.
P0 | P90 | P180 | P270	Enter the value with `P`, when you remotely control R&S signal analyzers.

Example:

```
SOUR1:EBOX:USER:CLOC:PHAS 180
```

define a phase shift of 180 degree for the clock edge.

[:SOURce]:BBIN:EXTernal:CLOCk:POLarity <Polarity>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:CLOCk:POLarity <Polarity>
SOURce:TRANsmitter:CLOCk:POLarity <Polarity>
SOURce:RECeiver:CLOCk:POLarity <Polarity>
[:SOURce<hw>]:EBOX:USER:CLOCk:POLarity <Polarity>

Sets the clock polarity of the active clock edge for triggering the signal transmission.

Note: Setting the clock polarity negative is equivalent to setting the clock phase to 180°.

Parameters:

<Polarity> POSitive | NEGative

Positive
Activates the rising edge of the clock signal.

Negative
Activates the falling edge of the clock signal.

*RST: POSitive

Example:

```
SOUR1:EBOX:USER:CLOC:POL NEG
```

sets negative polarity.

[:SOURce]:BBIN:EXTernal:CLOCk:RATE <Rate>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:CLOCk:RATE <Rate>
SOURce:TRANsmitter:CLOCk:RATE <Rate>

SOURce:RECeiver:CLOCk:RATE <Rate>
[:SOURce<hw>]:EBOX:USER:CLOCk:RATE <Rate>

Sets/queries the clock rate (frequency) for signal transmission between the R&S EX-IQ-BOX and the external device (DUT). Depending on the logic type and the clock source the clock rate range varies).

$$f_{CLK} = \frac{f_s \cdot WS \cdot INT}{DDR \cdot SCR}$$

Fig. 9-1: User defined > Clock rate

f_{clk} = clock rate
f_s = sample rate
WS = Word size
INT = Interleaving mode
DDR = double rata rate
SCR = sample/clock rate ratio

		Value range	
f_s =	Sample rate	1 kHz ... 100 MHz	
f_{clk} ==	Clock rate	**LVTTL**: 1 (25) kHz - 100 MHz*)	**LVDS**: 1 (25) kHz - 400 MHz*)
WS ==	Word size	4 ... 18 (serial mode)	1 (parallel mode)
Int ==	Interleaving mode	1 (non interleaved)	2 (I/Q and Q/I interleaved)
DDR ==	Double data rate	1 (SDR)	2 (DDR)
SCR ==	Sample/Clock rate ratio	1, 4/5, 2/5, 1/5, 1/10, 1/20	
*) 1 kHz represents the internal clock source, fed in from the R&S Instrument, 25 kHz are given from the external reference at the user interface.			

Note: The value range of the clock rate depends on **Protocol**, **Logic Type** and **Signal Type** settings.

Parameters:

<Rate> float

Range: 1 kHz to 400 MHz
*RST: 10 MHz

Example: `SOUR1:EBOX:USER:CLOC:RATE?`

query the current frequency of the clock signal of the R&S EX-IQ-BOX.

`SOUR1:EBOX:USER:CLOC:RATE 10MHZ`

set the clock rate of the R&S EX-IQ-BOX to 10 MHz.

[:SOURce<hw>]:EBOX:USER:CLOCk:REFerence:FREQuency <Frequency>

Note: This command applies to R&S DigIConf and is relevant for the internal clock source.

Defines the frequency value of the reference clock.

The R&S EX-IQ-BOX supports different reference frequencies to be input at REF IN. This value must be set on the frequency currently supplied.

Parameters:

<Frequency>	5MHZ | 10MHZ | 13MHZ *RST: 10 MHz

Example: `SOUR1:EBOX:USER:CLOC:RATE 13MHZ`
set the reference frequency to "13 MHz":

[:SOURce<hw>]:EBOX:USER:CLOCk:REFerence:VALue?

Queries the value of the clock signal at REF IN.

Return values:

<RefVal>	float

Example: `SOUR1:EBOX:USER:CLOC:REF:VAL?`
query the clock value.

Usage: Query only

[:SOURce]:BBIN:EXTernal:CLOCk:SKEW:IN <SkewIn>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:CLOCk:SKEW:IN <SkewIn>
SOURce:TRANsmitter:CLOCk:SKEW:IN <SkewIn>
SOURce:RECeiver:CLOCk:SKEW:IN <SkewIn>
[:SOURce<hw>]:EBOX:USER:CLOCk:SKEW:IN <SkewIn>

Sets a time shift of the active clock edge related to the data bits. This feature is used to compensate an internal clock skew which is caused by differences of the clock and data line lengths.

Parameters:

<SkewIn>	float Range: -100.0 ns to 100.0 ns *RST: 0 ns

Example: `SOUR1:EBOX:USER:CLOC:SKEW:IN 2ns`
sets a time shift of 2 ns.

[:SOURce]:BBIN:EXTernal:CLOCk:SKEW:OUT <Skew>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:CLOCk:SKEW:OUT <Skew>
SOURce:TRANsmitter:CLOCk:SKEW:OUT <Skew>
SOURce:RECeiver:CLOCk:SKEW:OUT <Skew>
[:SOURce<hw>]:EBOX:USER:CLOCk:SKEW:OUT <Skew>

Sets a time shift of the active clock edge related to the data bits. This feature is used to compensate an external clock skew which is caused by differences of the clock and data line lengths.

Parameters:

<Skew>	float Range: -5 ns to 5 ns *RST: 0 ns

Example: `SOUR1:EBOX:USER:CLOC:SKEW:OUT 2ns`
sets a time shift of 2 ns.

[:SOURce]:BBIN:EXTernal:CLOCk:SOURce <Source>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:CLOCk:SOURce <Source>
SOURce:TRANsmitter:CLOCk:SOURce <Source>
SOURce:RECeiver:CLOCk:SOURce <Source>
[:SOURce<hw>]:EBOX:USER:CLOCk:SOURce <Source>

Selects the clock source for data transmission. Either the R&S instrument or the external device (DUT) can deliver the reference, irrespective of the transmission path.

Parameters:

<Source> INTernal | EXTernal | REF

INTernal
The BNC reference of the frequency input is used. The R&S EX-IQ-BOX synthesizes the clock and forwards it to the external device.
Note: When using the internal clock frequency, the reference output of the R&S instrument must be connected to the REF IN of the R&S EX-IQ-BOX at the rear panel. The connection can be kept during the entire operation even if an external clock reference is used.

EXTernal
The clock reference is fed in from the external device (DUT) to the user interface of the R&S EX-IQ-BOX.

*RST: REF

Example: `SOUR1:EBOX:USER:CLOC:SOUR EXT`
select the "EXTernal" clock source.

[:SOURce]:BBIN:EXTernal:SCRatio <Scratio>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:SCRatio <Scratio>
SOURce:TRANsmitter:SCRatio <Source>
SOURce:RECeiver:SCRatio <Source>
[:SOURce<hw>]:EBOX:USER:SCRatio <Scratio>

Sets the sample to clock rate ratio in parallel data transmission mode. The parameter characterizes the ratio of the sample rate to the clock rate.

Note: SCPI notation varies

The SCPI notation differs between the commands of R&S generators, R&S DigIConf and the R&S analyzers, as described below.

Parameters:

<Scratio>	SCR1 | SCR4D5 | SCR2D5 | SCR1D5 | SCR1D10 | SCR1D20, or 1 | 0.8 | 0.4 | 0.2 | 0.1 | 0.05, respectively *RST: SCR1
SCR1 | SCR4D5...	Enter the respective string, if you run R&S DigIConf or R&S signal generators. SCR = **S**ample **C**lock rate **R**atio, and **D** represents the decimal point, according to the following values: SCR = 1, 4/5, 2/5, 1/5, 1/10, 1/20
1 | 0.8...	Enter the value numerically, when you remotely control R&S signal analyzers. **1, 4/5, 2/5, 1/5, 1/10, 1/20** Set a sample clock rate ratio. **For SCR < 1:** Dummy samples are added. The signal output SCR_VALID at the Reserved0 pin (UI_RESERVE_P0) of the user interface marks the validity of the data. **Note:** The values of the sample/clock rate depend on the parameter settings of "Word Size", "Interleaving" and "Data Rate" (see also `[:SOURce<hw>]:EBOX:USER:CLOCk:RATE` on page 324.

Example: `SOUR1:EBOX:USER:SCR SCR4D5`
set the sample clock rate ratio to "4/5".

9.3.6 Data Subsystem

The `USER:DATA` subsystem contains the commands for configuration of the digital I/Q baseband signal.

[:SOURce]:BBIN:EXTernal:DATA:ALIGnment <Alignment>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:ALIGnment <Alignment>
SOURce:TRANsmitter:DATA:ALIGnment <Alignment>
SOURce:RECeiver:DATA:ALIGnment <Alignment>
[:SOURce<hw>]:EBOX:USER:DATA:ALIGnment <Alignment>

Note: This command refers to parallel transmission mode.

Sets the alignment of the data bits on the data lines. Either the MSB or the LSB is mapped firmly to one data line. Depending on the word size the equivalent bit moves to the appropriate data line.

Parameters:

<Alignment>	MSB | LSB **MSB** The MSB (**M**ost **S**ignificant **B**it) is mapped firmly to the same data line and the data line of the LSB varies in dependency of the word size. **LSB** The LSB (**L**ast **S**ignificant **B**it) is mapped firmly to the same data line and the data line of the MSB varies in dependency of the word size. *RST: LSB

Example: `SOUR1:EBOX:USER:DATA:ALIG LSB`
sets the word alignment to "LSB".

[:SOURce]:BBIN:EXTernal:DATA:BORDer <Border>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:BORDer <Border>
SOURce:TRANsmitter:DATA:BORDer <Border>
SOURce:RECeiver:DATA:BORDer <Border>
[:SOURce<hw>]:EBOX:USER:DATA:BORDer <Border>

Sets the order of the data bits. In "Parallel mode", either the LSB or the MSB is transmitted on the first used data line. In "Serial mode" either the LSB or the MSB is transmitted as first bit.

Parameters:

<Border>	MSB | LSB **MSB** Transmits the MSB (**M**ost **S**ignificant **B**it) first. **LSB** Transmits the LSB (**L**ast **S**ignificant **B**it) first. *RST: LSB

Example: `SOUR1:EBOX:USER:DATA:BORD MSB`
sets the data bit order to MSB.

[:SOURce]:BBIN:EXTernal:DATA:NFORmat <Nformat>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:NFORmat <Nformat>
SOURce:TRANsmitter:DATA:NFORmat <Nformat>
SOURce:RECeiver:DATA:NFORmat <Nformat>
[:SOURce<hw>]:EBOX:USER:DATA:NFORmat <Nformat>

Selects the format of the transmitted data.

Allowed number range for word size n Bit:

$-2^{n-1} \leq n \leq +2^{n+1}$

Table 9-3: User defined > Numeric format coding

z		2´s Complement					Binary Offset			
-8		1	0	0	0		0	0	0	0
-7		1	0	0	1		0	0	0	1
-6		1	0	1	0		0	0	1	0
-5		1	0	1	1		0	0	1	1
-4		1	1	0	0		0	1	0	0
-3		1	1	0	1		0	1	0	1
-2		1	1	1	0		0	1	1	0
-1		1	1	1	1		0	1	1	1
0		0	0	0	0		1	0	0	0
1		0	0	0	1		1	0	0	1
2		0	0	1	0		1	0	1	0
3		0	0	1	1		1	0	1	1
4		0	1	0	0		1	1	0	0
5		0	1	0	1		1	1	0	1
6		0	1	1	0		1	1	1	0
7		0	1	1	1		1	1	1	1

Parameters:

<Nformat> TCOMplement | OBINary

TCOMplement
Formats the value of the transmitted data in 2´s complement.
The most significant bit has a value of -2^{n-1}, the bits of lesser significance follow as:
$+2^{n-2} ... +2^{0}$

OBINary
Formats the value of the transmitted data in binary offset.
Example
Adds a binary offset of -2^{n-1} such that the final values are always positive.
$n = 4 \rightarrow -8 \le z < 8$

*RST: TCOMplement

Example: `SOUR1:EBOX:USER:DATA:NFOR TCOM`
sets the numeric format to two´s-complement.

[:SOURce]:BBIN:EXTernal:DATA:POLarity:IQ <Iq>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:POLarity:IQ <Iq>
SOURce:TRANsmitter:DATA:POLarity:IQ <Iq>

SOURce:RECeiver:DATA:POLarity:IQ <Iq>
[:SOURce<hw>]:EBOX:USER:DATA:POLarity:IQ <Iq>

The command sets the polarity of the I and Q data lines of the R&S EX-IQ-BOX.

Parameters:

<Iq> POSitive | NEGative

POSitive
High level stands for a logic 1, low level for a logic 0.

NEGative
High level stands for a logic 0, low level for a logic 1.

*RST: POSitive

Example: `SOUR1:EBOX:USER:DATA:POL:IQ NEG`
set the inversion of the I and Q data signal.

[:SOURce]:BBIN:EXTernal:DATA:SIZE <Size>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:SIZE <Size>
SOURce:TRANsmitter:DATA:SIZE <Size>
SOURce:RECeiver:DATA:SIZE <Size>
[:SOURce<hw>]:EBOX:USER:DATA:SIZE <Size>

Sets the word size resolution of a sample. If the word size is set to a value n, the I word uses these n bits and the Q word uses n bits. The R&S EX-IQ-BOX supports word sizes from 4 to 18 bits.

Parameters:

<Size> float

Range: 4 to 18
*RST: 16
Default unit: Bit

Example: `SOUR1:EBOX:USER:DATA:SIZE 8`
sets the word size resolution to 8 bit.

[:SOURce]:BBIN:EXTernal:DATA:SPOLarity <Spolarity>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:SPOLarity <Spolarity>
SOURce:TRANsmitter:DATA:SPOLarity <Spolarity>
SOURce:RECeiver:DATA:SPOLarity <Spolarity>
[:SOURce<hw>]:EBOX:USER:DATA:SPOLarity <Spolarity>

Determines the polarity of the strobe marker signal. During a serial data transmission every data sample is marked by the strobe marker signal. The strobe marker is output at the UI_GP5 of the user interface..

Note: Clock Phase or Clock Skew settings do not affect the strobe marker signal.

Parameters:

<Spolarity>	POSitive | NEGative **POSitive** Sets the strobe polarity to high level. **NEGative** Sets the strobe polarity to low level. *RST: POSitive

Example: `SOUR1:EBOX:USER:DATA:SPOL NEG`
inverts of the strobe marker signal.

[:SOURce]:BBIN:EXTernal:DATA:SPOSition <Sposition>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:SPOSition <Sposition>
SOURce:TRANsmitter:DATA:SPOSition <Sposition>
SOURce:RECeiver:DATA:SPOSition <Sposition>
[:SOURce<hw>]:EBOX:USER:DATA:SPOSition <Sposition>

Note: This command refers to serial data transmission.

Sets the sample position of the strobe marker output. The strobe marker is output at the UI_GP5 of the user interface.

Parameters:

<Sposition>	float Range: 0 to word size-1 *RST: 0

Example: `SOUR1:EBOX:USER:DATA:SPOS 10`
sets the strobe marker output to sample position 10.

[:SOURce]:BBIN:EXTernal:DATA:STYPe <Stype>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:STYPe <Stype>
SOURce:TRANsmitter:DATA:STYPe <Stype>
SOURce:RECeiver:DATA:STYPe <Stype>
[:SOURce<hw>]:EBOX:USER:DATA:STYPe <Stype>

Selects the signal mode of the transmission. The digital I and Q signals are either transmitted separately or the I and Q samples are assembled to a carrier signal and shifted to an intermediate frequency (IF).

Note: Currently the signal type is firmly set to "IQ" and read only. IQ transmits the digital I and Q signal components separately.

Signal type "IF" is intended for future use.

Parameters:

<Stype>	IQ | IF **IQ** Transmits the digital I and Q signals separately. *RST: IQ

Example: `SOUR1:EBOX:USER:DATA:STYP?`
queries the set signal type.

[:SOURce]:BBIN:EXTernal:DATA:TYPE <Type>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:TYPE <Type>
SOURce:TRANsmitter:DATA:TYPe
SOURce:RECeiver:DATA:TYPe
[:SOURce<hw>]:EBOX:USER:DATA:TYPE <Type>

Selects the signal data type.

Data type "PFSamples" is intended for future use.

Parameters:

<Type> SAMPles | PFSamples

SAMPles
Sets signal type to samples.

*RST: SAMPles

Example: `EBOX:USER:DATA:TYPE?`
queries the set data type.

9.3.7 Test Subsystem

The `USER:TEST` subsystem provides commands for testing the user interface between the R&S EX-IQ-BOX and the DUT.

[:SOURce<hw>]:EBOX:USER:TEST:RX:BER?

Queries the bit error rate. The function consecutively counts the number of discrepancies that occur during the test. The BER result is the ratio, which is calculated by dividing the number of error bits by the total number of bits.

Return values:

<Ber> float

*RST: 0

Example:	`SOUR1:EBOX:USER:DIR REC`
	sets "Receiver" mode.
	`SOUR1:EBOX:USER:TEST:RX:STAT ON`
	activates Rx test.
	`SOUR1:EBOX:USER:TEST:RX:BER?`
	checks the bit error rate.

Usage:	Query only

[:SOURce<hw>]:EBOX:USER:TEST:RX:SIGNal <Signal>

Selects the incoming test signal for testing. The test receiver analyzes both PRBS 16 or counter test signals.

Parameters:

<Signal>	PRBS | COUNter **PRBS** Selects a PRBS 16 (**P**seudo **R**andom **B**inary **S**equence) sequence for testing. **COUNTer** Selects a counter test signal. Range: PRBS to COUN *RST: PRBS

Example:	`SOUR1:EBOX:USER:DIR REIC`
	`SOUR1:EBOX:USER:TEST:RX:SIGN COUN`
	sets to "Receiver" and selects a counter signal for testing.

[:SOURce<hw>]:EBOX:USER:TEST:RX:STATe <State>

Activates the test receiver.

The R&S EX-IQ-BOX expects a test signal at the user interface. First, the test receiver synchronizes to the last received data word, and then generates a test sequence and compares each generated sample with the corresponding received sample.

Parameters:

<State>	OFF | ON *RST: OFF

Example:	`SOUR1:EBOX:USER:DIR REC`
	.
	`SOUR1:EBOX:USER:TEST:RX:STAT ON`
	sets the "Receiver" mode and activates Rx test.

[:SOURce<hw>]:EBOX:USER:TEST:RX:WORDs?

Queries the total number of received bits. This functions consecutively counts the number of received bits, compares them with the sent data and determines the error rate.

Return values:

<Words> float

Example: `SOUR1:EBOX:USER:DIR REC`
sets to "Receiver" mode.
`SOUR1:EBOX:USER:TEST:RX:STAT ON`
activates Rx test.
`SOUR1:EBOX:USER:TEST:RX:WORD?`
checks the number of received bits.

Usage: Query only

[:SOURce<hw>]:EBOX:USER:TEST:TX:SIGNal <Signal>

Selects a test signal of the test generator.

The R&S EX-IQ-BOX internally generates either a sine, PRBS or counter signal for testing, defined as follows:

- PRBS
  The PRBS 16 sequence is defined by the generator polynomial G(x) = 1 + x^2 + x^3 + x^5 + x^{16}.
  The functional implementation of the **PRBS** generation defined by the following linear feedback shift register **(LFSR)**:

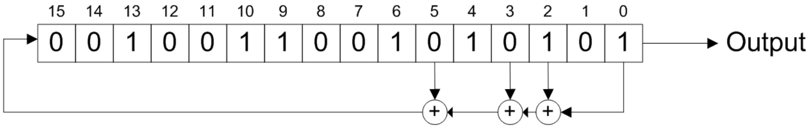


Fig. 9-2: User defined > Test PRBS linear feadback shift register (LFSR)

- Sine
  The sine signal follows the formula,

$$s(n) = e^{j2\pi \frac{f}{f_s} n} = cos\left[2\pi \frac{f}{f_s} n\right] + j\,sin\left[2\pi \frac{f}{f_s} n\right]$$

Fig. 9-3: User defined > sine signal formula

n = discrete time index
f = frequency of the test sine signal
f_s = sampling frequency, based on the "protocol", "data" and "clock" settings.

with the real component :

$$I(n) = cos\left[2\pi \frac{f}{f_s} n\right]$$

and the imaginary component:

$$Q(n) = j\,sin\left[2\pi \frac{f}{f_s} n\right]$$

Parameters:

<Signal> PRBS | COUNter | SINE

PRBS
Generates a PRBS 16 (Pseudo Random Binary Sequence) sequence. The output of this sequence complies to the "Protocol", "Data" and "Clock" settings of the R&S EX-IQ-BOX.
E.g. if the word size of the I / Q sample is 7 bits, the R&S EX-IQ-BOX sends the PRBS 16 sequence in 7-bit parts.
The I and Q values always contain the same copy of one test sample.

COUNTer
Generates a counter test signal. The counter size is based on the word size, set in the "Data" tab. Each output sample increases the counter by 1.

SINE
Provides a sine signal for testing, determined as shown by the formula above.

Range: PRBS to SINE
*RST: PRBS

Example:
`SOUR1:EBOX:USER:DIR TRAN`
`SOUR1:EBOX:USER:TEST:TX:SIGN COUN`
sets to "Transmitter" and selects a counter signal for testing.

[:SOURce<hw>]:EBOX:USER:TEST:TX:SINE:AMPLitude <Amplitude>

Sets the amplitude of the sine test signal in terms of dBFS. The maximum amplitude is full scale (0 dBFS).

Parameters:

<Amplitude> float

Range: -100 to 0
Increment: 1 dBFS

Example:
`SOUR1:EBOX:USER:DIR TRAN`
`SOUR1:EBOX:USER:TEST:TX:SINE:AMPL -50DBFS`
sets to "Transmitter" and "-50 dBFS" amplitude of the sine test signal.

[:SOURce<hw>]:EBOX:USER:TEST:TX:SINE:FREQuency <Frequency>

Sets the frequency of the sine test signal. The frequency is limited to "0.4 f_s", and the sampling frequency "f_s" depends on the clock, data rate and the interleaving mode settings.

Parameters:

<Frequency> float

Range: -4 MHz to 4 MHz
Increment: 1 kHZ

Example:	`SOUR1:EBOX:USER:DIR TRAN`
	`SOUR1:EBOX:USER:TEST:TX:SINE:FREQ 100KHZ`
	sets to "Transmitter" and the signal frequency "100 kHz".

[:SOURce<hw>]:EBOX:USER:TEST:TX:STATe <State>

Switches the test generator on or off. While the test generator is switched on, the test signal replaces the I/Q data source coming from "DIG IQ IN".

Parameters:

<State>	OFF | ON *RST: OFF

Example:	`SOUR1:EBOX:USER:DIR TRAN`
	`SOUR1:EBOX:USER:TEST:TX:STAT ON`
	sets "Transmitter" and switches on the test generator.

9.3.8 Trigger Subsystem

The `USER:TRIGger` subsystem contains the commands for configuring a trigger signal when the R&S EX-IQ-BOX is working in transmitter mode.

[:SOURce<hw>]:EBOX:USER:TRIGger:ARM

Stops the current signal output. It continues either automatically or synchronized, according to the used trigger source.

Example:	`EBOX:USER:TRIG:ARM` stops signal output.
Usage:	Event

[:SOURce<hw>]:EBOX:USER:TRIGger:CSTat?

Queries the current trigger status.

Return values:

<Status>	string
Example:	`EBOX:USER:TRIG:CSTAT?` Response: `Idle`, i.e. triggering is waiting for a trigger event.
Usage:	Query only

[:SOURce<hw>]:EBOX:USER:TRIGger:DELay <Delay>

Specifies a time delay after the trigger event. Trigger delay is defined in clock cycles

Parameters:

<Delay>	float
Example:	`EBOX:USER:TRIG:DEL 5` Signal output starts 5 clock cycles after the trigger event.

[:SOURce<hw>]:EBOX:USER:TRIGger:RESTart

Starts triggering again.

Example:	`EBOX:USER:TRIG:REST` restarts triggering.
Usage:	Event

[:SOURce<hw>]:EBOX:USER:TRIGger:SOURce <Source>

Selects the trigger source. The trigger signal starts the signal output at the user interface.

Parameters:

<Source>	AUTO | SYNC **AUTO** Outputs the signal immediately. **SYNC** Synchronizes signal output with an incoming trigger signal, i.e. the DUT triggers data output to the R&S EX-IQ-BOX. The trigger signal is applied at the SYNC IN pin of the user interface. *RST: AUTO
Example:	`EBOX:USER:TRIG:SOUR SYNC` uses a trigger signal from the DUT to synchronize signal output.

[:SOURce<hw>]:EBOX:USER:TRIGger:STATe?

Queries the trigger status.

Return values:

<State>	STOP | RUN
Example:	`EBOX:USER:TRIG:STAT?` Response: `STOP`, i.e. triggering is stopped.
Usage:	Query only

9.4 CPRI Remote Control Commands

This chapter describes all remote-control commands for the standardized protocol CPRI, including their parameters and value ranges. The parameters are set in the configuration software R&S DigIConf.

In remote control operation, R&S DigIConf itself is operated remotely by means of remote-control commands. For background information about the SCPI command structure and basic information on operating R&S DigIConf via remote control, refer to chapter 8, "Remote Control Basics", on page 269.

Beside the main controls like activating, CPRI test mode and save/recall settings, the interface is controlled by various parameters, grouped by the following functions:

- Multiwaveform Playback (ARB) settings
- Control & Managment settings
- Hardware information
- Main settings
- Recorder settings
- Test & Diagnostics
- Downlink/Uplink settings (TX/RX)
- Vendor Data

Find a list of all commands for the R&S EX-IQ-BOX at the end of the manual.

The following description lists the remote-control commands in alphabetical order, structured by function.

9.4.1 CPRI ARB Subsystem

The ARB subsystem contains all remote control commands that are relevant for loading a waveform file in the waveform memory of the R&S EX-IQ-BOX.To get a list of available waveform files, see `[:SOURce<hw>]:EBOX:ARB:CATalog` on page 305.

The numeric suffix to `ARB<ch>` distinguishes the channel of the waveform memory (`ARB1...4`).

[:SOURce<hw>]:EBOX:CPRI:ARB:PRESet

The command sets the wavefom memory to default, i.e. it erases the ARB table (all loaded waveform files and settings).

Example:	`SOUR1:EBOX:CPRI:ARB:PRES` clears the ARB table.
Usage:	Event

[:SOURce<hw>]:EBOX:CPRI:ARB:RELoad

Refreshes all currently loaded waveform files.

Example:	`SOUR1:EBOX:CPRI:ARB:REL` update assigned files in the waveform memory.
Usage:	Event

[:SOURce<hw>]:EBOX:CPRI:ARB:SAMPles:TOTal?

Queries the number of samples including all active waveform files.

Return values:

<Total>	float Increment: 1.0e-6 *RST: 0
Example:	`SOUR1:EBOX:CPRI:ARB:SAMP:TOT?` check the entire number of samples. Response: `0.154` MSamples
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:CONFlict?

The command queries whether an option conflict has occurred. A conflict arises, if a waveform requires an option, that is not installed on the R&S EX-IQ-BOX, or is not enabled.

Return values:

<Oconflict>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:CPRI:ARB:CONF?` check if there is an option conflict. Response: `0` if OK, `1` if not OK
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:FILE <File>

The command selects a stored waveform file. Enter directory and file name with the file extension `*.wv` for waveform files.

Parameters:

<File> <path>, <file_name>.<ext>

String parameter containing the directory, where the waveform file is located, the file name, and the file extension `*.wv` for waveform files.

Example: `SOUR1:EBOX:CPRI:ARB2:FILE "..\\DigIConf\Waveforms\p4DQPSK7.wv"`

load the file "waveform" into the second ARB waveform memory.

[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:SAMPles?

The command queries the number of samples the loaded signal is composed of.

Return values:

<Samples> integer

Increment: 1
*RST: 0

Example: `SOUR1:EBOX:CPRI:ARB1:SAMPl?`

query the samples of the signal loaded in ARB1 waveform memory.
Response: `122.88`
the current sample rate is 122.88 Mbit/s

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:SRATe?

The command queries the sample rate of the signal, loaded from the waveform memory. The sample rate represents the number of samples per second that are used for digitizing.

Return values:

<Srate> integer

Increment: 1
*RST: 0

Example: `SOUR1:EBOX:CPRI:ARB1:SRAT?`

query the sample rate of the signal loaded in ARB1 waveform memory.
Response: `122.88`
the current sample rate is 122.88 Mbit/s

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:STATe <State>

The command switches on the transmission of the test data.

Parameters:

<State>	ON | OFF *RST: OFF
Example:	`SOUR1:EBOX:CPRI:ARB1:STAT ON` activate waveform loaded in ARB1.

9.4.2 CPRI Control & Management Subsystem

The CPRI Control & Management (C&M) command subsystem comprises all remote-control commands related to the process of exchanging control information between RE (Radio Equipment) and REC (Radio Equipment Control) in base station systems. CPRI supports two different protocols for C&M data, the slower variation HDLC (High-Level Data Link Control) and the fast Ethernet.

[:SOURce<hw>]:EBOX:CPRI:CM:ETH:ACTive?

The command queries whether the interface is active.

Return values:

<Active>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:CPRI:CM:ETH:ACT?` check the activity of the Ethernet interface. Response: `0` the interface is not active.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:CM:ETH:BRATe?

The command queries the resulting bit rate of fast C&M data exchange. This bit rate depends on the CPRI line bit rate and the Ethernet pointer.

Return values:

<Rate>	float Increment: 0.01 *RST: 42240000
Example:	`SOUR1:EBOX:CPRI:CM:ETH:BRAT?` query the current bit rate of fast C&M. Response: `122.88` the current bit rate is 122.88 Mbit/s.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:CM:ETH:COMMand <Command>

This command enters a control command in fast C&M interactive mode.

Parameters:

<Command>	string

Example:	`SOUR1:EBOX:CPRI:CM:ETH:COMM "test cmd"`
	transmit the test command for fast C&M control to the control panel.
	`SOUR1:EBOX:CPRI:CM:ETH:EXEC`
	execute the test command.

[:SOURce<hw>]:EBOX:CPRI:CM:ETH:EXECute

The command sends the C&M data in fast C&M mode.

Example:	`SOUR1:EBOX:CPRI:CM:ETH:EXEC` executes the control command, or command sequence of fast C&M data.
Usage:	Event

[:SOURce<hw>]:EBOX:CPRI:CM:ETH:PPTR <Ptr>

This command sets the CPRI Ethernet pointer. This setting determines the Fast C&M bit rate, since this pointer represents the boundary between vendor data and Fast C&M Data in the CPRI control block.

Parameters:

<Ptr>	20...63 Range: 20 to 63 Increment: 1 *RST: 20

Example:	`SOUR1:EBOX:CPRI:CM:ETH:PPTR 25` set the ethernet pointer to 25.

[:SOURce<hw>]:EBOX:CPRI:CM:ETH:PTR?

The command queries the resulting Ethernet pointer after the link setup, i.e. the position after the handshake between the R&S EXBOX-B85 and the DUT.

Return values:

<Pptr>	float Range: 20 to 63 Increment: 1 *RST: 20
Example:	`SOUR1:EBOX:CPRI:CM:ETH:PTR?` check the position of the ethernet pointer after link setup. Response: `45` the resulting pointer is at position 45.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:CM:ETH:STATe <State>

The command activates the C&M data exchange via the Ethernet interface.

Parameters:

<State>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:CPRI:CM:ETH:STAT ON` switches on fast C&M.

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:ACTive?

The command queries whether the interface is active.

Return values:

<Active>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:CPRI:CM:HDLC:ACT?` checks the activity of the HDLC interface. Response: `0` the interface is not active.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:BRATe <Rate>

The command sets the bit rate for transmission of the control data in slow C&M mode (HDLC).

Note: The maximum HDLC rate for slow C&M depends on the CPRI Line Bit Rate. The following table shows the available HDLC bit rates for the corresponding CPRI bit rates.

CPRI Line Bit Rate	2x (1228.8 Mbit/s)	4x(2457.6 Mbit/s)	5x (3072.0 Mbit/s)
Possible HDLC Bit Rates in kbit/s	240 480 960	240 480 960 1920	240 480 960 1920 2400

Parameters:

<Rate>	240 | 480 | 960 | 1920 | 2400
	Range: 240000 to 2400000 Increment: 1 *RST: 240000 Default unit: kbit/s

Example: `SOUR1:EBOX:CPRI:CM:HDLC:BRAT 480`
select a bit rate of 480 kbit/s for slow C&M transmission.

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:COMMand <Command>

This command enters a control command in slow C&M interactive mode.

This command applies Slow C&M Source "Terminal". In direct mode, i.e. control data coming via the RS-232-C interface, this control is not active (CPRI REC Test mode).

Parameters:
<Command> string

Example: `SOUR1:EBOX:CPRI:CM:HDLC:COMM "test cmd"`
transmits the test command for slow C&M control to the control panel.
`SOUR1:EBOX:CPRI:CM:HDLC:EXEC`
executes the test command.

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:EXECute

The command sends the entered slow C&M data.

This command applies to slow C&M source "Terminal". In direct mode, i.e. with data coming via the RS-232 interface, the controls are not active (CPRI REC Test mode).

Example: `SOUR1:EBOX:CPRI:CM:HDLC:EXEC`
executes the control command of slow C&M data.

Usage: Event

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:FCS?

The command queries, if a frame check sequence error occurs. The HDLC protocol provides a CRC (**C**yclic **R**edundancy **C**heck) check. This CRC is evaluated during operation.

Return values:

<Fcs> OFF | ON

*RST: 1

Example: `SOUR1:EBOX:CPRI:CM:HDLC:FCS?`
query the result of the CRC check.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:MODE <Mode>

The command selects the mode for HDLC C&M data transmission.

Parameters:

<Mode> DIRect | ECODing

DIRect
The R&S EX-IQ-BOX transmits the data directly to the DUT, i.e. without internal encoding or decoding.
This mode applies to HDLC source "RS-232-C Connector".

ECODing
The R&S EX-IQ-BOX either encodes the plain text data before transmission to the DUT, or it decodes and then displays the incoming data.
This mode applies to HDLC source "Terminal".

*RST: ECODing

Example: `SOUR1:EBOX:CPRI:CM:HDLC:MODE DIR`
send the data without internal encodin/decoding.

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:RFRames?

The command queries the number of received HDLC frames.

Return values:

<Rframes> float

Increment: 1
*RST: 0

Example: `SOUR1:EBOX:CPRI:CM:HDLC:RFR?`
query the number of received HDLC frames.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:SFRames?

The command queries the number of sent HDLC frames.

Return values:

<Sframes>	float Increment: 1 *RST: 0
Example:	`SOUR1:EBOX:CPRI:CM:HDLC:SFR?` query the number of sent HDLC frames.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:SOURce <Source>

The command selects the source of the HDLC C&M data.

Parameters:

<Source> TERMinal

TERMinal|RS232
Use the integrated terminal of R&S DigIConf for C&M data input or output.
This method applies to the CPRI RE test mode.

RS232
Use the RS-232-C connector for C&M data input or output.
You can use the RS-232-C interface in the CPRI RE and the CPRI REC test mode.

*RST: TERMinal

Example: `SOUR1:EBOX:CPRI:CM:HDLC:SOUR TERM`
Enter the C&M data via the the terminal of R&S DigIConf.

[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:STATe <State>

The command activates and deactivates the C&M data exchange by means of HDLC protocol (slow C&M).

Parameters:

<State>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:CPRI:CM:HDLC:STAT ON` switch on slow C&M.

9.4.3 CPRI Hardware Subsystem

The hardware (`HW:`) command subsystem encloses remote-control commands for setting hardware parameters, including the assignment to the interfaces, special settings of the link, status information and reference clock settings.

The numeric suffix to `GPIO<dir>` distinguishes the transmission direction of the connected GPIO Interfaces.

[:SOURce<hw>]:EBOX:CPRI:HW:ALARm?

This command queries, if any alarm is detected on the CPRI communication link, i.e. it acts on behalf of all warnings.

Return values:

<Alarm>	0 | 1 *RST: 0

Example: `SOUR1:EBOX:CPRI:HW:ALAR?`
check if any link alarm is detected.
Response: `0`
no error occured.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:HW:BBRevision?

This command queries the revision number of the connected CPRI breakout board.

Return values:

<Bbrevision>	string

Example: `SOUR1:EBOX:CPRI:HW:BBR?`
query the revision number of the connected breakout board.
Response: `4`
the internal CPRI breakout board has revision 4.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:HW:CMODe?

Queries the role of the R&S EX-IQ-BOX, i.e. either master (CPRI RE test) or slave (CPRI REC test).

Return values:

<Cmode>	string **Master** The R&S EX-IQ-BOX is working in CPRI RE Test mode. **Slave** The R&S EX-IQ-BOX is working in CPRI REC Test mode.
Example:	`SOUR1:EBOX:CPRI:HW:CMOD?` query the role of the R&S EX-IQ-BOX in the CPRI communication link. Response: `Slave` the R&S EX-IQ-BOX operates as slave, i.e. in CPRI REC Test mode.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:HW:CORE?

Queries the current state of the CPRI core.

Return values:

<Cstatus>	string **Link is up** The CPRI core works in normal operating mode. **Reset** It is at the starting point of establishing the link. **L1 Synchronization** Attempt of L1 synchronization. **Setup protocol version** Protocol version setup. **Setup C&M parameter** C&M parameter setup. **Passive mode** Only I/Q data are active, C&M is not used.
Example:	`SOUR1:EBOX:CPRI:HW:CORE?` check the current mode of the CPRI core. Response: `Link is up` the CPRI conmmunication link operates in normal mode.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:HW:EBRevision?

Queries the revision number of the R&S EX-IQ-BOX´s internal board.

Return values:	
<Ebrevision>	string
Example:	`SOUR1:EBOX:CPRI:HW:EBR?` query the revision number of the internal EX-IQ-BOX board. Response: `123` the internal R&S EX-IQ-BOX board has revision 123.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:HW:FBVersion?

Queries the version of the FPGA (Field Programmable Gate Array) basic design.

Return values:	
<Fbversion>	string
Example:	`SOUR1:EBOX:CPRI:HW:FBV?` check the version of the FPGA basic design. Response: `02.01.123` the CPRI FPGA has revision 02.01.123.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:HW:FCVersion?

Queries the version of the FPGA (Field Programmable Gate Array) CPRI design.

Return values:	
<Fcversion>	string
Example:	`SOUR1:EBOX:CPRI:HW:FCV?` query the version of the CPRI FPGA. Response: `CPRI 01.01.001` the CPRI FPGA has revision 01.01.001.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:HW:GPIO<ch>:DIRection <Direction>

Determines the transmission direction at the connected GPIO interfaces. You can individually activate each of the three interfaces separately.

The numeric suffix to `GPIO<ch>` distinguishes between the available GPIO interfaces.

Parameters:

<Direction>	OFF | OUTPut | INPut Deactivate the GPIO interface. **OFF** Deactivates the GPIO interface. **OUTPut** Selects the respective GPIO interface as output, i.e. send a control signal to the external device. **INPut** Selects the appropriate GPIO interface as input, which means you receive a signal from the external device, e.g. for trigger purpose. *RST: OFF

Example: `SOUR1:EBOX:CPRI:HW:GPIO1:DIR OUTP`

outputs the control signal at GPIO port 1.

[:SOURce<hw>]:EBOX:CPRI:HW:GPIO<ch>:SIGnal <Signal>

The command determines the type of the control signal. You can define separate signals for each of the three interfaces.

The numeric suffix `GPIO<ch>` distinguishes between the GPIO interfaces 1, 2, 3 and 4.

Parameters:

<Signal> CLOW | CHIGh | DLBFrame | DLHFrame | DLNFrame | ULBFrame | ULHFrame | ULNFrame | TMCLock | RCLock | EXT1 | EXT2 | EXT3 | NONe

GPIO output settings
In output mode, you can assign the following signals to the GPIO interface.

CLOW|CHIGh
Sets the control signal to constant level high or low.

DLBFrame|ULBFrame
Takes the information in the CPRI basic frame for control. According to the WCDMA clock rate, the CPRI protocol synchronizes its basic frame with 3.84 MHz.

DLHFrame|ULHFrame
Uses the CPRI hyper frame clock for control. The hyper frame clock rate is 15 kHz.

DLNFrame|ULNFrame
Uses the information in the CPRI Node B frame for control. CPRI updates the B node every 10 ms, i.e. you can control the DUT with a clock rate of 100 Hz.

TMCLock
Uses the CPRI signal processing clock, e.g. 61.44 MHz at 2x line rate. This clock is used for timing measurements like response time, latency, etc..

RCLock
Uses the CPRI signal processing clock, e.g. 61.44 MHz at 2x line rate. This clock is used for timing measurements like response time, latency, etc..

EXT1|EXT2|EXT3
In input mode, each of the three GPIO ports provide also an external trigger signal.

NONe
Deactivates the GPIO interface.

*RST: NONe

Example: `SOUR1:EBOX:CPRI:HW:GPIO1:SIG DLNBF`
use the information in the CPRI Node B frame for control.

[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:INPut <Input>

The command determines the interface for signal input. Only one interface can be active at the same time.

Basically the R&S EX-IQ-BOX receives a CPRI signal via one of the optical interfaces SFP1, or SFP2.

Parameters:

<Input>	SFP1 | SFP2 | SMA | LOOPback | NONE **SFP1** Selects the SFP1 (**S**mall **F**orm-factor **P**luggable) interface, at which the R&S EX-IQ-BOX is connected to the DUT to receive the signal. **SFP2** Selects the SFP1 (**S**mall **F**orm-factor **P**luggable) interface, at which the R&S EX-IQ-BOX is connected to the DUT to receive the signal. **SMA** Select the SMA (**S**ub**M**iniatur version **A**) interface, if the R&S EX-IQ-BOX receives the signal from the DUT on this transmission line. **LOOPback** Assigns the internal loopback, if the signal is routed back internally. **NONE** Deactivates the input, if no connection is established. *RST: SFP1
Example:	`SOUR1:EBOX:CPRI:HW:HSSS:INP SFP1` assigns SFP1 for signal input.

[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP1[:STATe] <State>

Determines the SFP1 (**S**mall **F**orm-factor **P**luggable) interface for signal output, i.e. aligns the transmitter type of the DUT. You can activate more than one interface for the signal output simultaneously, e.g. set SFP1 for signal transmission to the DUT, and SMA for signal monitoring.

Parameters:

<State>	OFF | ON *RST: ON
Example:	`SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SFP1 ON` activates the SFP1 interface for signal output.

[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP2[:STATe] <State>

Determines the SFP2 (**S**mall **F**orm-factor **P**luggable) interface for signal output, i.e. aligns the transmitter type of the DUT. You can activate more than one interface for the signal output simultaneously, e.g. set SFP2 for signal transmission to the DUT, and SMA for signal monitoring.

The numeric suffix to SFP distinguishes between the available SFP interfaces.

Parameters:

<State>	OFF | ON *RST: OFF

Example: `SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SFP2 ON`
activates the SFP2 interface for signal output.

[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SMA[:STATe] <State>

Determines the SMA (**S**ub**M**iniatur version **A**) interface for signal output, i.e. aligns the transmitter type of the DUT. You can activate more than one interface for the signal output simultaneously, e.g. set SFP1 for signal transmission to the DUT, and SMA for signal monitoring.

Parameters:

<State> OFF | ON

*RST: OFF

Example: `SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SMA ON`
activates the interface for signal output.

[:SOURce<hw>]:EBOX:CPRI:HW:LBRate <Lbrate>

Selects the line bit rate for the communication link. The line bit rate defines the total number of bits transferred per second over the CPRI communication link, including control and I/Q data, and 8B10B line coding.

Parameters:

<Lbrate> LR2X | LR4X | LR5X

LR2X
2x1228.8 Mbit/s

LR4X
4x2457.6 Mbit/s

LR5X
5x3072.0 Mbit/s

*RST: LR2X

Example: `SOUR1:EBOX:CPRI:HW:LBR LR2X`
sets the line bit rate 2x1228.8 Mbit/s.

[:SOURce<hw>]:EBOX:CPRI:HW:LOF?

Queries the CPRI frame delimiter K28.5.

Return values:

<Lof> 0 | 1

*RST: 0

Example: `SOUR1:EBOX:CPRI:HW:LOF?`
check if the frame delimiter K28.5 is detected.
Response: `1 (0 = no error)`
the K28.5 frame delimiter is not found.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:HW:LOS?

The command queries data synchronization.

Return values:

<Los>	0 | 1 *RST: 0

Example: `SOUR1:EBOX:CPRI:HW:LOS?`
check if data is synchronized.
Response: `1 (0 = no error)`
data lost their synchronization.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:CRLocked?

This command queries, if clock recovery is unlocked. Clock recovery must be locked in CPRI REC test mode.

Return values:

<Reclocked>	0 | 1 **ON** **The clock recovery is locked.** **OFF** The clock recovery is unlocked. *RST: 1

Example: `SOUR1:EBOX:CPRI:HW:RCL:CRL?`
check if clock recovery is locked.
Response: `1`
clock recovery is locked.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:CSLocked?

This command queries, if the main PLL of the R&S EX-IQ-BOX is unlocked. This state is fundamental and must be locked in every operating mode of the R&S EX-IQ-BOX.

Return values:

<Slocked>	OFF | ON **ON** **The PLL is locked.** **OFF** The PLL is unlocked. *RST: 1

Example:	`SOUR1:EBOX:CPRI:HW:RCL:CSL?` check if the PLL of the R&S EX-IQ-BOX is locked. Response: `0` the PLL is unlocked.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:ROLocked?

This command checks, if the reference clock output is available.

A second synthesizer generates a 10 MHz reference clock selectable at one of the GPIO interface connectors. The status LED turns blue, if the clock output is available.

Return values:

<Reflocked>	0 | 1 *RST: 1
Example:	`SOUR1:EBOX:CPRI:HW:RCL:ROL?` check if the reference clock output is available. Response: `1` clock output is not available.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:SOURce <Source>

Selects the reference signal source. In test mode CPRI RE, the R&S EX-IQ-BOX is synchronized either external or internally. Test mode CPRI REC uses the reference clock embedded in the CPRI link.

The reference clock is extracted from the CPRI link. This selection is mandatory in a CPRI REC test setup, since the R&S EX-IQ-BOX operates in CPRI slave mode.

Applies to a CPRI REC test mode.

Parameters:

<Source>	RIN | INTernal | CRECovery **RIN** CPRI RE test setup with a connected R&S instrument. The R&S EX-IQ-BOX synchronizes the CPRI communication link with the reference signal provided by an R&S instrument. The 10 MHz signal is fed to the BNC connector REF IN on the back of the R&S EX-IQ-BOX. **INTernal** CPRI RE test setup, if the R&S EX-IQ-BOX is working standalone. The R&S EX-IQ-BOX uses its internal reference oscillator for synchronization. **CRECovery** CPRI REC test mode. The reference clock is extracted from the CPRI link. This selection is mandatory in a CPRI REC test setup, since the R&S EX-IQ-BOX operates in CPRI slave mode. *RST: RIN

Example: `SOUR1:EBOX:CPRI:HW:RCL:SOUR RIN`
set the internal clock source for reference.

[:SOURce<hw>]:EBOX:CPRI:HW:SMA:DOSWing <Doswing>

Determines the differential output voltage swing of the CML (**C**urrent **M**ode **L**ogic) transmitter.

Parameters:

<Doswing>	float Range: 0.1 to 1.6 Increment: 0.1 *RST: 0.8

Example: `SOUR1:EBOX:CPRI:HW:SMA:DOSW 1.0`
sets 1.0 Vpp differential output voltage of the CML.

[:SOURce<hw>]:EBOX:CPRI:HW:SMA:RXEGain <Rxegain>

The command sets the input gain of the equalizer. This equalizer is an active high-pass filter, that equalizes the low-pass behaviour of the transmission medium, such as e.g. the FR4 backplane. The gain, expressed in dB, relates to the freqeuncy of 2 GHz.

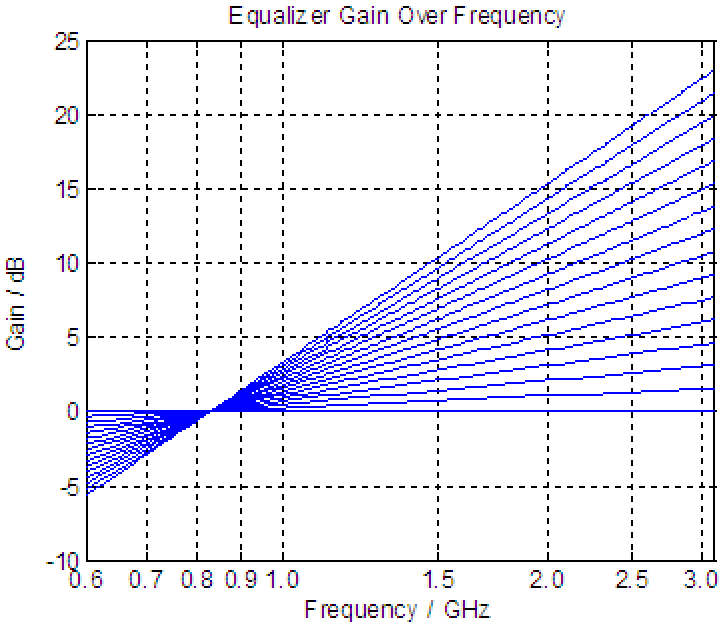


Fig. 9-4: CPRI - equalizer gain over frequency

Parameters:

<Rxegain>	float Range: 0 to 15 Increment: 1 *RST: 0 Default unit: dB
Example:	`SOUR1:EBOX:CPRI:HW:SMA:RXEG 10` sets the equalizer gain to 10 dB.

[:SOURce<hw>]:EBOX:CPRI:HW:TIMing?

The command queris, if the R21 timing calculation is invalid (CPRI requirement 21).

Return values:

<Timing>	0 | 1 *RST: 0
Example:	`SOUR1:EBOX:CPRI:HW:TIM?` check if timing calculation is correct. Response: `1 (0 = no error)` the R21 timing calculation is invalid.
Usage:	Query only

9.4.4 CPRI Main Control Commands

The **main controls** commands provide the selection of the "CPRI test mode", and commands as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading previously defined settings.

[:SOURce<hw>]:EBOX:CPRI:MODE <Mode>

Selects the CPRI test mode. The R&S EX-IQ-BOX simulates either the baseband module or the RF module to test the appropriate counterpart.

Parameters:

<Mode> RETest | RECTest

RETest
The R&S EX-IQ-BOX works as RF module for testing the baseband module (**R**adio **E**quipment).

RECTest
The R&S EX-IQ-BOX emulates the baseband module for testing the RF module (**R**adio **E**quipment **C**ontrol).

*RST: RETest

Example: `SOUR1:EBOX:CPRI:MODE RECT`
activate CPRI REC test mode.

[:SOURce<hw>]:EBOX:CPRI:PRESet

Sets all parameters to default. Refer to chapter A.3.2, "CPRI Default Settings", on page 466, with an overview of the most important default settings.

Example: `SOUR1:EBOX:CPRI:PRES`
set to CPRI default.

Usage: Event

[:SOURce<hw>]:EBOX:CPRI:STATe <State>

The command activates and deactivates the CPRI standardized protocol. The corresponding FPGA (**F**ield **Pro**g**r**ammable **A**rray) is loaded automatically into the R&S EX-IQ-BOX.

Parameters:

<State> OFF | ON

*RST: OFF

Example: `SOUR1:EBOX:CPRI:STAT ON`
activates CPRI protocol transmission.

9.4.5 CPRI Recorder Subsystem

The `CPRI:RECorder` subsystem contains all remote-control commands that are relevant for recording an I/Q signal and storing the recorded data in a waveform file.

[:SOURce<hw>]:EBOX:CPRI:RECorder:ABORt

Stops and cancels the recording. You can abort the recording at any time and restart again.

Example: `SOUR1:EBOX:CPRI:REC:ABOR`
stops recording.

Usage: Event

[:SOURce<hw>]:EBOX:CPRI:RECorder:DATA:SOURce <Source>

Selects the signal source of the signal to be recorded. All RX signals are available. In order to record a signal, the signal must be selected in the respective RX dialog. Either the uplink signal in CPRI RE test mode, or the downlink signal of the CPRI REC testmode are possible. Assign the signal "DIG OUT 2 IQ / Recorder" or "Recorder" under `[:SOURce<hw>]:EBOX:CPRI:RX:SIGNal<ch>:OUTPut` on page 373. Switch on signal state, see `[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:STATe` on page 392.

Parameters:

<Source> string

String parameter to specify the I/Q data source of the signal to be recorded.

Example: `SOUR1:EBOX:CPRI:REC:DATA:SOUR "signal_1"`
select the signal_1 for recording.

[:SOURce<hw>]:EBOX:CPRI:RECorder:DATA:SOURce:CATalog?

Returns a list of data sources, i.e. output signals in the current, or specified directory.

Return values:

<Srcs>	string
Example:	`SOUR1:EBOX:CPRI:REC:DATA:SOUR:CAT?` read out all waveform files of the current directory.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:RECorder:DATA:SRATe?

Queries the sample rate of the recorded signal.

Return values:

<Srate>	float *RST: 3840000 Default unit: Hz
Example:	`SOUR1:EBOX:CPRI:REC:DATA:SRAT?` query the sample rate value of the selected signal.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:RECorder:EXECute

Starts the recording.

Example:	`SOUR1:EBOX:CPRI:REC:EXEC` starts recording of the currently selected signal.
Usage:	Event

[:SOURce<hw>]:EBOX:CPRI:RECorder:FILE:CREate

This command creates a file and stores the recorded data.

Note: R&S DigIConf stores the recorded data in the waveform file format with the predefined file extension `*.wv`. By default, waveform files are stored in the directory **%Program Files%/Rohde-Schwarz/DigIConf/Settings**, unless another directory is selected. File name and the directory are user-selectable.

Parameters:

<Create>	<Path>, <File_Name> String parameter to specify directory and path. String parameter to specify the name of the new file.
Example:	`SOUR1:EBOX:CPRI:REC:FILE:CRE` save the recorded data in a file
Usage:	Event

[:SOURce<hw>]:EBOX:CPRI:RECorder:FILE:SELect <Select>

Saves the the recorded data in a file. Filename and directory are specified within the command.

If no file of the specified name exists, it is created. The file extension may be omitted. R&S DigIConf stores the recorded I/Q data streams in the R&S WinIQSim2 waveform file format with the predefined file extension `*.wv`.

Setting parameters:

<Select> <path>, <file_name>

String parameter to select directory, path and file name.

Example: `SOUR1:EBOX:CPRI:REC:FILE:SEL "D:\3GPP_CPRIRE.wv"`

select the recorded file `3GPP_CPRIRE.wv` from `D:/` directory.

Usage: Setting only

[:SOURce<hw>]:EBOX:CPRI:RECorder:RLENgth <Length>

Sets the data length to be recorded in samples.

Parameters:

<Length> integer

Specifies the number of samples to be recorded.

Range: 1 to 128000000
Increment: 1
*RST: 100 Samples

Example: `SOUR1:EBOX:CPRI:REC:RLENgth 1024`

record 1024 samples of the signal.

[:SOURce<hw>]:EBOX:CPRI:RECorder:RTIMe?

Queries the recording time. The recording time results from the recording length and the sample rate.

Return values:

<Duration> float

Increment: 0.000001
*RST: 0
Default unit: s

Example: `SOUR1:EBOX:CPRI:REC:RTIM?`

returns the time needed for recording.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:RECorder:STATe?

This command queries whether the selected data source signal is active or not. If inactive, the recorder cannot be started.

Return values:

<State> 0 | 1

*RST: 0

Example: `SOUR1:EBOX:CPRI:REC:STAT?`
Response: `0` (inactive)

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:RECorder:STATus?

Return values:

<Status> IDLE | FRUN | READy | WTRigger | TRIGgered | DONE

Returns the state of the recording process.

IDLE
Recording is inactive. Configure the recorder in that state.
The recorder remains in "Idle" state until you start with `Execute`.

FRUN
The recorder records the signal continuously in a ring memory.
These data are required for pre-trigger analyzes.

READy
Recording has passed through the ring memory once at least, i.e. it has described the memory completely. At this point the data is valid and R&S DigIConf activates the trigger signal automatically.

WTRigger
The recorder continues recording until the trigger event occurs.
Then the process switches to the next state.
If trigger source "Software" is used, the trigger event occurs immediately.

TRIGgered
After the trigger event, only the remaining samples after the trigger position are recorded (post-trigger data).

DONE
If all post-trigger data are recorded, the recording is completed and the recorder stops. The data is available in the memory.

*RST: IDLE

Example: `SOUR1:EBOX:CPRI:REC:STAT?`
Response: `WTR`, i.e. the process is waiting for a trigger event.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:RECorder:TRIGger:POSition <Position>

Determine the position of the trigger event on the waveform. The position provides to realize a pre-trigger recording, as well as a post-trigger recording. The value is set in the samples from 0 to Recording Length-1.

- Post-trigger, i.e. position 0 at the beginning of the waveform enables to evaluate the signal after the trigger event.
- Pre Trigger, with the trigger position at the end of the waveform, provides the evaluation of the signal before the trigger event.

Parameters:

<Position> integer

Specify a numeric value.

Range: 0 to 99
Increment: 1
*RST: 0

Example: `SOUR1:EBOX:CPRI:REC:TRIG:POS 2`

set trigger position 2.

[:SOURce<hw>]:EBOX:CPRI:RECorder:TRIGger:SOURce <Source>

Select the trigger source for starting the recording. A trigger event can be initiated by the software itself or by hardware events.

Parameters:

<Source> SOFTware | EXT1 | EXT2 | EXT3 | TXBF | TXHF | TXNF | RXBF | RXHF | RXNF

SOFTware
Software trigger starts the recording immediately after the record is switched on. No other event is necessary.

EXT1...3
Starts recording with an external trigger event.
External trigger events are generated by the hardware and fed at the GENERAL PURPUSE IO interface.

TXBF|TXHF|TXNF|RXBF|RXHF|RXNF
Starts recording with an external trigger event. These trigger events come within the CPRI communication link.
Available trigger evens are:
CPRI DL/UL Basic Frame: TXBF | RXBF
CPRI DL/UL Hyper Frame: TXHF | RXHF
CPRI DL/UL NodeB Frame: TXNF | RXNF

*RST: SOFTware

Example: `SOUR1:EBOX:CPRI:REC:TRIG:SOUR EXT2`

start recording with an external trigger event, fed at the 2nd GPIO interface.

9.4.6 CPRI Settings Subsystem

With the commands of the `SETTing` subsystem, you can save settings of a CPRI application, or recall previously saved configurations. It covers all commands for file handling.

[:SOURce<hw>]:EBOX:CPRI:SETTing:CATalog?

The command queries the available settings files in the specified directory. Settings files are used to store current application settings. Only files with the file extension *.cpri will be listed.

Access to the files via remote is possible using the commands of the `MEMM` subsystem.

Return values:

<Catalog>	string String parameter to select the directory where settings files are stored.

Example:	`MEMM:CDIR "d:\DigIConf\Settings\CPRI"`
	Set the default directory and path to `d:\DigIConf\Settings\CPRI`.
	`SOUR1:EBOX:CPRI:SETT:CAT?`
	read out all settings files of the `\DigIConf\Settings\CPRI` directory on drive `d:`

Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:SETTing:DELete <Delete>

The command removes a settings file from the specified directory.

Setting parameters:

<Delete>	<directory>, <file_name>, <ext> Determine the file to be deleted by adding directory, file name and the file extension (`*.cpri`).
Example:	`SOUR1:EBOX:CPRI:SETT:DEL "d:\DigIConf\Settings\CPRI\RETest.cpri"` delete the file `RETest.cpri`.
Usage:	Setting only

[:SOURce<hw>]:EBOX:CPRI:SETTing:LOAD <Load>

The command loads a previously saved CPRI configuration. Define directory and file name, R&S DigIConf automatically assigns the file extension `*.cpri`.

Setting parameters:

<Load>	<directory>, <file_name> String parameter to determine the target directory and the filename for loading the settings file.
Example:	`SOUR1:EBOX:CPRI:SETT:LOAD "D:/USER/CPRISettings/RETest"` load the CPRI settings file `RETest.cpri` from the directory `d:\USER\CPRISettings`.
Usage:	Setting only

[:SOURce<hw>]:EBOX:CPRI:SETTing:STORe <Store>

Saves the current CPRI signal configuration. Specify the directory and file name. R&S DigIConf automatically assigns the file extension `*.cpri` to CPRI configuration files.

Setting parameters:

<Store>	<directory>, <file_name> String parameter to determine the target directory and the filename for storing the settings file.
Example:	`SOUR1:EBOX:CPRI:SETT:STOR "D:/USER/CPRISettings/RETest"` save the currently defined CPRI settings in the file `RETest.cpri` in the directory `d:\USER\CPRISettings`.
Usage:	Setting only

9.4.7 CPRI Test & Diagnostics Subsystem

The `TEST:` & Diagnostics subsystem contains the remote-control commands to get information on the SFP transceiver connection and RX alarms. You also find the commands for executing a low level BER test in this panel.

The numeric suffix to `SFP<st>` distinguishes the SFP interfaces (SFP1,SFP2).

[:SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:RATE?

The command queries the number of bit errors. This function consecutively counts the number of discrepancies that occur during the test. The BER result is the ratio, which is calculated by dividing the number of error bits by the total number of bits.

Return values:

<Rate> float

Range: 0 to 1.000
Increment: 0.01
*RST: 0

Example: `SOUR1:EBOX:CPRI:TEST:BER:RX:RATE?`
query the number of bit errors.
Response: `2`
2 bit errors occured during low level BER test.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:STATe <State>

Switches on the test receiver.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `SOUR1:EBOX:CPRI:TEST:BER:RX:STAT ON`
switch on test receiver.

[:SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:WORDs?

The command queries the number of received IQ words during low level BER RX test. Low level BER test consecutively counts the number of received words in order to compare them with the sent data and to determine the error rate.

Return values:

<Words> integer

Increment: 1
*RST: 0

Example: `SOUR1:EBOX:CPRI:TEST:BER:RX:WORD?`
query the number of received IQ words.
Response: `10005`
R&S DigIConf received 10005 words during low level BER test.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:BER:TX:STATe <Execute>

The command starts the transmission of the test data.

Parameters:

<Execute>	ON | OFF *RST: OFF
Example:	`SOUR1:EBOX:CPRI:TEST:BER:TX:STAT ON` start PRBS TX test.

[:SOURce<hw>]:EBOX:CPRI:TEST:RX:LOF?

Queries whether the received signal is synchronized correctly, i.e. LOF (**L**oss **o**f **F**rame).

Return values:

<Lof>	0 | 1 *RST: 0
Example:	`SOUR1:EBOX:CPRI:TEST:RX:LOF?` check if received data is synchronized. Response: `1` (error), data lost synchronization.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:RX:LOS?

The command queries a **L**oss **o**f **S**ignal (LOS).

Return values:

<Los>	0 | 1 *RST: 0
Example:	`SOUR1:EBOX:CPRI:TEST:RX:LOS?` check if loss of signal happened. Response: `0` (no error)
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:RX:RAI?

The command queries the RAI (**R**emote **A**rm **I**ndication) state, i.e. if any remote part of the end-to-end link has failed.

Return values:

<Rai>	0 | 1 *RST: 0
Example:	`SOUR1:EBOX:CPRI:TEST:RX:RAI?` check if a remote part of the end-to-end link has failed. Response: `0` if OK, `1` if not OK

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:RX:RESet?

Checks the reset state of the DUT.

Return values:

<Reset> 0 | 1

1
CPRI RE test mode: Confirms that a reset was performed.
CPRI REC test mode: Confirms a reset request.

0
CPRI RE test mode: No reset was performed.
CPRI REC test mode: No reset is requested.

*RST: 0

Example: `SOUR1:EBOX:CPRI:TEST:RX:RES?`
check the reset state of the DUT.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:RX:SDI?

The command queries if the data communication failed (SDI **S**ervice Access Point **D**efect **I**ndication).

Return values:

<Sdi> 0 | 1

*RST: 0

Example: `SOUR1:EBOX:CPRI:TEST:RX:SDI?`
check the data communication.
Response: **1** (error)
data communication failed.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:INFO?

The command provides information on all SFP module parameters.

Return values:

<Info> string

Example: `SOUR1:EBOX:CPRI:TEST:SFP:INFO?`
query all parameters of the SFP1 module.
Response: `'Vendor:R&S, Part number: 90567, 'Connector:LC, 'Bit Rate: 2400kbit/s, 'Wave Length:1024,...'.`

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:LOS?

Queries whether data communication via the SFP module failed and the signal was lost.

Return values:

<Sloss>	0 | 1 *RST: 0
Example:	`SOUR1:EBOX:CPRI:TEST:SFP1:LOS?` check whether the data was transferred correctly through the SFP1 module, or whether the signal was lost. Response: `0` if OK, `1` if not OK
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:TX:DISabled?

Queries whether the interface of the breakout board and the SFP transmission line are disabled.

Return values:

<Disabled>	0 | 1 *RST: 0
Example:	`SOUR1:EBOX:CPRI:TEST:SFP:TX:DIS?` check the interface between the breakout board and the SFP transmission line. Response: `1` if active `0` if inactive.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:TX:FAULt?

Queries the error states at the SFP interfaces. If a SFP is disconnected, R&S DigIConf responses with `0` (error).

Return values:

<Fault>	0 | 1 *RST: 0
Example:	`SOUR1:EBOX:CPRI:TEST:SFP:TX:FAUL?` check if a transmission error occured. Response: `0` if OK, `1` if not OK
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TEST:TX:REReset <Rereset>

The command sets or clears the bit on the downlink connection which requests the RE to reset.

Note: This function applies to CPRI RE test mode. In this mode, the R&S EX-IQ-BOX acts as a CPRI REC (master). As defined in the CPRI standard specification, the CPRI REC provides the generation of Layer 1 messages. In this section, you can simulate some events. Use this function to see how the DUT responds to these events.

Parameters:

<Rereset>	ON | OFF *RST: 0

Example: `SOUR1:EBOX:CPRI:TEST:TX:RER ON`
request the RE to reset.

[:SOURce<hw>]:EBOX:CPRI:TEST:TX:SDI <Sdi>

Activates the SDI (**S**ervice Access Point **D**efect **I**ndication) defect indicator. This function intentionally provokes an SDI event, in order to examine whether the DUT evaluates it. In realtime applications, the function detects whether an SAP (**S**ervice **A**ccess **P**oint) is defective or not working properly.

Note: The command applies to CPRI RE test mode. In this mode, the R&S EX-IQ-BOX acts as a CPRI REC (master). As defined in the CPRI standard specification, the CPRI REC provides the generation of Layer 1 messages. In this section, you can simulate some events. Use this function to see how the DUT responds to these events.

Parameters:

<Sdi>	0 | 1 *RST: 0

Example: `SOUR1:EBOX:CPRI:TEST:TX:SDI ON`
activate transmitter SAP Defect Indication.

9.4.8 CPRI TX/RX - Downlink/Uplink Subsystem

The `{TX|RX}` subsystem comprises the remote control commands related to the CPRI Uplink and Downlink.

Depending on the CPRI test mode, the R&S EX-IQ-BOX works either as a transmitter (TX) or receiver (RX), as shown in the following diagrams.

Terms used in the description and familiar synonyms

UL (Uplink): The UL defines the direction from a mobile device to a base station. A synonym to UL is RL (Reverse Link).

DL (Downlink): The DL defines the direction from the base station to the mobile device. A synonym to DL is FL (Forward Link).

- In **CPRI RE** test mode, the R&S EX-IQ-BOX works in the DL (downlink) as a transmitter (TX) and in the UL (uplink) as a receiver (RX).

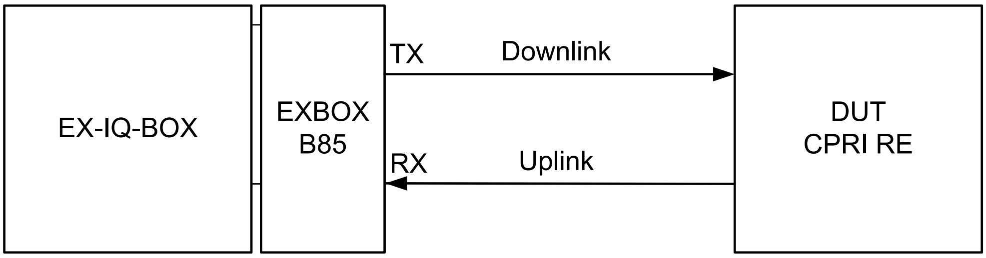


Fig. 9-5: CPRI RE test - schematic representation

- In **CPRI REC** test mode, the R&S EX-IQ-BOX works in the DL as a receiver (RX) and in the UL as a transmitter (TX).

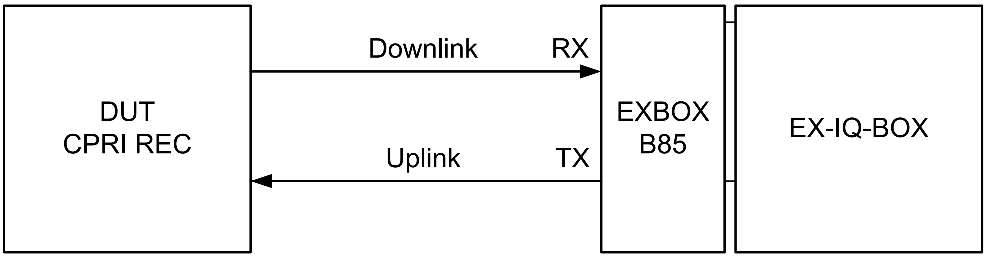


Fig. 9-6: CPRI REC test - schematic representation

The downlink and uplink settings are similar; they both define the signals I/Q data and their distribution inside the CPRI basic frame container (AxC allocation).

The following description of a remote-command applies to both directions of transmission. `{TX|RX}` depicted in curly brackets in the command syntax, distinguishes the transmission direction.

The numeric suffix `<ch>` to `SIGNal` distinguishes the selected signal. Up to 24 signals can be addressed. The signals are indexed in ascending order according to their position in the list.

`<ch>` exclusively addresses the position of the signal in the list. It does not select a signal with an index in the signal name.

[:SOURce<hw>]:EBOX:CPRI:RX:SIGNal<ch>:OUTPut <Output>

Determines the output interface, to transmit the received baseband signal from the DUT to an R&S instrument and/or to the built-in I/Q recorder. That is, if you work in the **RE Test Uplink** or the **REC Test Downlink** mode.

The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, and forwards it to an R&S instrument. Simultaneously, you can also record the signal with the I/Q recorder.

Parameters:

<Output>	IQOutput | RECorder *RST: IQO
Example:	`SOUR1:EBOX:CPRI:RX:SIGN:OUTP IQO` assigns the digital interface to signal output.

[:SOURce<hw>]:EBOX:CPRI:TX:SIGNal<ch>:SOURce <Source>

Determines the signal source for signal transmission to the DUT. That is, if you work in the **RE Test Downlink** or the **REC Test Uplink** mode.

The signal comes either from an R&S instrument via the Digital I/Q Interface of the R&S EX-IQ-BOX, or the signal is generated internally or by means of the waveform memory in the R&S EX-IQ-BOX.

The R&S EX-IQ-BOX converts the I/Q format of the signal into the CPRI protocol format. Embedded with additional control information, the link transfers the data to the DUT.

Parameters:

<Source> PATTern | IQIN | ARB1 | ARB2 | ARB3 | ARB4

PATTern
Uses the internal pattern generator as signal source.

IQIN
An R&S instrument applies a digital baseband signal at DIQ IQ IN 1 connector of the R&S EX-IQ-BOX.

ARB1...4
Selects one of the waveform memories with a loaded I/Q signal.
Notes:
This feature requires, that the R&S EX-IQ-BOX is equipped with the appropriate waveform memory option.
A conflict arises, if no signal is loaded in the memory, or is not activated.
The Multi Waveform options support simultaneous playback of up to four signals. For information on the available options refer to chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory ", on page 23.

*RST: IQIN

Example: `SOUR1:EBOX:CPRI:TX:SIGN:SOUR ARB1`
selects the signal of the first waveform memory as signal source.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:APPLy

Assigns the downlink/uplink settings in order to become effective.

Example: `SOUR1:EBOX:CPRI:TX:APPL`
accept the settings.

Usage: Event

[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC:COUNt?

Queries the number of used AxCs.

Return values:

<Count> integer

Range: 1 to 24
Increment: 1
*RST: 1

Example:	`SOUR1:EBOX:CPRI:TX:AXC0:SOUR?` check the number of used AxCs. Response: `18` 18 AxCs are currently in use.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:BADDress <Baddress>

The position of the AxC within the CPRI basic frame is defined by word address and bit address. This command queries or defines the bit address, i.e. the starting bit inside the word, see `[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:WADDress` on page 376.

Parameters:

<Baddress>	float Range: 0 to 38 Increment: 2 *RST: 0
Example:	`SOUR1:EBOX:CPRI:TX:AXC0:BADD 0` set the starting bit to "0".

[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:CONFlict?

A conflict arises, when AxCs overlap. The command queries the status of overlapping.

Return values:

<Conflict>	OFF | ON No overlapping occurred. AxCs overlapped. *RST: 0
Example:	`SOUR1:EBOX:CPRI:TX:AXC3:CONF?` check if AxC3 overlaps with a previous one. Response: `0` if OK, `1` if not OK
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:SIZE?

Queries the size of the AxC in bits. The size depends on the selected signal source.

With the exception of signals from the signal source Sync Pattern, the size is calculated using the following formula:

$$AxC\_size_{axc}[bit] = I/Q\,\mathrm{Re}\,solution_{signal} \cdot 2$$

For Sync Pattern signals, calculate the source with the formula:

$$AxC\_size_{axc}[bit] = Pattern\ Length_{signal}$$

Return values:

<Size>	integer	
	Range:	2 to 40
	Increment:	1
	*RST:	32

Example: `SOUR1:EBOX:CPRI:TX:AXC1:SIZE?`
check the AxC size.
Response: `32`
the length of AxC1 is 32 bit.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:SOURce?

Queries the signal name the AxC is assigned to.

Note: This command applies to downlink.

Return values:
<Source> string

Example: `SOUR1:EBOX:CPRI:TX:AXC0:SOUR?`
check the signal allocated in AxC 0.
Response: `signal_1`
signal_1 is assigned to the first AxC.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:WADDress <Waddress>

The position of the AxC within the CPRI basic frame is defined by word address and bit address. This command queries or defines the word address, i.e. with which word the AxC starts, while the bit address specifies the bit index inside the word, see `[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:BADDress` on page 375.

Parameters:

<Waddress>	integer	
	Range:	0 to 38
	Increment:	1
	*RST:	1

Example: `SOUR1:EBOX:CPRI:TX:AXC0:WADD 15`
start at word address 20 with the signal in the first AxC.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXCStatus?

The command queries the status of all AxCs.

Note: This command applies to downlink.

Return values:
<Axcstatus> 0 | 1
*RST: 0

Example: `SOUR1:EBOX:CPRI:RX:AXCS?`
check the staus of all AxCs in receiver mode.
Response: `1` if active `0` if not active.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:DRATe:ASSigned?

Queries the assigned I/Q data rate of all active signals. This parameter depends on the size of each assigned AxC and is calculated with the formula:

The assigned data rate is calculated with the formula:

$$Data\,Rate_{assigned}\left[Mbit/s\right] = \sum AxC\_size_{axc} \cdot 3.84\left[MHz\right]$$

Return values:
<Assigned> float
Increment: 0.01
*RST: 0

Example: `SOUR1:EBOX:CPRI:TX:DRAT:ASS?`
query the data rate of all active signals.
Response: `491.52` Mbit/s
the entire data rate of the active signals is 491.52' Mbit/s.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:DRATe:AVAilable?

Queries the available data rate for the I/Q data in the AxC container.

The data rate is calculated with the formula:

$$\begin{aligned} Data\,Rate_{avaliable}\left[Mbit/s\right] &= Data\,Word\,Count \cdot Word\,Length\left[bit\right] \cdot 3.84\left[MHz\right] \\ &= 15 \cdot Word\,Length\left[bit\right] \cdot 3.84\left[MHz\right] \end{aligned}$$

Note: The word length depends on the line bit rate, refer also to "CPRI Basic Frame Graph" on page 169.

Return values:
<Available> float
Increment: 1000
*RST: 921600000

Example: `SOUR1:EBOX:CPRI:TX:DRAT:AVA?`
query the available I/Q data rate.
Response: `921.60` Mbit/s
the CPRI basic frame provides a data rate of 921.6 Mbit/s for I/Q.

Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal:APPend

Adds a new signal to the list. R&S DigIConf attaches a signal with default parameter values, a predetermined name and a name index following the last list entry.

Example:	`SOUR1:EBOX:CPRI:TX:SIGN2:APP` adds a new signal as second list item to the signal list.
Usage:	Event

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal:COUNt?

This command queries the number of active signals.

Note: This command applies to downlink.

Return values:

<Count>	integer Range: 1 to 24 Increment: 1 *RST: 1
Example:	`SOUR1:EBOX:CPRI:TX:SIGN:COUNt?` check the number of used signals. Response: 3 3 signals are currently in use.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:ARB:CONFlict?

The command queries the status of a signal loaded from a waveform memory. A conflict arises, if a waveform memory is selected as signal source and no signal is loaded in the memory, or is not activated.

Note: This command applies to downlink.

Return values:

<Conflict>	0 | 1 | OFF | ON *RST: 0
Example:	`SOUR1:EBOX:CPRI:TX:SIGN:ARB:CONF?` check if the signal in the waveform memory is loaded and activated. Response: `1` if active `0` if ARB is off.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:ARB:FILE?

Queries the loaded waveform file from a waveform memory signal source.

Notes:

This parameter is relevant when operating with ARB. I.e., if you load a file and select the signal source ARB, R&S DigIConf indicates the file name. For standard communication signals, the field is hidden.

R&S DigIConf loads waveforms calculated by simulation software such as Matlab or R&S WinIQSIM2 into the memory of the R&S EX-IQ-BOX. With the aid of the CPRI breakout board, the R&S EX-IQ-BOX then embeds the signal into the CPRI protocol.

Return values:

<File> string

Example: `SOUR1:EBOX:CPRI:TX:SIGN:ARB:FILE?`
query the currently loaded wave file.
Response: `p4DQPSK7_68M_OV4_2016Samples.wv`

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:ALLocation <Allocation>

Defines how to allocate the AxCs to the signal. R&S DigIConf automatically assigns the AxCs to a signal, and this parameter specifies the method.

Parameters:

<Allocation> PACKed | FLEXible

PACKed
The AxCs allocate a continuous area inside the CPRI basic frame. Word address and offset address of the first AxC define the starting position. If possible, the following AxCs are placed successively. The signal AxCs are automatically laid in a free area of the CPRI frame. If there is not enough free space, the signal AxCs are placed at the beginning of the base frame, i.e. at the position of word 1.

FLEXible
Manually assign the position of the AxCs by word address and offset address.
Tip: Use this setting, to embed each sample of a signal individually within the CPRI basic frame.

Range: 1 to 4
*RST: PACKed

Example: `SOUR1:EBOX:CPRI:TX:SIGN:AXC:ALL FLEX`
selects *flexible* to manually assign the AxC position.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:COUNt:ASSign?

Queries the assigned number of AxCs and the assigned data rate. The assigned data rate depends on the signal group settings, i.e. on the repetition rate and the number of active AxCs per group.

The assigned data rate is calculated with the formula:

Data $\text{Rate}_{\text{assigned}}$ [Mbit/s] = 3.84 [MHz] x 2 x I/Q Resolution ($\sum$($\text{AxC\_on\_count}_{\text{grp}}$ x $\text{Repetition}_{\text{grp}}$) / $\sum$($\text{Repetition}_{\text{grp}}$))

Note: In case of "Sync Pattern" signals, the assigned data rate depends on the pattern length and the sample rate. It is calculated by the sample rate as shown:

Data $\text{Rate}_{\text{assigned}}$ = Sample Rate x Pattern Length

Return values:

<Assign>	integer Range: 1 to 24 Increment: 1 *RST: 1

Example: `SOUR1:EBOX:CPRI:TX:SIGN2:AXC:COUN:ASS?`
check the data rate and the AxCs assigned to the second signal.
Response: `3 / 368.40` Mbit/s
this signal requires 3 AxCs and a data rate of 368.4 Mbit/s.
To checkup, ask whether the allocated values fit to the required values:
`SOUR1:EBOX:CPRI:TX:SIGN2:AXC:DRAT:STAT?`
Response: `0` if OK, `1` if not OK
Refer also to `[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:DRATe:STATus` on page 382.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:COUNt:NEEDed?

Queries the needed number of AxCs and the required data rate.

Depending on the sample rate, a signal needs one or more AxCs to carry its I/Q data. If possible, R&S DigIConf automatically assigns the number of needed AxCs to the signal.

Note: The maximum number of AxCs for all signals is 24.

The needed number of AxCs is calculated with the formula:

$\text{AxCs}_{\text{needed}}$ = ceil (Sample Rate x Oversampling / 3.84 [MHz])

The data rate is calculated with the formula:

Data $\text{Rate}_{\text{needed}}$ [Mbit/s] = Sample Rate x Oversampling x 2 x I/Q Resolution

Note: For signal source "Pattern" the needed number of AxCs is 1.

Return values:

<Needed>	integer Range: 1 to 24 Increment: 1 *RST: 1

Example:	`SOUR1:EBOX:CPRI:TX:SIGN2:AXC:COUN:NEED?`
	check the data rate and the AxCs needed from the second signal.
	Response: `3 / 358.40` Mbit/s
	this signal requires '3' AxCs and a data rate of '358.4' Mbit/s'.
	To checkup, ask whether the needed values fit to the assigned values:
	`SOUR1:EBOX:CPRI:TX:SIGN2:AXC:DRAT:STAT?`
	Response: `0` if OK, `1` if not OK

Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:DRATe:ASSigned?

Queries the data rate assigned to the signal.

The assigned data rate depends on the signal group settings, i.e. on the repetition rate and the number of active AxCs per group.

The assigned data rate is calculated with the formula:

Data Rate$_{\text{assigned}}$ [Mbit/s] = 3.84 [MHz] x 2 x I/Q Resolution (∑(AxC_on_count$_{\text{grp}}$ x Repetition$_{\text{grp}}$) / ∑(Repetition$_{\text{grp}}$))

Note:

In case of "Sync Pattern" signals, the assigned data rate depends on the pattern length and the sample rate. It is calculated by the sample rate as shown:

Return values:

<Assigned>	float Increment: 10000 *RST: 122880000
Example:	`SOUR1:EBOX:CPRI:TX:SIGN:AXC:DRAT:ASS?` check the data rate of the first signal. Response: `122.88` Mbit/s this signal is transmitted with 122.88 Mbit/s data rate.
Usage:	Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:DRATe:NEEDed?

Queries the data rate required from the signal.

This command applies to downlink.

Return values:

<Needed>	float Increment: 10000 *RST: 122880000

Example: `SOUR1:EBOX:CPRI:TX:SIGN:AXC:DRAT:NEED?`
check the data rate the first signal needs.
Response: `122.88` Mbit/s
this signal uses `122.88` Mbit/s data rate.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:DRATe:STATus?

Queries whether the assigned data rate fits to the required data rate.

Deviations in data rates! Refer to the example under "Example to CPRI Groups Concept" on page 171, on what to do if the values do not fit.

Return values:

<Status>	OFF | ON The needed and the assigned data rates values are the same. No error occurs. The needed and the assigned data rate values differ. Signal transmission cannot be performed. To fix the problem, proceed as described in "Example to CPRI Groups Concept" on page 171. *RST: 1

Example: `SOUR1:EBOX:CPRI:TX:SIGN:AXC:DRAT:STAT?`
checks if the assigned values fit to the values required from the signal.
Response: `0` if OK, `1` if not OK

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:LIST?

Note: This command applies to downlink.

Return values:

<List>	string

Example: `SOUR1:EBOX:CPRI:TX:SIGN2:AXC:LIST?`
query the AxCs assigned to the second signal.
Response: `AXC3, AXC4, AXC5` this signal uses 3 AxCs.

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:COPY

Creates a copy of a signal selected with the index `<ch>`. The function copies the parameter values and assigns the same name with suffix for distinction. The new signal is added at the end of the list, i.e. the index of the copied signal is incremented by 1 after the last signal.

Example:	`SOUR1:EBOX:CPRI:TX:SIGN3:COPY` copies the third signal from the list of downlink signals.
Usage:	Event

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:CRESt <Crest>

Sets the crest factor. This parameter is required for the correct indication of the RMS Level value, see `[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:RMS` on page 389.

The rms level is calculated with the formula:

RMS [dB] = Peak [dB] - Crest Factor [dB] + Gain [dB]

The crest factor must correspond to the input signal. Enter the value, e.g. a connected baseband generator provides.

Note: Crest factor applies to external signals, i.e. to digital standards or to user defined signals. If the R&S EX-IQ-BOX is working with an internal signal, that is generated by a pattern or a waveform file, the parameter is already known must not be entered manually.

Parameters:

<Crest>	float Range: 0 to 30 Increment: 0.01 *RST: 0 Default unit: dB
Example:	`SOUR1:EBOX:CPRI:TX:SIGN:CRES 10dB` set the 10 dB crest factor.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:DELete

Removes a signal from the list. The function removes the corresponding AxCs from the list of used AxCs. The signal is selected by the index `<ch>`.

Example:	`SOUR1:EBOX:CPRI:TX:SIGN2:DEL` removes the second signal from the list of downlink signals.
Usage:	Event

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GAIN <Gain>

Sets a gain value for the I/Q signal. Positive values lead to a digital signal amplification, and negative values correspond to a digital signal attenuation. A gain value of 0 dB results in an unchanged level of the I/Q signal. By default, the value is set to 0 dB.

Parameters:

<Gain>	float Range: -40 to 6 Increment: 0.01 *RST: 0 Default unit: dB
Example:	`SOUR1:EBOX:CPRI:TX:SIGN:GAIN -20` set -20 dB gain.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GROup:COUNt <Count>

Determines the number of groups for a signal. The grouping enables to achieve arbitrary sample rates that are not necessarily integer multiples of the CPRI basic frame rate. Each group defines an AxC configuration for a certain time, i.e. repetitions. Thus you can change the AxC assignment over time by using more than one group with different settings.

Parameters:

<Count>	integer Range: 1 to 4 Increment: 1 *RST: 1
Example:	`SOUR1:EBOX:CPRI:TX:SIGN:GRO:COUN 2` specify 2 groups for distribution of the first signal in the CPRI frame.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GROup<user0>:AXC<ch0>:PATTern <Pattern>

Queries the binary data pattern of an AxC and responses in binary format.

Enter the required pattern with the command, respecting the syntax as follows:

`"#B0101010101010101,16"`

`#B` = binary representation

`0101010101010101` = pattern

`16` = pattern length

See also the example below for a complete command.

By default, all data pattern is set to zero. You can basically set up to 40 bits, but the currently possible number depends on the signal length that is specified in "Pattern Length" on page 161.

Parameters:

<Pattern>	integer *RST: 0000

Example: `SOUR1:EBOX:CPRI:TX:SIGN:GRO1:AXC0:PATT "#B0101010101010101,16"`
insert the pattern for the first signal, and assign the signal to AxC1 in the first group of the AxC allocation table,

---

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GROup<user0>:AXC<ch0>:STATe <State>

Switches on /off the respective AxC. By default, all AxCs are activated.

Parameters:

<State>	OFF | ON *RST: OFF

Example: `SOUR1:EBOX:CPRI:TX:SIGN2:GRO1:AXC1:STAT ON`
activates AxC1 in the first group of the AxC allocation table.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:GROup<user0>:REPetition <Repetition>

Selects the AxC group and specifies the repetitions for the signal.

Sets the number of repetitions, i.e. how many CPRI basic frames follow the current group setting.

The numeric suffix `GROUP<user0>` distinguishes the selected group. Up to 4 groups can be specified, i.e. "G #0" to "G #3".

Note: AxC status and AxC pattern depend on the used signal sources. Status refers to externally used sources and pattern indicates the coding of the AxCs with internal signal source.

Parameters:

<Repetition>	suffix, integer Range: 1 to 20000 Increment: 1 *RST: 1

Example: `SOUR1:EBOX:CPRI:TX:SIGN:GRO1:REP 3`
repeats the signal of Group1 3 times.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:IQResolution <Iqresolution>

Sets the I/Q resolution in bits. The resolution is valid for both, the I and the Q values. I.e, if you set the resolution to 16 bits, the sample rate is 32 bits wide, composed of 16-bit I and 16-bit Q.

Parameters:

<Iqresolution> float

Range: 4 to 18
Increment: 1
*RST: 16

Example: `SOUR1:EBOX:CPRI:TX:SIGN:IQR 16`
sets 16 bits I/Q resolution.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:NAME <Name>

This command enters or changes the signal name.

Parameters:

<Name> string

Example: `SOUR1:EBOX:CPRI:TX:SIGN4:NAME "sig_3gpp"`
assign the signal name `sig_3gpp` to the fourth signal of the list in transmitter mode.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:NFORmat <Nformat>

Selects a numeric representation for data transmission.

Allowed number range for word size n Bit:

$-2^{n-1} \leq n \leq +2^{n+1}$

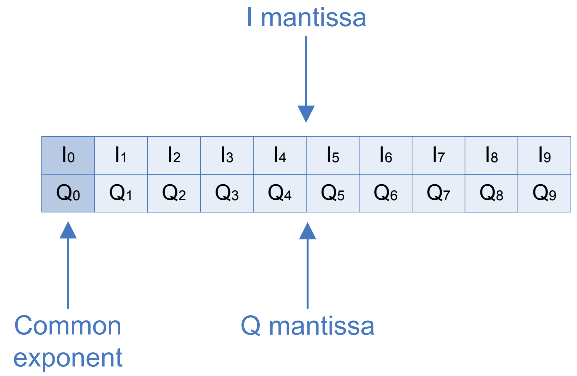
Table 9-4: User defined > Numeric format coding

z		2´s Complement					Binary Offset			
-8		1	0	0	0		0	0	0	0
-7		1	0	0	1		0	0	0	1
-6		1	0	1	0		0	0	1	0
-5		1	0	1	1		0	0	1	1
-4		1	1	0	0		0	1	0	0
-3		1	1	0	1		0	1	0	1
-2		1	1	1	0		0	1	1	0
-1		1	1	1	1		0	1	1	1
0		0	0	0	0		1	0	0	0
1		0	0	0	1		1	0	0	1
2		0	0	1	0		1	0	1	0
3		0	0	1	1		1	0	1	1
4		0	1	0	0		1	1	0	0
5		0	1	0	1		1	1	0	1

z		2´s Complement					Binary Offset			
6		0	1	1	0		1	1	1	0
7		0	1	1	1		1	1	1	1

9E2 encoding format is used in mobile base stations to extend the dynamic range of I and Q, while reducing the needed amount of bits.

The coding is 9E2 with 9 bits mantissa and 2 bits exponent, that are shared from I and Q, as shown in the figure.



I_0	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9
Q_0	Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7	Q_8	Q_9

Fig. 9-7: 2's complement 9E2

The I and Q samples of the 2's complement 9E2 are calculated with the formulas:

I sample 10 bits = 9 bits mantissa + 1 bit, i.e. bit_0 exponent

$$I = \left(\left(\sum_{i=0}^{7} 2^{i} \cdot I_{i+1} \right) - 2^{8} \cdot I_{9} \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

Q sample 10 bits: 9 bits Q mantissa + 1 bit, i.e. bit_1 exponent

$$Q = \left(\left(\sum_{i=0}^{7} 2^{i} \cdot Q_{i+1} \right) - 2^{8} \cdot Q_{9} \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

Parameters:

<Nformat>	COMPlement | C9E2 | BOFFset

COMPlement
Formats the signal in two's-complement.
The most significant bit has a value of -2^{n-1}, the bits of lesser significance follow as:
$+2^{n-2}...+2^0$

C9E2
Formats the signal in two's-complement variant 9E2.

BOFFset
Formats the signal in binary offset.
Adds a binary offset of -2^{n-1} such that the final values are always positive.
Example
Adds a binary offset of -2^{n-1} such that the final values are always positive.

*RST: COMPlement

Example: `SOUR1:EBOX:CPRI:TX:SIGN2:NFOR COMP`
set the numeric format of the second signal to 2's complement 2.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:OSAMpling <Osampling>

Determine the oversampling factor.

Note: Oversampling appliers to external signals, i.e. to digital standards or to user defined signals. If the R&S EX-IQ-BOX is working with an internal signal, that is generated by a pattern or a waveform file, the parameter is already considered and therefore not relevant.

Parameters:

<Osampling> integer

Range:	1 to 4
Increment:	1
*RST:	1

Example: `SOUR1:EBOX:CPRI:TX:SIGN:OSAM 2`
sets oversampling factor 2.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:PLENgth <Plength>

Defines the length of the pattern used by the internal pattern generator.

Note: The parameter applies to the physical source `PATTern`.

Parameters:

<Plength> float

Range:	2 to 40
Increment:	2
*RST:	16

Example: `SOUR1:EBOX:CPRI:TX:SIGN:PLEN 4`
sets the pattern length 4.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:RMS?

Queries the rms level of the signal. The signal level is expressed in terms of an rms value. It always refers to both signal components (SQR(I2+Q2)).

In order to get the RMS value correctly, the crest factor of the signal must be specified, see `[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:CRESt` on page 383.

The rms level is calculated with the formula:

RMS [dB] = Peak [dB] - Crest Factor [dB] + Gain [dB]

Note: The RMS level refers to external signals, i.e. to digital standards or to user defined signals. If the R&S EX-IQ-BOX is working with an internal signal, that is generated by a pattern or a waveform file, the parameter is already known must not be entered manually.

Return values:
<Rms> float

Range: -40 to 6
Increment: 0.01
*RST: 0

Example: `SOUR1:EBOX:CPRI:TX:SIGN:RMS?`
query the crest factor.
Response: `-10 dbFS`

Usage: Query only

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:SRATe <Srate>

Queries the sample rate. If you process user defined signals, you can set the value.

Consider that the sampling rate of the R&S signal generator fits to the sampling rate of R&S DigIConf, as well as to the sampling rate of the R&S signal analyzer.

The table shows the predefined sample rates of the available signals. The sample rate of a digital standard varies corresponding to the frequency.

Table 9-5: Sample rate values, depending on the signal type

Standard	Frequency variant	Sample Rate
GSM/EDGE		270.8333 kHz
3GPP FDD		3.84 MHz
CDMA 2000		1.228 MHz
LTE	1.4 MHz	1.92 MHz
	3.0 MHz	3.84 MHz
	5.0 MHz	7.68 MHz
	10.0 MHz	15.36 MHz

Standard	Frequency variant	Sample Rate
	15.0 MHz	23.04 MHz
	20.0 MHz	30.72 MHz
WiMAX	3.5 MHz	4.0 MHz
	5.0 MHz	5.6 MHz
	7.0 MHz	8.0 MHz
	8.75 MHz	10.0 MHz
	10.0 MHz	11.2 MHz
Sync Pattern		3.84 MHz

Parameters:

<Srate> float

Range: 1000 to 100000000

*RST: 3840000

Example: `SOUR1:EBOX:CPRI:TX:SIGN:SRATe?`

query the sample rate of the first signal in transmitter mode.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:STANdard <Standard>

This command selects a communication standard. R&S DigIConf provides the selection of a standard signal with automatically assigned sample rate. Alternatively, select a signal from a waveform file, the ARB function, or assign user-specific values.

R&S DigIConf supports all current standards and their variants. When selecting a standard signal, the program automatically sets the relevant parameters and values.

For example, a loaded digital standard automatically adjusts the needed AxCs, assigns the sample rate, and sets up several other relevant parameters.

Note: The digital standard signals, or user defined signals refer to external signal input or output, i.e. the physical signal sources DIG IQ IN or DIG IQ OUT.

Parameters:

<Standard> USER | W3GPP | LTE_1M4 | LTE_3M | LTE_5M | LTE_10M | LTE_15M | LTE_20M | WIMAX_3M5 | WIMAX_5M | WIMAX_7M | WIMAX_8M75 | WIMAX_10M | CDMA2K | WIMAX_20M | GSM

USER
Specifies a user defined signal for transmission, define a signal with arbitrary parameters.

W3GPP
Selects the parameters of the W-CDMA standard 3GPP FDD.
W-CDMA (**W**ideband **C**ode **D**ivision **M**ultiple **A**ccess) covers the radio technology UMTS (**U**niversal **M**opbile **T**elecommunications **S**ystem). 3GPP (**3**rd **G**eneration **P**artnership **P**roject) is a collaboration between groups of telecommunication associations, which define a globally applicable third generation mobile phone system specification. 3GPP standardization comprises all GSM and W-CDMA specifications.

LTE_1M4|LTE_3M|LTE_5M|LTE_10M|LTE_15M|LTE_20M
Selects an LTE (**L**ong **T**erm **E**volution) signal. Based on UMTS, LTE provides a wireless broadband internet system with voice and other services built on top, e.g. authentication.
LTE bandwidths: 1.4 | 3.0 | 5.0 | 10.0 | 15.0 | 20.0 MHz

WIMAX_3M5|WIMAX_5M|WIMAX_7M|WIMAX_8M75| WIMAX_10M|WIMAX_20M
Selects the digital standard IEEE 802.16 WiMAX (**W**orldwide **I**nteroperability for **M**icrowave **A**ccess). WiMAX provides wireless transmission of data using a variety of transmission modes, as e.g. point-to-multipoint links or mobile internet access.
WiMAX bandwidths: 3.5 | 5.0 | 7.0 | 8.75 | 10.0 | 20.0 MHz

CDMA2K
Selects a signal that follows the CDMA standard.
CDMA2000 (**C**ode **D**ivision **M**ultiple **A**ccess) uses a multiple access scheme for digital radio, to send voice, data, and signaling data (such as a dialed telephone number) between mobile phones and cell sites.

GSM
Selects a signal that follows te GSM/EDGE standard.
GSM/EDGE (**G**lobal **S**ystem for **M**obile Communications/ **E**nhanced **D**ata **R**ates for **GSM** **E**volution) covers the 2nd generation mobile radio technology. Selecting this signal standard, the sample rate is set to 270,833333 kSps. This sample rate does not fit well into the CPRI basic frame rate. Therefore, the sampling rate of GSM/EDGE is only achieved by using a rather complicated group setup, the AxC settings over time.

*RST: W3GPP

Example:

`SOUR1:EBOX:CPRI:TX:SIGN:STAN LTE_20M`
select an LTE signal with 20 MHz bandwidth.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:STATe <State>

The command activates a signal for transmission selected with `<ch>`.

Parameters:

<State>	OFF | ON *RST: OFF

Example: `SOUR1:EBOX:CPRI:RX:SIGN:STAT ON`
activates the fist signal for transmission in reciever mode.

[:SOURce<hw>]:EBOX:CPRI:TX|RX:WARNing?

The command asks if settings have been changed, but not accepted.

Return values:

<Warning>	0 | 1 *RST: 0

Example: `SOUR1:EBOX:CPRI:TX:WARN?`
check if changed settings have been accepted.
Response: `1` if settings are not yet accepted, `0` if OK.

Usage: Query only

9.4.9 CPRI Vendor Data Subsystem

The `VENDor:DATA` command subsystem provides input of user-specific information via remote control commands.

[:SOURce<hw>]:EBOX:CPRI:VENDor:DATA <Data>

With this command you can enter data for transmission, or query received data received.

In TX mode, i.e. CPRI RE downlink or CPRI REC uplink, you can determine vendor-specific data for transmission.

As a receiver (RX), i.e. in uplink CPRI RE or downlink CPRI REC test mode, you can query the received vendor specific data.

Find additional information on vendor data exchange in the CPRI specification.

Parameters:

<Data>	string The value range depends on the word width.

Example: `SOUR1:EBOX:CPRI:VEND:DATA 16,#H2A`
determine vendor-specific data for transmission.

[:SOURce<hw>]:EBOX:CPRI:VENDor:DIRection <Direction>

The command selects the data direction for vendor data exchange.

Parameters:

<Direction>	DOWN | UP **DOWN** **CPRI RE test mode (TX):** User data entered in the table is embedded in the CPRI link for transmission to the DUT. **CPRI REC test mode (RX):** Vendor data is extracted from the CPRI link and displayed in the table. **UP** **CPRI RE test mode (RX):** Vendor data is extracted from the CPRI link and displayed in the table. **CPRI REC test mode (TX):** User data entered in the table is embedded in the CPRI link for transmission to the DUT. *RST: DOWN
Example:	`SOUR1:EBOX:CPRI:VEND:DIR DLIN` determine the direction for vendor data transmission.

[:SOURce<hw>]:EBOX:CPRI:VENDor:STATe <State>

The command starts and stops vendor data exchange.

Parameters:

<State>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:CPRI:VEND:STAT ON` start vendor data exchange.

[:SOURce<hw>]:EBOX:CPRI:VENDor:WWIDth?

The command queries the word width. The word width depends on the CPRI line bit rate.

The following table shows the word width related to the line bit rate

Table 9-6: Word width related to the line bit rate.

Line bit rate	**Word width**
[Mbit/s]	**[bits]**
2x (1228.8)	16
4x (2457.6)	32
5x (3072.0)	40

Note: By determining the line bit rate, the DUT also defines the word width. See also `[:SOURce<hw>]:EBOX:CPRI:HW:LBRate` on page 354.

Return values:

<Wwidth>	float Range: 1 to 18 Increment: 1 *RST: 16
Example:	`SOUR1:EBOX:CPRI:VEND:WWID?` query the word width.
Usage:	Query only

9.5 DigRF - Remote Control Commands

9.5.1 DigRF ARB Subsystem

The ARB subsystem contains all remote control commands that are relevant for loading a waveform file in the waveform memory of the R&S EX-IQ-BOX.To get a list of available waveform files, see `[:SOURce<hw>]:EBOX:ARB:CATalog` on page 305.

The numeric suffix to `ARB<ch>` distinguishes the channel of the waveform memory (`ARB1...4`).

[:SOURce<hw>]:EBOX:DRF:ARB:PRESet

The command sets the wavefom memory to default, i.e. it erases the ARB table (all loaded waveform files and settings).

Example:	`SOUR1:EBOX:DRF:ARB:PRES` clears the ARB table.
Usage:	Event

[:SOURce<hw>]:EBOX:DRF:ARB:RELoad

Updates downloaded waveform files, if data has changed. Reload updates all currently assigned files.

Example:	`SOUR1:EBOX:DRF:ARB:REL` update assigned files in the waveform memory.

Usage: Event

[:SOURce<hw>]:EBOX:DRF:ARB<ch>:FILE <file>

Selects a stored waveform file. Enter directory and file name with the file extension `*.wv` for waveform files.

Parameters:

<file> <path>, <file_name>.<ext>

String parameter containing the directory, the file name, and the file extension `*.wv` for waveform files.

Example: `SOUR1:EBOX:DRF:ARB1:FILE "..\\DigIConf\DigRF\waveforms\3gpp.wv"`

load the waveform file in the IQ sources (ARB) waveform memory.

[:SOURce<hw>]:EBOX:DRF:ARB<ch>:OPTions?

Queries the name of the waveform option in an IQ source.

If the wave form file is provided by R&S WinIQSIM2, and is based on a digital standard, the command returns the name of the option, like e.g., EXBOX-K242, which represents the 3GPP-FDD-Standard. "None" indicates that the loaded waveform file was created with another software, or does not base on a digital standard signal.

Find the list of supported R&S options in chapter 3.2.2.4, "Digital Standards with R&S WinIQSIM2", on page 23.

Return values:

<opts> string

Example: `SOUR1:EBOX:DRF:ARB1:OPT?`

Query the currently loaded waveform option.

Response: `EXBOX-K242`

The option `"...K242"` is installed to process digital 3GPP standard signals.

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:ARB<ch>:SAMPles?

Returns the number of samples of a waveform.

Return values:

<samples> float

Example: `SOUR1:EBOX:DRF:ARB1:SAMP?`

query the samples of the waveform in the first waveform memory.

Response: `7.680` samples.

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:ARB<ch>:SRATe?

Queries the sample rate the waveform is calculated with. The sample rate represents the number of samples per second that are used for digitizing.

Return values:

<srate>	float

Example:	`SOUR1:EBOX:DRF:ARB1:SRAT?`
	query the sample rate of the signal loaded in the IQ sources waveform memory.
	`Response: 122.88`
	the current sample rate is "122.88 Mbit/s"

Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:ARB<ch>:STATe <state>

Activates the loaded waveform. It must be active, as a prerequisite for the transfer of the data stream in the script.

To activate signal transmission, assign the signal as the signal source in the DigRF script. The R&S EX-IQ-BOX then embeds the signal into the DigRF protocol.

Parameters:

<state>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:DRF:ARB1:STAT ON` activate the waveform loaded in ARB1.

[:SOURce<hw>]:EBOX:DRF:ARB<ch>:TSAMples?

Returns the number of samples of all active waveform files.

Return values:

<tsamp>	float
Example:	`SOUR1:EBOX:DRF:ARB1:TSAM?` query the samples of the active signals in the IQ sources waveform memories. Response: `4.425`
Usage:	Query only

9.5.2 DigRF BER Subsystem

The `TEST:` subsystem contains the remote-control commands to evaluate signal transmission at the interface. Aditionally payload test parameters are supported. Both tests provide BER evaluation.

The following description of a remote-command applies to both tests, distinguished by `{IFC|PL}` in the command syntax.

[:SOURce<hw>]:EBOX:DRF:BER:IFC <ifc>

Selects the DigRF interface for the Interface BER test.

Parameters:

<ifc>	D3G | D4V *RST: D3G

Example: `SOUR1:EBOX:DRF:BER:IFC D3G`
select DigRF 3G interface.

[:SOURce<hw>]:EBOX:DRF:BER:IFC:MODE <mode>

Selects the interface mode, i.e. the line rate for the BER test. The available modes depend on the selected interface.

Parameters:

<mode>	LS | HS | HS1P | HS1S *RST: LS
DigRF 3G	**LS** Test at the **L**ow **S**peed line rate, which corresponds to the used reference frequency. **HS** Use the **H**igh **S**peed line rate, which corresponds to the used reference frequency.
DigRF v4	**LS** Test at the **L**ow **S**peed line rate, which corresponds to the used reference frequency. **HS1P** Test at **H**igh **S**peed **P**rimary interface frequency. **HS1S** Test at the **H**igh **S**peed **S**econdary interface frequency.

Example:	`SOUR1:EBOX:DRF:BER:IFC D3G`
	`SOUR1:EBOX:DRF:BER:IFC:MODE LS`
	test the DigRF 3G interface at low speed trate.
	`SOUR1:EBOX:DRF:BER:IFC D4V`
	`SOUR1:EBOX:DRF:BER:IFC:MODE H1SP`
	test the DigRF v4 interface at low speed trate.

[:SOURce<hw>]:EBOX:DRF:BER:IFC:PATTern <pattern>

Defines a user-specific bit pattern with a maximum length of 16 bits.

Parameters:	
<pattern>	integer
Example:	`SOUR1:EBOX:DRF:BER:IFC:PATT #B0101010101010101,16` set a bit pattern to generate the test signal.

[:SOURce<hw>]:EBOX:DRF:BER:IFC:SIGNal <signal>

Selects the test signal for the BER interface test.

Parameters:	
<signal>	PRBS | PATT **PRBS** Select a PRBS16 sequence as test pattern. The length of the test pattern is defined as 2^{16}-1=65535 bits. **PATTERN** Define a test pattern manually. *RST: PRBS
Example:	`SOUR1:EBOX:DRF:BER:IFC:SIGN PATT` test the interface with a defined pattern.

[:SOURce<hw>]:EBOX:DRF:BER:IFC:SIGNal:STATe <state>

Starts the interface BER tester.

Parameters:	
<state>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:DRF:BER:IFC:SIGN:STAT ON` start TX interface BER test.

[:SOURce<hw>]:EBOX:DRF:BER:IFC|PL:BER?

Queries the bit error rate. The BER result is the ratio, which is calculated by dividing the number of error bits by the total number of bits (RX Error Bits/RX Received Bits).

Return values:

<ber>	float
Example:	`SOUR1:EBOX:DRF:BER:IFC:BER?` query the bit error rate of the interface BER test.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:BER:IFC|PL:RXBits?

Queries the total number of received bits. Low Level BER test consecutively counts the number of received bits in order to compare them with the sent data and to determine the error rate.

Return values:

<bits>	float
Example:	`SOUR1:EBOX:DRF:BER:IFC:RXB?` query the received bits from the interface BER test.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:BER:IFC|PL:RXERrors?

Queries the number of received incorrect bits. The function always starts counting from 0 at the start of the BER measurement.

Return values:

<errors>	float
Example:	`SOUR1:EBOX:DRF:BER:IFC:RXER?` query the received error bits from the interface BER test.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:BER:PL:SIGNal <signal>

Selects the test signal for the low level payload BER test.

Parameters:

<signal>	PRBS | COUNTER **PRBS** Select a PRBS16 sequence as test pattern. The length of the test pattern is defined as 2^{16}-1=65535 bits. **COUNTER** Use a counter for the number of bits/blocks and the number of error bits. *RST: PRBS16
Example:	`SOUR1:EBOX:DRF:BER:PL:SIGN PRBS` execute the test with a PRBS sequence.

[:SOURce<hw>]:EBOX:DRF:BER:PL:STATe?

Queries the state of the payload test.

Return values:

<state>	OFF | ON	
	Range:	0 to 1
	*RST:	OFF

Example:	`SOUR1:EBOX:DRF:BER:PL:STAT?` check whether the DigRF payload test is running.
Usage:	Query only

9.5.3 DigRF Status Subsystem

The `CSTatus:` subsystem contains the remote-control commands to evaluate the activities in the DigRF communication link statistically.

The following description of a remote-command applies to DigRF standards, distinguished by `D3G|D4V` in the command syntax.

[:SOURce<hw>]:EBOX:DRF:CSTatus:D3G|D4V:ERRors: BADEye|SMISmatch|DAOF|PAZ?

The command enables you to query the number of errors of a specific error type, occurred at the corresponding DigRF interface.

Return values:

<errors>	float
Example:	`SOUR1:EBOX:DRF:CST:D3G:ERR:BADE?` returns the number of occurred badeye mismatches at DigRF 3G.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:CSTatus:D3G|D4V:ERRors:RESet

Resets the error counter of the corresponding DigRF interface.

Example:	`SOUR1:EBOX:DRF:CST:D3G:ERR:RES` resets the error counter of DigRF 3G.

[:SOURce<hw>]:EBOX:DRF:CSTatus:D3G|D4V:ERRors:STATus?

Queries the global error status of the DigRF interface.

Return values:

<stat>	string
Example:	`SOUR1:EBOX:DRF:CST:D3G:ERR:STAT?` returns the error status.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:CSTatus:D3G|D4V:RX:EVENts<st>?

Queries the events of the corresponding DigRF interface.

Return values:

<Events>	float
Example:	`SOUR1:EBOX:DRF:CST:D4V:RX:EVEN:RES?` returns the number of events at the DigRF v4 interface.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:CSTatus:D3G|D4V:TX:EVENts<st>?

Queries the events of the corresponding DigRF interface.

Return values:

<Events>	1 | 2 | 3 | 4
Example:	`SOUR1:EBOX:DRF:CST:D3G:TX:EVEN:RES?` returns the number of received events at the DigRF 3G interface.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:CSTatus:EVENts:RESet

Resets all events.

Parameters:

<doReset>	OFF | ON
Example:	`EBOX:DRF:CST:EVEN:RES 1` resets events.
Usage:	Event

[:SOURce<hw>]:EBOX:DRF:CSTatus:EVENts:SRESet <doReset>

Resets all events at startup of a script.

Parameters:

<doReset>	OFF | ON

Example:	`EBOX:DRF:CST:EVEN:SRES 1` activates that all events are reset when a script starts.

9.5.4 DigRF D3G|DV4 Subsystem

The `DRF:D3G|DV4` subsystem comprises the remote control commands related to the DigRF hardware settings.

The description of a remote-command applies to DigRF standards, distinguished by `D3G|D4V` in the command syntax.

The numeric suffix `<ch>` to `CHANnel` distinguishes between channel 1 and 2.

[:SOURce<hw>]:EBOX:DRF:D3G:CHANnel<ch>:TX:SLEWrate <slew>

Activates the reduced slew rate of the output signal. When activated the slew rate decreases.

Parameters:

<slew>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:DRF:D3G:CHAN1:TX:SLEW ON` supplies the signal in channel 1 with reduced slew rate.

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:RX:IPOLarity <pol>

Activates the inverted polarity of the RX1 or RX2 input signal, respectively.

Parameters:

<pol>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:DRF:D3G:CHAN1:RX:IPOL ON` inverts the incoming signal in channel1 (RX1).

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:INTerface <ifc>

Sets the interface standard for data transmission.

Parameters:

<ifc>	USER | LVDS18 | LVDS12 | SLVS18 | SLVS12 | USER4 | LA12 | SA12 | LA18 | SA18 *RST: 1.8 V LVDS
DigRF 3G	**USER** Enables to configure the electrical parameters for transmission manually. **LVDS18 | LVDS12** Selects the 1.8 or 1.2 V LVDS voltage level to be used in the RX Data and TX Data links (**L**ow **V**oltage **D**ifferential **S**ignaling). **SLVS18 | SLVS12** Select the 1.8 or 1.2 V SLVS voltage level (**S**calable **L**ow **V**oltage **S**ignaling).
DigRF v4	**USER4** Enables to configure the electrical parameters individually. **LA12 | LA18** Selects the 1.2 or 1.8 V LA voltage level (**L**ong **A**mplitude). **SA12 | SA18** Selects the 1.2 or 1.8 V SA voltage level (**S**mall **A**mplitude).

Example: `SOUR1:EBOX:DRF:D3G:CHAN1:TX:INT LVDS12`
operates with 1.2 V LVDS in channel 1 of the DigRF 3G interface.

Example: `SOUR1:EBOX:DRF:D4V:CHAN1:TX:INT LA18`
transmits the signal with 1.8 V LA in channel 1 of the DigRF v4 interface.

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:IPOLarity <ipol>

Activates the inverted polarity of the TX1 or TX2 output signal, respectively.

Parameters:

<ipol> OFF | ON
*RST: OFF

Example: `SOUR1:EBOX:DRF:D3G:CHAN1:TX:IPOL ON`
inverts the TX1 output signal.

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:LTYPe <typ>

Sets the load type for the differential output voltage of the TX signal. Interface standards are firmly set to "Terminated". If you work in User mode, you can also send the signal unterminated.

Parameters:

<typ> UNTERM | TERM

UNTERM
Vdiff is doubled

TERM
Vdiff is halved

*RST: TERM

Example: `SOUR1:EBOX:DRF:D3G:CHAN1:TX:INT USER`
`SOUR1:EBOX:DRF:D3G:CHAN1:TX:LTYP UNTERM`
sets the DigRF 3G interface standard to `USER` and supplies the TX output signal unterminated.

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:SLEWrate <slew>

Activates the reduced slew rate of the output signal. When activated the slew rate decreases.

Parameters:

<slew> OFF | ON

*RST: OFF

Example: `SOUR1:EBOX:DRF:D3G:CHAN1:TX:SLEW ON`
supplies the signal in channel 1 with reduced slew rate.

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:VCM <vcm>

Queries the common mode voltage of the DigRF interface. The common mode voltage Vcm is defined as the average of the voltages in a TX path (TX_n, TX_p).

For the "Interface Standards", the value is given, and in user-defined mode, you can set Vcm for TX1, as shown in the table below.

Table 9-7: DigRF Vcm

DigRF 3G			DigRF v4		
Interface Standard	**TX1**	**TX2**	**Interface Standard**	**TX1**	**TX2**
1.8 LVDS	1.2 V		1.8 V LA		
1.2 LVDS	0.6 V	1.2 V	1.2 V LA	0.2 V	0.2 V
1.8 SLVS	1.2 V		1.8 SA		
1.2 SLVS	0.6 V		1.2 SA	0.1 V	0.1 V
User	Configurable 0.1 ... 1.4 V		User	Configurable 0.05 ... 0.4 V	corresponding to TX1
Vcm in TX2 is firmly set			Vcm in TX2 is coupled to TX1		

Parameters:

<vcm>	float Increment: 0.01 *RST: 1.2

Example:
`SOUR1:EBOX:DRF:D3G:CHAN1:TX:VCM?`
queries the common mode voltage Vcm of the DigRF 3G interface standard in channel 1.
Response: `1.2`

Example:
`SOUR1:EBOX:DRF:D3G:CHAN1:TX:INT USER`
`SOUR1:EBOX:DRF:D3G:CHAN1:TX:VCM 0.1`
sets the DigRF 3G interface standard to `USER` and defines 0.1 V Vcm.
`SOUR1:EBOX:DRF:D4V:CHAN1:TX:INT USER4`
`SOUR1:EBOX:DRF:D4V:CHAN1:TX:VCM 0.1`
sets the DigRF v4 interface standard to `USER` and defines 0.1 V Vcm.

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:VDD <vdd>

Queries the voltage of the DigRF interface. In standard mode the supply voltage is determined by the interface standard. You can set the value in user defined mode.

Parameters:

<vdd>	float Range: 1.1 to 1.9 Increment: 0.01 *RST: 1.8

Example:
`SOUR1:EBOX:DRF:D3G:CHAN1:TX:VDD?`
queries the supply voltage Vdd of the DigRF 3G interface standard.
Response: `1.8`

Example:
`SOUR1:EBOX:DRF:D3G:CHAN1:TX:INT USER`
`SOUR1:EBOX:DRF:D3G:CHAN1:TX:VDD 1.5`
sets the DigRF 3G interface standard to `USER` and defines 1.5 V supply voltage.
`SOUR1:EBOX:DRF:D4V:CHAN1:TX:INT USER4`
`SOUR1:EBOX:DRF:D4V:CHAN1:TX:VDD 1.8`
sets the DigRF v4 interface standard to `USER` and defines 1.8 V supply voltage.

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:CHANnel<ch>:TX:VDIF <vdiff>

Queries the differential voltage. Vdiff represents the difference between maximum and minimum voltage of the differential output signal (differential voltage, peak-peak).

For the "Interface Standards", the value is given, and in user-defined mode, you can set Vdiff for TX1, as shown in the table.

Table 9-8: DigRF Vdiff

DigRF 3G			**DigRF v4**		
Interface Standard	**TX1**	**TX2**	**Interface Standard**	**TX1**	**TX2**
1.8 LVDS	0.4 V	0.4 V	1.8 V LA	0.2 V	0.2 V
1.2 LVDS			1.2 V LA		
1.8 SLVS	0.2 V		1.8 SA	0.1 V	0.1 V
1.2 SLVS			1.2 SA		
User	Configurable 0.05 ... 0.4 V 0.01 .... 0.8 V		User	Configurable 0.09 ... 0.21 V 0.18 ... 0.42 V	corresponding to TX1
Vdiff in TX2 is firmly set			Vdiff in TX2 is coupled to TX1		

Parameters:

<vdiff> float

Increment: 0.02

*RST: 0.4

Example: `SOUR1:EBOX:DRF:D3G:CHAN1:TX:VDIF?`

queries Vdiff of the DigRF 3G interface standard.

Response: `0.8`.

Example: Interface Standard: **User**

```
SOUR1:EBOX:DRF:D3G:CHAN1:TX:INT USER
SOUR1:EBOX:DRF:D3G:CHAN1:TX:VDIF 0.2
```

sets the DigRF 3G interface standard to `USER` and defines 0.2 V Vdiff.

```
SOUR1:EBOX:DRF:D4V:CHAN1:TX:INT USER4
SOUR1:EBOX:DRF:D4V:CHAN1:TX:VDIF 0.1
```

sets the DigRF v4 interface standard to `USER` and defines 0.1 V Vdiff

---

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:MODE <mode>

Selects the active channel of DigRF.

Parameters:

<mode> CHANNEL1 | CHANNEL2

*RST: CHANNEL1

Example: `SOUR1:EBOX:DRF:D3G:MODE CHANNEL1`

activate channel 1 of the DigRF 3G interface.

[:SOURce<hw>]:EBOX:DRF:D3G|D4V:VDSence <vds>

Activates the "VDD Sense" function.

Activating the interface requires that a correct voltage is applied to the sense input.

Parameters:

<vds>	OFF | ON *RST: OFF

Example:	`SOUR1:EBOX:DRF:D3G:VDS ON` activates VDD Sense in DigRF 3G.

9.5.5 DigRF DIFC Subsystem

The `DIFC` subsystem contains the remote-control commands to query the Digital IQ IN / OUT interfaces. Get information about a connected R&S instrument, and on the incoming or outgoing signals at these interfaces.

The following description of a remote-command applies to both digital IQ interfaces, distinguished by `DIFC:IN|DIFC:OUT` in the command syntax.

[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:DEVice?

Queries the ID (serial number) of the connected R&S instrument, either at the digital IQ IN or the IQ OUT interface.

Return values:

<dev>	string
Example:	`SOUR1:EBOX:DRF:DIFC:OUT:DEV?` Response: `100002` (AMU200A).
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:PEP?

Queries the PEP (**P**eak **E**nvelope **P**ower) value of the signal applied at the R&S Digital IQ IN/OUT Interface. The command returns the value in dBFS (**F**ull **S**cale ratio).

Return values:

<pep>	float
Example:	`SOUR1:EBOX:DRF:DIFC:IN:PEP?` query the PEP value of the incoming signal.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:RMS?

Queries the rms value of the signal level at the corresponding digital IQ interface. The command returns the value in dBFS (**F**ull **S**cale ratio).

Return values:

<rms>	float
Example:	`SOUR1:EBOX:DRF:DIFC:IN:RMS?` query the rms value of the incoming signal from the R&S instrument.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:DIFC:IN|OUT:SRATe?

Queries the sample rate of the signal at the digital IQ IN or IQ OUT interface.

Return values:

<srate>	float
Example:	`SOUR1:EBOX:DRF:DIFC:IN:SRAT?` query the sample rate of the signal applied at the digital IQ IN interface.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:DIFC:OUT:D3G:SRATe?
[:SOURce<hw>]:EBOX:DRF:DIFC:OUT:D4V:SRATe?

Queries the sample rate of the RX stream in the active DigRF link

Return values:

<rate>	float
Example:	`SOUR1:EBOX:DRF:DIFC:OUT:D3G:SRAT?` query the sample rate of the DigRF 3G IQ stream. Response: `'7 680 000 MHz'`
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:DIFC:OUT:D3G:STATe?
[:SOURce<hw>]:EBOX:DRF:DIFC:OUT:D4V:STATe?

Queries if the link is active.

Return values:

<state>	OFF | ON *RST: OFF
Example:	`EBOX:DRF:DIFC:OUT:D4V:STAT?` Response: `'1'` DigRF v4 IQ stream is acive.

Usage: Query only

9.5.6 DigRF Clock Subsystem

The `HW:CLOCk` subsystem contains the commands for configuration of the reference clock signals.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:FUNCtion <func>

Sets the function of the "CLOCK1" signal. The function depends on the test mode, and additionally, in RF-IC test mode, also on the used reference source.

Parameters:

<func> CLKIN | CLKOUT

CLKIN (BB-IC Test mode)
The R&S EX-IQ-BOX provides the reference signal digitally ("RefClk Out").

CLKOUT (RF-IC Test mode)
Provides the reference clock signal digitally at the CLOCK1 connector of the DigRF breakout board. In this case, the RF-IC provides an analog signal, applied at the "REF IN" connector of the R&S EX-IQ-BOX.

CLKIN (RF-IC Test mode)
Receives the reference clock signal digitally at the "CLOCK 1" connector.

*RST: CLKIN

Example:

```
SOUR1:EBOX:DRF:MODE RF_IC
SOUR1:EBOX:DRF:HW:CLOC:FCL:FUNC CLKIN
```

receives the reference clock signal digitally in RF-IC test mode.

Example:

```
SOUR1:EBOX:DRF:MODE BB_IC
SOUR1:EBOX:DRF:HW:CLOC:FCL:FUNC CLKOUT
```

outputs the reference clock signal digitally in BB-IC test mode.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:ITERmination <term>

Activates the input termination of the signal reference input signal.

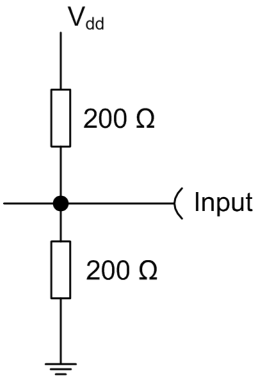


Fig. 9-8: DigRF Hardware > Clock > Input termination resistance

This function is provided when you derive the reference signal from the DigRF link, i.e. reference source "CLOCK1" and function "Ref Clk In" are selected.

Parameters:

<term>	OFF | ON *RST: OFF

Example: `SOUR1:EBOX:DRF:HW:CLOCk:FCL:ITER ON`
activate input termination for the received clock signal.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:RCOC <rcoc>

Sets the output mode of the digital `CLKOUT` in the BB-IC test mode.

Parameters:

<rcoc>	ALWAYS | REFCLKEN **ALWAYS** Outputs the reference clock signal continuously. **REFCLKEN** Outputs the signal at the request of the RF-IC. *RST: ALWAYS

Example: `SOUR1:EBOX:DRF:HW:CLOC:FCL:RCOC ALWAYS`
provides the signal continuously.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:SLEWrate <slew>

Activates the slow slewrate of the reference output signal to reduce RF distortions and EMI.

Parameters:

<slew>	OFF | ON *RST: OFF

Example:	`SOUR1:EBOX:DRF:HW:CLOCk:FCL:SLEW ON` switch on slow slew rate.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:FCLock:VDD <vdd>

Assigns the supply voltage Vdd of the DigRF interface to the clock signal.

Parameters:

<vdd>	D3G | D4V *RST: D3G
Example:	`SOUR1:EBOX:DRF:HW:CLOC:FCL:VDD D3G` couples Vdd of the DigRF 3G interface to the reference clock signal.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:RCFRequency <cfreq>

Selects a DigRF system clock frequency.

The supported frequencies depend on the DigRF standard.

Parameters:

<cfreq>	F52MHZ | F26MHZ | F38_4MHZ | F19_2MHZ *RST: 26 MHz
Example:	`SOUR1:EBOX:DRF:HW:CLOC:RCFR F52MHZ` sets the system clock frequency to 52 MHz.
Example:	`SOUR1:EBOX:DRF:`

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:RFRequency <rfreq>

Sets the frequency value that is applied at the REF IN connector of the R&S EX-IQ-BOX. In this case, the R&S EX-IQ-BOX provides the reference frequency (BB-IC Test), externally applied by an R&S instrument.

Parameters:

<rfreq>	F5MHZ | F10MHZ | F13MHZ | F19_2MHZ | F26MHZ | F38_4MHZ | F52MHZ *RST: 10 MHz
Example:	`SOUR1:EBOX:DRF::HW:CLOC:RFR F10MHZ` assigns the externally applied 10 MHz clock frequency.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:RSFRequency?

Queries the frequency of the reference signal source in MHz. This function counts the reference frequency signal per second at the selected input.

Return values:

<rfreq>	integer Range: 0 to maximum Increment: 1 *RST: 0

Example: `SOUR1:EBOX:DRF:HW:CLOC:RSFR?`
queries the reference frequency signal.

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:RSOUrce <rsrc>

Selects the system clock source for synchronization. The available signal sources depend on the test mode.

Parameters:

<rsrc> RCLKIN | BNC | INT | DEMO

RCLKIN
Parameter of RF-IC test.
The RF-IC delivers the system clock signal digitally. Assign this signal to the CLOCK1 connector of the DigRF breakout board.

BNC
Parameter of RF-IC test.
The R&S EX-IQ-BOX synchronizes the DigRF communication link with an analog reference clock signal. The signal comes from the RF-IC and is applied via the BNC connector REF IN at the rear of the R&S EX-IQ-BOX.

INT
Parameter of BB-IC test.
The R&S EX-IQ-BOX synchronizes the DigRF communication link with an analog reference clock signal. The signal comes from an R&S instrument and is applied via the BNC connector REF IN at the rear of the R&S EX-IQ-BOX.

DEMO
Parameter of BB-IC test.
For demonstration purposes, you can generate the system clock frequency with the internal reference oscillator of the R&S EX-IQ-BOX, regardless of the test mode.

*RST: RCLKIN

Example:

```
SOUR1:EBOX:DRF:MODE RF_IC
SOUR1:EBOX:DRF:HW:CLOC:RSOU RCLKIN
```

set the RF-IC test mode, with the reference clock applied at the Clock1 connector, i.e. RefClk In.

Example:

```
SOUR1:EBOX:DRF:MODE BB_IC
SOUR1:EBOX:DRF:HW:CLOC:RSOU INT
```

operates in BB-IC test mode with the internal reference frequency.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:FUNCtion <func>

Queries the "CLOCK2" signal function.

Note: Currently, the function of the second clock signal is firmly set to "Ref Out". In future extensions, the signal may be bidirectional.

Parameters:

<func>	CLKOUT	
	*RST:	CLKOUT

Example: `SOUR1:EBOX:DRF:HW:CLOC:SCL:FUNC?`
queries the function of second clock signal.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:ITERminate <iterm>

Activates the input termination of the second reference clock signal (RefCLk In).

Note: Currently, the 2nd reference signal is firmly set to "Ref Out", and input termination is inactive. In future extensions the CLOCK 2 interface may be bidirectional. As a result, input termination will be modifiable.

Parameters:

<iterm>	OFF | ON	
	*RST:	OFF

Example: `SOUR1:EBOX:DRF:HW:CLOC:SCL:ITER?`
queries the termination state of the 2nd clock signal.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:OFRequency <ofreq>

Sets the output frequency of the second reference signal (Ref Out).

Parameters:

<ofreq>	F5MHZ | F10MHZ	
	*RST:	10 MHz

Example: `SOUR1:EBOX:DRF:HW:CLOCk:SCLock:OFRequency F5MHZ`
sets the second clock signal to 5 MHz.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:SLEWrate <slew>

Activates slow slewrate of the reference output signal (Ref Out).

Parameters:

<slew>	OFF | ON	
	*RST:	OFF

Example: `SOUR1:EBOX:DRF:HW:CLOC:SCL:SLEW ON`
switches on slow slew rate.

[:SOURce<hw>]:EBOX:DRF:HW:CLOCk:SCLock:VDD <vdd>

Sets the supply voltage of the "CLOCK2" signal.

Parameters:

<vdd>	V1_2 | V1_5 | V1_8 | V2_5 | V3_3 *RST: 1.8 V

Example: `SOUR1:EBOX:DRF:HW:CLOC:SCL:VDD V1_8`
sets 1.8 V Vdd.

9.5.7 DigRF IO Subsystem

The `DRF:IO` command subsystem encloses remote-control commands for setting the voltages of the GPIO, SPI/I2C, RFFE and GPIO GROUP signals and the configuration of the USER I/O signals. These signals are assigned to the three 50-pole SMC connectors at the front of the DigRF breakout board.

[:SOURce<hw>]:EBOX:DRF:IO:GPIO:GROup<st>:VDD <vdd>

Sets the supply voltage of the GPIO_GRP0...4 group signals.

Parameters:

<vdd>	float Range: 1.2 to 3.3 Increment: 0.1 *RST: 1.8

Example: `SOUR1:EBOX:DRF:IO:GPIO:GRO2:VDD 1.5`
sets 1.5 V supply voltage to the GPIO signal group 2.

[:SOURce<hw>]:EBOX:DRF:IO:GPIO:VDD <vdd>

Sets the supply voltage for GPIO signals.

Parameters:

<vdd>	float Range: 1.2 to 3.3 Increment: 0.1 *RST: 1.8

Example: `SOUR1:EBOX:DRF:IO:GPIO:VDD 2.0`
sets 2 V Vdd to the signals.

[:SOURce<hw>]:EBOX:DRF:IO:RFFE:VDD <vdd>

Sets the supply voltage of the RFFE signal.

Parameters:

<vdd> float

Range:	1.1 to 1.9
Increment:	0.1
*RST:	1.8

Example: `SOUR1:EBOX:DRF:IO:RFFE:VDD 1.8`

sets 1.8 V supply voltage.

[:SOURce<hw>]:EBOX:DRF:IO:SPI:VDD <vdd>

Sets the supply voltage of the SPI and I2C signals.

Parameters:

<vdd> float

Range:	1.2 to 3.3
Increment:	0.1
*RST:	1.8

Example: `SOUR1:EBOX:DRF:IO:SPI:VDD 1.5`

sets 1.5 V Vdd.

[:SOURce<hw>]:EBOX:DRF:IO:USER:DIRection<st> <dir>

Sets the direction for the user signals. Transmission direction is coupled in pairs with two signals each.

The signals are provided at the bidirectional USER I/O interface connectors of the DigRF breakoaut board. You can select the signal to be sent with the command `[:SOURce<hw>]:EBOX:DRF:IO:USER:SIGNal`.

Parameters:

<dir> OUT | IN | OFF

OUT
Sets the selected USER I/O interface as output, i.e. the R&S EX-IQ-BOX sends a control signal to the external device.

IN
Sets the USER I/O interface as input, i.e. the R&S EX-IQ-BOX receives a signal from the external device.

OFF
Deactivates the USER I/O interface.

*RST: OFF

Example: `SOUR1:EBOX:DRF:IO:USER:DIR1 OUT`

the user signal is output at the first USER I/O connector, coupled with the second.

[:SOURce<hw>]:EBOX:DRF:IO:USER:SIGNal <signal>

Determines the control signal. You can define separate signals for each of the two interface pairs. The selection list depends on the transmission direction.

Parameters:

<signal>	NONE | EXT1 | EXT2 | EXT3 | EXT4 | CLOW | CHIGH | MARK1 | MARK2 | MARK3 | MARK4 | SCRIPT1 | SCRIPT2 | SCRIPT3 | SCRIPT4 *RST: NONE
Off	**NONE** The USER I/O connector is deactivated.
Input	**EXT1 | EXT2 | EXT3 | EXT4** Selects an external trigger signal at the corresponding USER I/O connector.
Output	**CLOW | CHIGH** Sets the control signal to constant level low or high. **MARK1 | MARK2 | MARK3 | MARK4** Uses the configured marker for control. The marker signals are configured in chapter 7.3.11, "Marker", on page 257. **SCRIPT1|SCRIPT2|SCRIPT3|SCRIPT4** Determines a script signal for control. SCRIPT 1...4 correspond to the scripts gpo 20 / gpo 21 / gpo 22 / gpo 23.

Example:

```
SOUR1:EBOX:DRF:IO:USER:DIR1 OUT
SOUR1:EBOX:DRF:IO:USER:SIGN  CHIGH
```

sends a constant high signal to the external device.

```
SOUR1:EBOX:DRF:IO:USER:DIR3 IN
SOUR1:EBOX:DRF:IO:USER:SIGN EXT1
```

uses the external trigger signal applied at the USER3 connector.

9.5.8 DigRF Main Controls Subsystem

The **main controls** commands provide the selection of the DigRF test mode, and commands as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading previously defined settings.

[:SOURce<hw>]:EBOX:DRF:MODE <mode>

The command selects the DigRF test mode.

Parameters:

<mode>	RF_IC | BB_IC **RF_IC** The R&S EX-IQ-BOX is emulates the baseband module (BB-IC) for testing the RF-IC **BB_IC** The R&S EX-IQ-BOX simulates the RF module (RF-IC) for testing the BB-IC. *RST: RF_IC Test
Example:	`SOUR1:EBOX:DRF:MODE RF_IC` activates DigRF RF-IC test mode.

[:SOURce<hw>]:EBOX:DRF:PRESet

Sets all parameters to default values. Refer to chapter A.3.3, "DigRF Default Settings", on page 469, containing an overview of the most important default settings.

Example:	`SOUR1:EBOX:DRF:PRES` sets to DigRF default.
Usage:	Event

[:SOURce<hw>]:EBOX:DRF:STATe <State>

Activates and deactivates the DigRF standard. The corresponding FPGA (**F**ield **Pro**grammable **A**rray) is loaded automatically into the R&S EX-IQ-BOX.

Parameters:

<State>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:DRF:STAT ON` activates DigRF protocol transmission.

9.5.9 DigRF Marker Subsystem

The `MARker` subsystem contains the remote-contol commands to configure a marker signal. Marker signals are applied to the USER I/O connectors and can be referenced as a trigger for the recorder. All markers provide the same functionality determined by the selected source and the trigger parameters.

[:SOURce<hw>]:EBOX:DRF:MARKer:CLC <clc>

Selects the mode of the logical channel type in the DigRF v4 trigger pattern.

The information in a control logical channel (LC Control) varies according to the selected transmission path, i.e. the source. Data logical channel parameters (LC Data) are provided in both transmission paths.

The following parameter description differs between the logical channel types, and the transmission paths where required. Control locical channel type is abbreviated with **CLC**, and **DLC** stands for data logical channel type.

Parameters:

<clc>	USER_TX | DCARE_TX | TICLC | TASLC | CWCLC | CRCLC | TACLC | THLCLC | TSCLC | USER_RX | DCARE_RX | RICLC | RNCLC | RBCLC | RACLC | RHCLC | RSCLC | USER_DATA | DCARE_DATA | CH0 | CH1 | CH2 | CH3 | CH4 | CH5 | CH6 | SUB_DATA *RST: USER_TX

TX CLC	Settings avaliable in the TX path of a DigRF v4 control logical channel. **USER_TX** Set the coding individually. **DCARE_TX** Disable the parameter since the information is not needed in signal transmision. **TICLC** Assign **T**X **I**nterface **C**ontrol **L**ogical **C**hannel **TASLC** **TAS** **L**ogical **C**hannel **CWCLC** **C**onfiguration **W**rite **C**ontrol **L**ogical **C**hannel **CRCLC** **C**onfiguration **R**ead **C**ontrol **L**ogical **C**hannel **TACLC** **T**X not **A**cknowledge **C**ontrol **L**ogical **C**hannel **THLCLC** **T**X **H**igh **L**evel **C**ontrol **L**ogical **C**hannel **TSCLC** **T**X **S**ub **C**ontrol **L**ogical **C**hannel
RX CLC	Avaliable settings in the RX path of a DigRF v4 control logical channel. **USER_RX** Set the coding individually. **DCARE_RX** Disable the parameter since the information is not needed in signal transmision. **RICLC** Assign **R**X **I**nterface **C**ontrol **L**ogical **C**hannel **RNCLC** **R**X informatio**N** **C**ontrol **L**ogical **C**hannel **RBCLC** **R**ead **B**ack **C**ontrol **L**ogical **C**hannel **RACLC** **R**X not **A**cknowledge **C**ontrol **L**ogical **C**hannel **RHCLC** **R**X **H**igh **L**evel **C**ontrol **L**ogical **C**hannel **RSCLC** **R**X **S**ub **C**ontrol **L**ogical **C**hannel

DLC

Settings of a DigRF v4 data logical channel, used in the TX as well as the RX path.
For simultaneous or alternating transmission of different data streams eight configurable data logical channels DLC are defined.

USER_DATA
Set the coding individually.

DCARE_DATA
Disable the parameter since the information is not needed in signal transmision.

CH0...CH6
Select a channel.

SUB_DATA
Used for further sub-data logical channels or I/Q data compression (**S**ub **D**ata **L**ogical **C**hannel).

Example:

Activate interface control in the TX path:

```
SOUR1:EBOX:DRF:MARK:SOUR D4VTX
SOUR1:EBOX:DRF:MARK:LC CONTROL
SOUR1:EBOX:DRF:MARK:CLC TICLC
```

Deactivate control logical channel in the RX path:

```
SOUR1:EBOX:DRF:MARK:SOUR D4VRX
SOUR1:EBOX:DRF:MARK:LC CONTROL
SOUR1:EBOX:DRF:MARK:CLC DCARE_RX
```

Select data logical channel 6.

```
SOUR1:EBOX:DRF:MARK:SOUR DATA
SOUR1:EBOX:DRF:MARK:CLC CH6
```

[:SOURce<hw>]:EBOX:DRF:MARKer:CLC:PATTern <pattern>

Sets the trigger pattern of the logical channel type in DigRF v4.

Parameters:

<pattern>	string

Example:

Sets the pattern for the control logical channel in the TX path to "TX Write Config":

```
SOUR1:EBOX:DRF:MARK:SOUR D4VTX
SOUR1:EBOX:DRF:MARK:LC CONTROL
SOUR1:EBOX:DRF:MARK:CLC:PATT "010"
```

Set the control logical channel in the RX path to "RX Unsolicited Readback":

```
SOUR1:EBOX:DRF:MARK:SOUR D4VRX
SOUR1:EBOX:DRF:MARK:LC CONTROL
SOUR1:EBOX:DRF:MARK:CLC:PATT "010"
```

Select "Channel 2" in a data logical channel:

```
SOUR1:EBOX:DRF:MARK:LC DATA
SOUR1:EBOX:DRF:MARK:CLC:PATT "010"
```

[:SOURce<hw>]:EBOX:DRF:MARKer:CRI <cri>

Selects the CRI (**C**yclic **R**unning **I**ndex) mode in the trigger pattern. CRI identifies the frame order and potentially lost frames in the ARQ scheme.

Parameters:

<cri>	USER | DCARE **USER** Enables you to individually set the coding. **DCARE** Disables evaluation of the bits in the marker trigger pattern. *RST: USER
Example:	`SOUR1:EBOX:DRF:MARK:CRI USER` activates CRI information.

[:SOURce<hw>]:EBOX:DRF:MARKer:CRI:PATTern <pattern>

Sets the CRI pattern as criteria for the marker signal.

Parameters:

<pattern>	string
Example:	`SOUR1:EBOX:DRF:MARK:CRI:PATT "110"` assigns CRI information to frame 6.

[:SOURce<hw>]:EBOX:DRF:MARKer:CTS <cts>

Selects the evaluation of the CTS (**C**lear **T**o **S**end) bit for the marker signal generation.

Parameters:

<cts>	USER | DCARE **USER** Activates or deactivates the bit for evaluation. **DCARE** Disables evaluation of the bits in the marker trigger pattern. *RST: USER
Example:	`SOUR1:EBOX:DRF:MARK:CTS DCARE` deactivate the CTS field.

[:SOURce<hw>]:EBOX:DRF:MARKer:CTS:PATTern <pattern>

Sets the CTS (**C**lear **T**o **S**end) bit for the marker signal generation.

Parameters:

<pattern>	string
Example:	`SOUR1:EBOX:DRF:MARK:CTS:PATT "1"` sets the CTS bit.

[:SOURce<hw>]:EBOX:DRF:MARKer:ENABle <enable>

Activates the marker generator.

Parameters:

<enable>	OFF | ON *RST: OFF
Example:	`SOUR1:EBOX:DRF:MARK:ENAB ON` activates the marker generator.

[:SOURce<hw>]:EBOX:DRF:MARKer:G3PL <payload>

Selects the payload of DigRF 3G for the marker signal generator.

The payload field contains the I/Q data or control information. The payload size of the marker trigger pattern is 24 Bit.

Parameters:

<payload>	USER | DCARE **USER** Enables you to individually set the coding. **DCARE** Disables evaluation of the bits in the marker trigger pattern. *RST: DCARE
Example:	`SOUR1:EBOX:DRF:MARK:G3PL USER` activates the coding of the payload pattern.

[:SOURce<hw>]:EBOX:DRF:MARKer:G3PL:PATTern <pattern>

Defines the trigger pattern for the detection of a specific payload in the DigRF 3G frame.

Parameters:

<pattern>	string

Example:	`SOUR1:EBOX:DRF:MARK:G3PL:PATT`
	`"101010101010101010101010"`
	sets the payload pattern.

[:SOURce<hw>]:EBOX:DRF:MARKer:LC <lc>

Selects the logical channel type in the trigger pattern. DigRF v4 distinguishes two logical channel types, CLC (**C**ontrol **L**ogical **C**hannels) and DLC (**D**ATA **L**ogical **C**hannel). The logical channel type is defined by the LSB in the header. Additionally three bits are used for logical channel identification.

Parameters:

<lc>	CONTROL | DATA **CONTROL** Select control logical channel type. **DATA** Select control logical channel type. *RST: CONTROL
Example:	`SOUR1:EBOX:DRF:MARK:LC DATA` selects the logical channel type "Data".

[:SOURce<hw>]:EBOX:DRF:MARKer:LC:PATTern?

Sets the coding of the logical channel type in the DigRF v4 trigger pattern. The logical channel is selected with `[:SOURce<hw>]:EBOX:DRF:MARKer:LC`.

Return values:

<pattern>	string

Example:	`SOUR1:EBOX:DRF:MARK:LC DATA`
	selects the logical channel type `Data`.
	`SOUR1:EBOX:DRF:MARK:LC:PATT "101"'`
	activates *Data Locigal Channel 5* in the trigger pattern.

Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:MARKer:LCT <lct>

Selects the logical channel type in the trigger pattern. The information in a logical channel varies according to the selected transmission path, i.e. the source.

Refer also to chapter 7.3.3.3, "Logical Channel Types", on page 202 for description and coding in detail.

Parameters:

<lct>	USER | DCARE | IFC | TAS | RFIC | RFICR | CTS | A...H **USER** Enables you to individually set the coding. **DCARE** Disables evaluation of the bits in the marker trigger pattern. **IFC** Covers all interface related control information. This setting is generally coded with 0000. **A | B | C | D | E | F | G | H** Transfers various types of data, e.g. primary or diversity, specified in the profile of each defined combination of data. *RST: USER

DigRF 3G TX	**TAS** TAS (**T**ime **A**ccurate **S**trobe) provides exact timing reference. **RFIC** Provides control information from the BB-IC to the RF-IC.
DigRF 3G RX	**RFIC** RF-IC Unsolicited Status is used to accommodate unsolicited frames in the BB-IC hardware interface, and to handle such frames in the RF-IC driver software correctly. **RFICR** Provides responses to the RF-IC Control Logical Channel. **CTS** The CTS transfer bit supports the control on the transmission data buffer.

Example:	`SOUR1:EBOX:DRF:MARK:SOUR D3GTX`
	`SOUR1:EBOX:DRF:MARK:LCT RFIC`
	defines RF-IC as logical channel type in the TX path.
	`SOUR1:EBOX:DRF:MARK:SOUR D3GRX`
	`SOUR1:EBOX:DRF:MARK:LCT A`
	sets data channel A as logical channel type in the RX path.

[:SOURce<hw>]:EBOX:DRF:MARKer:LCT:PATTern <pattern>

Sets the bit pattern of the logical channel type in the DigRF 3G trigger pattern.

Parameters:

<pattern>	string
Example:	`SOUR1:EBOX:DRF:MARK:LCT:PATT "0000"` Pattern *0000* sets interface control.

[:SOURce<hw>]:EBOX:DRF:MARKer:PSIZe <psize>

Selects the payload size of DigRF 3G in the trigger pattern. You can either choose a size of the predefined values or configure the size manually.

Refer also to table 7-9 for coding.

Parameters:

<psize>	USER | DCARE | BIT8 | BIT32 | BIT64 | BIT96 | BIT128 | BIT256 | BIT512 | PROFILE **USER** Enables you to individually set the coding. **DCARE** Disables the parameter when the information is not needed in signal transmission. **8...512 BIT** Select the target value. **PROFILE** Specifies that the size is RF-IC-specific. *RST: USER
Example:	`SOUR1:EBOX:DRF:MARK:PSIZ BIT64` sets 64 bit payload size.

[:SOURce<hw>]:EBOX:DRF:MARKer:PSIZe:PATTern <pattern>

Sets the DigRF 3G payload size bit pattern.

Parameters:

<pattern>	string
Example:	`SOUR1:EBOX:DRF:MARK:PSIZ:PATT "011"` assign 96 bit (011) payload size.

[:SOURce<hw>]:EBOX:DRF:MARKer:RTI <rti>

Selects the RTI (**R**e**T**ransmission **I**ndicator) bit in the DigRF v4 trigger pattern. RTI distinguishes between ordinary and retransmitted frames.

Parameters:

<rti>	USER | DCARE **USER** Enables you to individually set the coding. **DCARE** Disables evaluation of the bits in the marker trigger pattern. *RST: USER
Example:	`SOUR1:EBOX:DRF:MARK:RTI DCARE` ignores RTI information.

[:SOURce<hw>]:EBOX:DRF:MARKer:RTI:PATTern <pattern>

Sets the RTI bit in the trigger pattern.

Parameters:

<pattern>	string

Example: `SOUR1:EBOX:DRF:MARK:RTI:PATT "1"`
sets the transmission indicator.

[:SOURce<hw>]:EBOX:DRF:MARKer:SOURce <src>

Selects the source for the marker generator.

Parameters:

<src> D3GTX | D3GRX | D4VTX | D4VRX

*RST: D3GRX

Example: `SOUR1:EBOX:DRF:MARK:SOUR D3GTX`
selects DigRF 3G TX as marker source.

[:SOURce<hw>]:EBOX:DRF:MARKer:V4PL <payload>

Selects the payload of DigRF v4 for the marker signal generator.

The payload field transports the actual data, either control or data, depending on the frame type.

Parameters:

<payload> USER | DCARE

USER
Enables you to individually set the coding.

DCARE
Disables evaluation of the bits in the marker trigger pattern.

*RST: DCARE

Example: `SOUR1:EBOX:DRF:MARK:V4PL USER`
activates payload data definition.

[:SOURce<hw>]:EBOX:DRF:MARKer:V4PL:PATTern <pattern>

Defines the trigger pattern for the detection of a specific payload in the DigRF v4 frame.

Parameters:

<pattern> string

Example: `SOUR1:EBOX:DRF:MARK:V4PL:PATT "10101010101010101010101010"`
sets the payload pattern.

9.5.10 DigRF Operation Subsystem

The `OPERation` remote-control commands provide all functions of script execution, including the processing of script parameters and user memory, and the respective file management.

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:ABORt

The command stops execution of a script. When stopped it is not possible to continue.

Example: `SOUR1:EBOX:DRF:OPERation:SCRipt:ABOR`
stop the execution of a script in FPGA.

Usage: Event

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:ALL

The command executes sequentially the steps `COMPile`, `DOWNload` and `EXECute`s from the PAWN script.

Example: `SOUR1:EBOX:DRF:OPERation:SCRipt:ALL`
compile, download and execute Pawn script in one step.

Usage: Event

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:CATalog?

The command queries the available Pawn script files in the specified directory. Only files with the file extension `*.p` are listed.

Return values:

<Catalog>	string

Example:	`MMEM:CDIR "d:/user/pawn/source"`
	set the default directory to `d:/user/pawn/source`.
	`SOUR1:EBOX:DRF:OPER:SCR:CAT?`
	list all script files of the default directory.
	Response:
	`loop_test, tx_send_ctrl, script_params`
	the directory contains the configuration files `loop_test.p`, `script_params.p` and `tx_send_ctrl.p`.

Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:COMPile

Compiles the selected script file (`*.p`). The compiler translates the script in the executable `*.amx` format.

Example:	`SOUR1:EBOX:DRF:OPER:SCR:COMP "d:/user/pawn/source script_params.p"` compiles the script file to teh executable format `script_params.amx`.
Usage:	Event

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:DOWNload

The command downloads the compiled Pawn script into the FPGA of the R&S EX-IQ-BOX.

Example:	`SOUR1:EBOX:DRF:OPER:SCR:DOWN` download compiled Pawn script into the FPGA.
Usage:	Event

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:ERRors:STATe?

Queries whether any errors occurred during script execution.

Return values:

<State>	OFF | ON Range: 0 to 1 Increment: 1 *RST: 0
Example:	`SOUR1:EBOX:DRF:OPER:SCR:ERR:STAT?` check if a script error occurred. Response: `1` (error)
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:EXECute

The command executes the compiled Pawn script in the FPGA of the R&S EX-IQ-BOX.

Example: `SOUR1:EBOX:DRF:OPER:SCR:EXEC`
execute the compiled Pawn script in FPGA.

Usage: Event

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:FILE <ScriptFile>

The command opens the selected script file in the script editor. As programming environment for the PAWN (`*.p`) script files R&S DigIConf uses Quincy, providing am editor and a compiler.

Parameters:

<ScriptFile> <path>, <file_name>.<ext>

String parameter containing the directory, where the script file is located, the file name, and the file extension `*.p` for pawn script files.

Example: `SOUR1:EBOX:DRF:OPER:SCR:FILE "d:/user/pawn/source script_params.p"`
open the script file `script_params.p` in the "Quincy" editor.

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams:CATalog?

The command queries the available parameter files in the specified directory. Only files with the file extension `*.par` are listed.

Return values:

<Catalog> string

Example: `MMEM:CDIR "d:/user/script/parameters"`
set the default directory to `d:/user/script/parameters`.
`SOUR1:EBOX:DRF:OPER:SCR:PAR:CAT?`
list all parameter files of the default directory.

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams:DOS <DownPar>

Loads the script parameters automatically to the R&S EX-IQ-BOX at start of script execution.

Parameters:

<DownPar> OFF | ON

Range:	0 to 1
Increment:	1
*RST:	OFF

Example: `SOUR1:EBOX:DRF:OPER:SCR:PAR:DOS`
download the script parameters in the FPGA when script execution starts.

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams:DOWNload

Loads the script parameters into the R&S EX-IQ-BOX.

Example: `SOUR1:EBOX:DRF:OPER:SCR:PAR:DOWN`
download script parameters in the FPGA.

Usage: Event

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams:RECall|SAVe <file>

The command stores or loads DigRF script parameter data. Define directory and file name, R&S DigIConf automatically assigns the file extension `*.par`.

Setting parameters:

<file> string

String parameter to determine the target directory and the filename of the script parameter file.

Example: `SOUR1:EBOX:DRF:OPER:SCR:PAR:SAV "d:/digiconf/digrf/script/parameters/tx_params.par"`
save the script parameters in the file `tx_param.par` in the directory `d:/digiconf/digrf/script/parameters`.
`SOUR1:EBOX:DRF:OPER:SCR:PAR:REC "d:/digiconf/digrf/script/parameters/tx_params.par"`
select the directory and load the script parameter file `tx_params.par`.

Usage: Setting only

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams<ch>:NAMe <name>

Assigns parameter names. The maximum length of a name is 12 characters. Default name is "Parameter x". Up to 32 parameters with name and value can be specified in a file.

Parameters:

<name> <file_name>

Example: `SOUR1:EBOX:DRF:OPER:SCR:PAR1:NAM  "param1"`
assign the name 'param1' to the first parameter.

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:PARams<ch>:VALues <values>

Enters the value of the parameter. Valid formats for a value are hexadecimal format (0x), decimal format and floating point.

Parameters:

<values>	string
Example:	`SOUR1:EBOX:DRF:OPER:SCR:PAR1:VAL "10"` assign the value '10' to the first parameter.

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:RESume

The command continues script execution, if halted.

The "Resume" button is active when the script execution is paused, i.e. when script status is in halt state.

Example:	`SOUR1:EBOX:DRF:OPER:SCR:RES` resume the execution of a script in FPGA.
Usage:	Event

[:SOURce<hw>]:EBOX:DRF:OPERation:SCRipt:STATus?

The command queries the status of the script processing.

Return values:

<ScriptStatus>	NONE | LOADed | RUNNing | HALTed | FINished **NONE** No script loaded. **LOADed** Script is loading. **RUNNing** Currently processing. **HALted** Execution paused. **FINIshed** Script execution is completed.

Example:	`SOUR1:EBOX:DRF:OPERation:SCRipt:STATus?`
	queries the status of script in FPGA (loaded, running,...).
	Response:
	`'RUNNing'`

Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:CATalog?

The command queries the available user memory files in the specified directory. Only files with the file extension `*.mem` are listed.

Return values:

<Catalog>	string

Example: `MMEM:CDIR "d:/user/memory"`
set the default directory to `d:/user/memory`.
`SOUR1:EBOX:DRF:OPER:UMEM:CAT?`
list all user memory of the default directory.

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:DOWNload

Downloads the data from the (`*.mem`) file into the user memory of the R&S EX-IQ-BOX.

Select the file with `[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:DOWNload:FILE`

Example: `SOUR1:EBOX:DRF:OPER:UMEM:DOWN`
download the data of the selected user memory file.

Usage: Event

[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:DOWNload:FILE <fileName>

Selects the file (`*.mem`) to be downloaded into the user memory.

The destination memory is determined with the command `[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:SELect` on page 432.

Parameters:

<fileName> <path>, <file_name>.<ext>

String parameter containing the directory, where the memory file is located, the file name, and the file extension `*.mem` for user memory data files.

Example: `SOUR1:EBOX:DRF:OPER:UMEM:DOWN:FILE "d:/user/memory/userdata.mem"`
select the file to be downloaded from selected user memory.

[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:SELect <mem>

Selects the user memory. The R&S EX-IQ-BOX provides two memories, "User Memory 1 / 2" for storing user-specific data.

Parameters:

<mem> MEM1 | MEM2

Range:	MEM1 to MEM2
Increment:	1
*RST:	MEM1

Example: `SOUR1:EBOX:DRF:OPER:UMEM:SEL MEM2`
select the user memory MEM2 to store your user specific data.

[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:UPLoad

Uploads the selected user memory data from the R&S EX-IQ-BOX into the destination file.

Select the destination file with `[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:UPLoad:FILE` on page 433.

Example: `SOUR1:EBOX:DRF:OPER:UMEM:UPL`
upload the user memory data to the selected file.

Usage: Event

[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:UPLoad:FILE <fileName>

Select the destination `*.mem` file for upload from the user memory.

The user memory is determined with the command `[:SOURce<hw>]:EBOX:DRF:OPERation:UMEMory:SELect` on page 432.

Parameters:

<fileName> <path>, <file_name>.<ext>

String parameter containing the directory, where the memory file is located, the file name, and the file extension `*.mem` for user memory data files.

Example: `SOUR1:EBOX:DRF:OPER:UMEM:UP:FILE "d:/user/memory/userdata.mem"`
determine the file for saving data in the user memory.

9.5.11 DigRF Recorder Subsystem

Equipped with the corresponding options, the R&S EX-IQ-BOX provides two recorders for recording I/Q or raw data streams of DigRF. Only if an RX stream is active, you can record data. In general, the recording is triggered by the script, but you can also start directly in R&S DigIConf.

The `DRF:RECorder` subsystem contains all remote-control commands that are relevant for recording DigRF I/Q or raw data streams, and for storing the recorded data.

[:SOURce<hw>]:EBOX:DRF:RECorder:ABORt

Stops and cancels recording. The process of recording can be aborted at any time.

Avoid data loss! Discard erases the recorder memory and turns back to "Idle" state, ready for a new recording. In order to keep the data, save it first with the command `[:SOURce<hw>]:EBOX:DRF:RECorder:FILE:CREate`.

Discard changes the recording status from "Record Done" back to "Idle". R&S DigIConf is ready for a new recording.

Example: `SOUR1:EBOX:DRF:REC:ABOR`
stops recording.

Usage: Event

[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:DURation?

Queries the duration of recording. The recording time results from the recording length and the sample rate.

Return values:

<time> float

Returns the data length in seconds.

Default unit: s

Example: `SOUR1:EBOX:DRF:REC:RTIM?`
returns the time value needed for recording.

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:RLENgth <length>

Specifies the length of data trace in samples.

Parameters:

<length> integer

Range: 1 to 128000000
Increment: 1
*RST: 100

Example: `SOUR1:EBOX:DRF:REC:DATA:RLEN 100`
sets 100 samples recording length.

[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:SOURce?

Selects the data source for recording. Data transmission is controlled by script commands, i.e. the data stream must be configured and started in the script.

Return values:

<Source> string

*RST: UNDEF

Example: `SOUR1:EBOX:DRF:REC:DATA:SOUR?`
queries the data source active for recording.
Response: `RX1`, DigRF 3G IQ stream is selected.

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:SOURce:CATalog?

Queries the files in the specified directory containing recorded data streams. Files with the appropriate extension of DigRF files are listed. File name and the directory are user-selectable. Access to the files via remote is possible using the commands of the `MEMM` subsystem.

Note: R&S DigIConf stores the recorded IQ data streams in the R&S WinIQSim2 waveform file format with the predefined file extension `*.wv`, and raw data streams in the corresponding formats `*.drf3` and `*.drf4`. To view raw file formats, Rohde & Schwarz provides the DigRF Viewer as an additional functionality of R&S DigIConf.

Return values:

<Catalog> string

String parameter to select the directory where recorded files are stored.

Example: `MEMM:CDIR "d:\DigIConf\RecorderWaveForms"`
sets the default directory and path to `d:\DigIConf\RecorderWaveForms`.
`SOUR1:EBOX:DRF:REC:DATA:SOUR:CAT?`
reads out all recorded files in the specified directory.
Response: `DigRF3GRaw.drf3,Digrf3gIQ.wv`

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:SRATe?

Queries the sample rate of the recorded data.

Return values:

<rate> float

Default unit: Hz

Example: `SOUR1:EBOX:DRF:REC:DATA:SRAT?`
queries the sample rate value of the selected signal.

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:RECorder:DATA:STATe?

Queries if data stream is active.

Return values:

<state>	OFF | ON *RST: OFF
Example:	`EBOX:DRF:REC:DATA:STAT?` Response: `'1'` the DigRF data stream is acive.
Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:RECorder:EXECute

Starts the recording.

Example:	`SOUR1:EBOX:DRF:REC:EXEC` executes recording.
Usage:	Event

[:SOURce<hw>]:EBOX:DRF:RECorder:FILE:CREate

Creates a file and stores the recorded data. File name and the directory are user-selectable. The file extension can be omittted.

Note: R&S DigIConf stores the recorded I/Q data streams in the R&S WinIQSim2 waveform file format with the predefined file extension `*.wv`, and raw data streams in the corresponding formats `*.drf3` and `*.drf4`. To view raw file formats, Rohde & Schwarz provides the DigRF Viewer as an additional functionality of R&S DigIConf.

Example:	`SOUR1:EBOX:DRF:REC:FILE:CRE "d:\DigIConf\RecorderWaveForms\DigRF3GRaw"` creates the file and automatically adds the file extension, according to the data-stream type, as in this example `*.drf3g` for raw data.
Usage:	Event

[:SOURce<hw>]:EBOX:DRF:RECorder:FILE:SELect <Select>

Selects a file to store the recorded data. The path is specified within the command.

If no file of the specified name exists, it is created. The file extension may be omitted. R&S DigIConf stores the recorded I/Q data streams in the R&S WinIQSim2 waveform file format with the predefined file extension `*.wv`, and raw data streams in the corresponding formats `*.drf3` and `*.drf4`. File name and the directory are user-selectable.

Setting parameters:

<Select>	<path>, <file_name> String parameter to select directory, path and file name.

Example: `SOUR1:EBOX:DRF:REC:FILE:SEL "d:\DigIConf\RecorderWaveForms\Digrf3gIQ.wv"`
store the recordedx data stream in `Digrf3gIQ.wv`.

Usage: Setting only

[:SOURce<hw>]:EBOX:DRF:RECorder:STATus?

Return values:

<Status> IDLE | FRUN | READy | WTRigger | TRIGgered | DONE

Returns the state of the recording process.

IDLE
Recording is inactive. Configure the recorder in that state.
The recorder remains in "Idle" state until you start with `Execute`.

FRUN (Free Run)
The recorder records the signal continuously in a ring memory.
These data are required for pre-trigger analyzes.

READy
Recording has passed through the ring memory once at least, i.e. it has described the memory completely. At this point the data is valid and R&S DigIConf activates the trigger signal automatically.

WTRigger (Wait for Trigger)
The recorder continues recording until the trigger event occurs.
Then the process switches to the next state.
If trigger source "Software" is used, the trigger event occurs immediately.

TRIGgered
After the trigger event, only the remaining samples after the trigger position are recorded (post-trigger data).

DONE
If all post-trigger data are recorded, the recording is completed and the recorder stops. The data is available in the memory.

*RST: IDLE

Example: `SOUR1:EBOX:DRF:REC:STAT?`
Response: `"WTR"`, i.e. the process is waiting for a trigger event.

Usage: Query only

[:SOURce<hw>]:EBOX:DRF:RECorder:TRIGger:POSition <Position>

Determines the position of the trigger event in the recorded data stream. With this function you can perform pre-trigger, as well as post-trigger recording. The value is set in the samples from 0 to "Recording Length"-1.

- **Post-trigger**
  When the trigger position is at the beginning of the data stream, you can evaluate the signal after the trigger event.

- **Pre-trigger**
  The trigger position is at the end of the data stream to evaluate the signal before the trigger event.

Parameters:

<Position> integer

Range: 0 to 99
Increment: 1
*RST: 0

Example: `SOUR1:EBOX:DRF:REC:TRIG:POS 2`
sets trigger position 2.

[:SOURce<hw>]:EBOX:DRF:RECorder:TRIGger:SOURce <src>

Selects the trigger source for starting the recording. A trigger event can be initiated by the software itself, by markers or by externally applied trigger signals. The available trigger sources depend on the active markers and the external trigger signals.

Parameters:

<src> SOFTware | USR1 | USR2 | USR3 | USR4

SOFTware
Starts recording immediately at startup of the script.

USR1...4
Start recording with a trigger event initiated by the selected user signal in the hardware tab.
Depending on these settings the trigger signal is either an internal signal (Marker or Script gpo), or a signal externally applied at the USER I/O connectors, see "User I/O Settings" on page 229.

*RST: SOFTware

Example: `SOUR1:EBOX:DRF:REC:SOUR USR1`
uses the signal at User IO connector 1 as trigger source.

9.5.12 DigRF Settings Subsystem

With the commands of the `SETTing` subsystem, you can save settings of a DigRF application, or recall previously saved configurations. It covers also the commands for handling DigRF settings files.

[:SOURce<hw>]:EBOX:DRF:SETTing:CATalog?

Queries the available settings files in the specified directory. Settings files are used to store current application settings. Only files with the file extension `*.digrf` will be listed. Access to the files via remote is possible using the commands of the `MEMM` subsystem.

Return values:

<Catalog>	string String parameter to select the directory where settings files are stored.

Example:	`MEMM:CDIR "d:\DigIConf\Settings\DigRF"`
	sets the default directory and path.
	`SOUR1:EBOX:DRF:SETT:CAT?`
	reads out all settings files of the selected directory.

Usage:	Query only

[:SOURce<hw>]:EBOX:DRF:SETTing:DELete <del>

The command removes a settings file from the specified directory.

Parameters:

<del>	<directory>, <file_name>, <ext> Determine the file to be deleted by adding directory, file name and the file extension (`*.digrf`).
Example:	`SOUR1:EBOX:DRF:SETT:DEL "d:\DigIConf\Settings\DigRF\script_params.digrf` deletes the file `script_params.digrf`.

[:SOURce<hw>]:EBOX:DRF:SETTing:LOAD <load>

The command loads a previously saved DigRF configuration. Define directory and file name. R&S DigIConf automatically assigns the file extension `*.digrf`.

Parameters:

<load>	<directory>, <file_name> String parameter to determine the target directory and the filename for loading the settings file.
Example:	`SOUR1:EBOX:DRF:SETT:LOAD "d:\DigIConf\Settings\DigRF\script_params` loads the settings file.

[:SOURce<hw>]:EBOX:DRF:SETTing:STORe <Store>

Saves the current DigRF signal configuration. Specify the directory and file name. R&S DigIConf automatically assigns the file extension `*.digrf` to DigRF configuration files.

Setting parameters:

<Store>	<directory>, <file_name> String parameter to determine the target directory and the filename for storing the settings file.

Example:	`SOUR1:EBOX:DRF:SETT:STOR "d:\DigIConf\Settings\DigRF\script_params` saves the settings.
Usage:	Setting only

9.5.13 DigRF Sine Subsystem

With the `DRF:SINe` remote-control commnands, you can define a simple sine wave for use as signal source.

With the `DRF:SINe` remote-control commands, you can define a simple sine wave, and use it in the script as signal source. The signal is generated internally in the R&S EX-IQ-BOX.

[:SOURce<hw>]:EBOX:DRF:SINe:FREQuency <freq>

Sets the frequency of the sine test signal.

Parameters:

<freq>	integer Range: +/- 40% Virtual Sample Rate Increment: 1 *RST: 1 MHz
Example:	`SOUR1:EBOX:DRF:SIN:FREQ 1.5 MHz` sets 1.5 MHz test signal frequency.

[:SOURce<hw>]:EBOX:DRF:SINe:SRATe <srate>

Sets the virtual sample rate to generate the test sine signal.

Parameters:

<srate>	integer Range: 10 kHz to 100 000 000 MHz Increment: 1 *RST: 3 840 000 MHz
Example:	`SOUR1:EBOX:DRF:SIN:SRAT 100` sets a sample rate of 100 MHz.

10 Interfaces

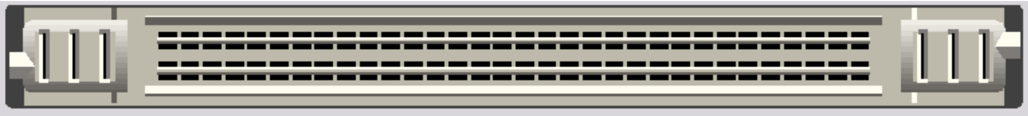
The following chapters describe the characteristics of the user interface and the available breakout boards.

10.1 User Interface of the R&S EX-IQ-BOX

The user interface depends on the selected protocol, i.e. the functions of the pins change depending on the standard.

The pin description and pinout table in the following chapters refer to the user interface of **User Defined** protocols, i.e. for single ended or differential applications. For these applications the user interface provides the transmission of serial or parallel I/Q data, data clock and control signals.

10.1.1 Z-DOK-Adapter Board Connector



Type:	Z-DOK-Adapter Board Connector
Manufacturer:	Tyco Electronics
Part number:	6367557-1

10.1.2 Pin Description

The user interface consists of a specific and a common part. In the specific part the pins are assigned individually for each breakout board. They are located on the left and the right side of the connector. The common part with fixed pin assignment is located in the middle of the connector.

The pin assignment of the specific part is defined by designing the layout of the breakout boards.

The common pin assignment is shown in Pinout Z-DOK-Adapter Board Connector (User Interface). Additionally, the specific pin assignments of the user interface are shown in the respective drawings of the breakout boards, which are attached to the operating manual.

Information on Z-DOK-Adapter Board Connector

The described pin assignment applies to applications with the R&S EX-IQ-BOX controlled by R&S DigIConf. If an R&S Instrument controls the R&S EX-IQ-BOX directly, the pinout varies. For information on the differences, refer to chapter 10.1.3, "Advanced pinout with R&S DigIConf", on page 443.

Find detailed information on the PC Board Footprint, the Housing and the Block Diagram Mating Face Configuration in the customer drawing C-6367557, attached to the operating manual.

Table 10-1: Pinout Z-DOK-Adapter Board Connector (User Interface)

Signal Name	Pin	Dir	Description
BO_TYPE0	A2	I	breakout board identification or EEPROM
BO_TYPE1	A1	I	
BO_SENS	Z3, X3, Y3, W3		breakout board sense
UI_I_N/P0 ... UI_I_N/P17	F1/F2 ... C9/C10	I/O	I data (real part)
UI_Q_N/P0 ... UI_Q_N/P17	C13/C14 ... D23/D24	I/O	Q data (imaginary part)
UI_VALID_N/P	F13/F14	I/O	indicates valid data blocks **Note:** This signal must be active in receiver mode.
D_CLK_UIN_N/P	F25/F26	I	interface clock input. **Note:** This clock signal is required as a reference for PLL. Therefore, it must be active continuously.
D_CLK_UOUT_N/P	A13/A14	O	interface clock output
UI_GP_N/P0 ... UI_GP_N/P5 [1]	F11/F12 ... A25/26	I/O	additional protocol dependent control / signaling. If not needed the signal can be unconnected.
UI_AUXIO_N/P0 ... UI_AUXIO_N/P3	A23/A24 ... D11/D12	I/O	additional auxiliary signals
TX_N_A/TX_P_A	A27/A28	O	high speed serial transmitter output. These signals are used by standardized protocols.
TX_N_B/TX_P_B	F27/F28	O	
TX_N_C/TX_P_C	D2/D1	O	
RX_N_A/RX_P_A	D28/D27	I	high speed serial receiver input. These signals are used by standardized protocols.
RX_N_B/RX_P_B	C28/C27	I	
RX_N_C/RX_P_C	C26/C25	I	

[1] GP0 ... GP5 correspond to the General Purpose signals 0...5 as they are named in other R&S instruments and R&S devices.

The N/P notation applies to differential interface standards (LVDS). For single ended standards (e.g. LVTTL) only the P signals are used.

10.1.3 Advanced pinout with R&S DigIConf

The configurator software R&S DigIConf supports additional signals at the user interface, compared to direct control of the R&S DigIConf by an R&S instrument. The advanced pin assignment applies to both, the R&S EX-IQ-BOX 1409.5502.02 and the 1409.5502.K04.

As a result, the pin configuration changed:

- reduction of word length 20 to 18 bits for additional AUX IO signals
- renaming of UI_MARKER_ / UI_TRIGGER_/ UI_RESERVE to general purpose signals UI_GP...

The following table points out the differences in pin assignment depending on the control of R&S DigIConf or R&S Instruments:

Table 10-2: User Interface > pinout when the R&S EX-IQ-BOX is controlled by ...

Pin	... R&S DigIConf			... R&S Instruments		
	Signal Name	**Dir.**	**Description**	**Signal Name**	**Dir.**	**Description**
D11/D12	UI_AUXIO_N/P0	I/O	additional auxiliary signals	UI_I_N/P18	I/O	I data (real part)
A11/A12	UI_AUXIO_N/P1	I/O		UI_I_N/P19	I/O	
A23/A24	UI_AUXIO_N/P2	I/O		UI_Q_N/P18	I/O	Q data (imaginary part)
F23/F24	UI_AUXIO_N/P3	I/O		UI_Q_N/P19	I/O	
F11/F12	UI_GP_N/P0	I/O	additional protocol dependent control / signaling. If not needed the signal can be unconnected.	UI_MARKER_N/P0	I/O	additional protocol dependent control / signaling
C11/C12	UI_GP_N/P2			UI_TRIGGER_N/P0	I/O	
D25/D26	UI_GP_N/P3			UI_TRIGGER_N/P1	I/O	
C23/C24	UI_GP_N/P4			UI_MARKER_N/P1	I/O	
D13/D14	UI_GP_N/P1			UI_RESERVE_N/P0	I/O	
A25/A26	UI_GP_N/P5			UI_RESERVE_N/P1	I/O	

10.2 LAN Connector

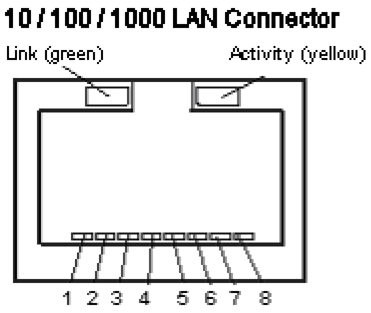


Fig. 10-1: 10/100/1000 LAN

Table 10-3: LAN connector > pinout

Pin Number	Signal Description
1	TXP
2	TXN
3	RXP
4	Not used
5	Not used
6	RXN
7	Not used
8	Not used

10.3 Breakout Boards

The digital interface module R&S EX-IQ-BOX communicates with the aid of a breakout board directly with the DUT. A variety of available breakout boards provide convenient customization of digital signal formats, since they are all connected at the same interface (user interface) of the R&S EX-IQ-BOX. Thus with the R&S EX-IQ-BOX and the appropriate breakout board you can easily perform applications of user-defined or standardized transmission protocols.

The following chapters provide information on the interfaces, connectors and pinouts of the available breakout boards:

- chapter 10.1, "User Interface of the R&S EX-IQ-BOX", on page 441
  - chapter 10.3.1.1, "Breakout Board Single Ended 3585.7280.00", on page 445
  - chapter 10.3.1.2, "Breakout Board Differential 3585.7296.00", on page 447
  - chapter 10.3.1.3, "Breakout Board Cadence Palladium 090002-24x", on page 450
- chapter 10.3.3, "CPRI - Option R&S EXBOX-B85", on page 453
- chapter 10.3.4, "DigRF - Option R&S EXBOX-B81", on page 455

10.3.1 User Defined

Various interchangeable breakout boards are available for adjusting customer specific signal formats to the common R&S digital signal format.

A breakout board is connected directly to the user interface on the front panel of the R&S EX-IQ-BOX without using a cable. The pin assignment for each breakout board is defined by the layout.

Two breakout boards for User Defined protocols are included in delivery of the R&S EX-IQ-BOX:

- single ended 090002-22x, type II, see Breakout Board Single Ended 3585.7280.00

- differential 090002-23x, type III, as described in Breakout Board Differential 3585.7296.00

For the Cadence emulation as a specific application of the R&S EX-IQ-BOX with the Protocol Tester R&S CMW, a Cadence breakout board is also provided, see chapter 10.3.1.3, "Breakout Board Cadence Palladium 090002-24x", on page 450. You find the description to this test case in the internet under http://www.rohde-schwarz.com/appnote/1CM75.

10.3.1.1 Breakout Board Single Ended 3585.7280.00

This breakout board contains the counterpart to the user interfaceof the R&S EX-IQ-BOX, i.e. a Z-DOK-Adapter board connector (X1), and two connectors for adjusting the external user signals.

The breakout board is intended for testing single ended signals. The signals are assigned to two 25-pole connectors.

Connector Type X2, X3 - Single Ended

Type:	2x25-pole connector
Manufacturer:	Harting
Part number:	0919 550 6323

Connector Locations - Single Ended

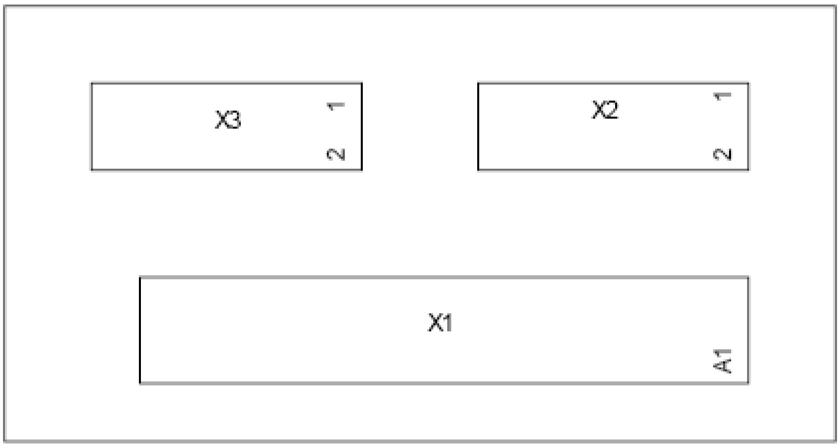


Fig. 10-2: Connector locations on Single Ended breakout board

Pin Description - Single Ended

Table 10-4: Pinout 2 x 50-pin connectors (BreakOut-Board 2, 3585.7280.00)

Pin Number	Signal Name	Comment	Pin Number	Signal Name	Comment
X2.1	UI_I_P0	I component (single ended)	X3.1	UI_Q_P0	Q component (single ended)
X2.3	UI_I_P1		X3.3	UI_Q_P1	
X2.5	UI_I_P2		X3.5	UI_Q_P2	
X2.7	UI_I_P3		X3.7	UI_Q_P3	
X2.9	UI_I_P4		X3.9	UI_Q_P4	
X2.11	UI_I_P5		X3.11	UI_Q_P5	
X2.13	UI_I_P6		X3.13	UI_Q_P6	
X2.15	UI_I_P7		X3.15	UI_Q_P7	
X2.17	UI_I_P8		X3.17	UI_Q_P8	
X2.19	UI_I_P9		X3.19	UI_Q_P9	
X2.21	UI_I_P10		X3.21	UI_Q_P10	
X2.23	UI_I_P11		X3.23	UI_Q_P11	
X2.25	UI_I_P12		X3.25	UI_Q_P12	
X2.27	UI_I_P13		X3.27	UI_Q_P13	
X2.29	UI_I_P14		X3.29	UI_Q_P14	
X2.31	UI_I_P15		X3.31	UI_Q_P15	
X2.33	UI_I_P16		X3.33	UI_Q_P16	
X2.35	UI_I_P17		X3.35	UI_Q_P17	
X2.37	AUX_IO_P0	auxiliary signals	X3.37	AUX_IO_P2	auxiliary signals
X2.39	AUX_IO_P1		X3.39	AUX_IO_P3	
X2.41	GP_GP0	additional protocol dependent control / signaling	X3.41	GP_GP4	additional protocol dependent control / signaling
X2.43	GP_GP1		X3.43	GP_GP5	
X2.45	GP_GP2		X3.45	GP_GP3	
X2.47	D_CLK_UOUT_P	interface clock output	X3.47	D_CLK_UIN_P	interface clock input
X2.49	UI_VALID_P	indicates valid data blocks	X3.49	n.c.	
even numbered pins	GND		even numbered pins	GND	

In receiver mode, the signal UI_VALID_P/N must be operated and continuously active, since this clock signal is required as a reference for the PLL.

Information on the pinouts of the connectors - Single Ended Breakout Board

Find a detailed pin assignment to this breakout board in the appendix of the operating manual, drawing number 3585.7280.00. The drawing covers the user interface, connector X1 as well as the connectors X2 an X3.

10.3.1.2 Breakout Board Differential 3585.7296.00

The breakout board supports test cases with differential signals. It contains the Z-DOK-Adapter board connector (X1), for connection to the user interface of the R&S EX-IQ-BOX, and two 50-pole SMD connectors for assigning the differential signals.

Connector Type X2, X3 - Differential

Type:	2x50-pole connector
Manufacturer:	Samtec
Part number:	ASP-65067-01

Connector Locations - Differential

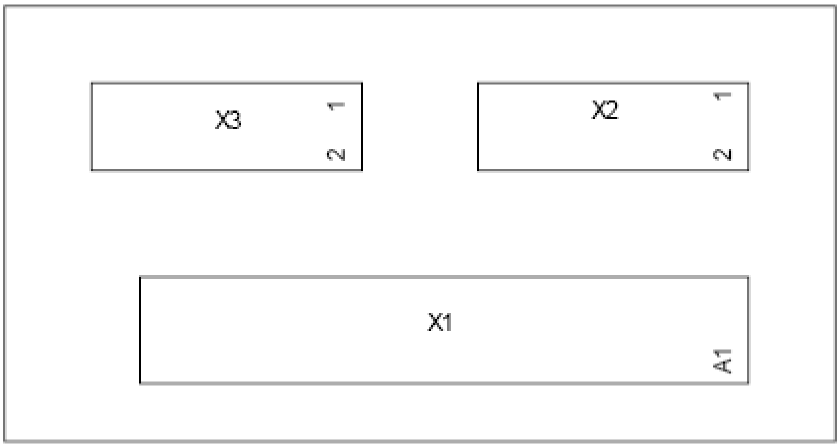


Fig. 10-3: Connector locations on Differential breakout board

Pin Description - Differential

Table 10-5: Pinout 2 x 100-pin Samtec Connectors (Breakout-Board 3, 3585.7296.00)

Pin Number	Signal Name	Comment	Pin Number	Signal Name	Comment
X2.1, X2.2	GND	I component (differential)	X3.1, X3.2	GND	Q component (differential)
X2.3	UI_I_N0		X3.3	UI_Q_N0	
X2.4	UI_I_P0		X3.4	UI_Q_P0	

Pin Number	Signal Name	Comment	Pin Number	Signal Name	Comment
X2.5, X2.6	GND		X3.5, X3.6	GND	
X2.7	UI_I_N1		X3.7	UI_Q_N1	
X2.8	UI_I_P1		X3.8	UI_Q_P1	
X2.9, X2.10	GND		X3.9, X3.10	GND	
X2.11	UI_I_N2		X3.11	UI_Q_N2	
X2.12	UI_I_P2		X3.12	UI_Q_P2	
X2.13, X2.14	GND		X3.13, X3.14	GND	
X2.15	UI_I_N3		X3.15	UI_Q_N3	
X2.16	UI_I_P3		X3.16	UI_Q_P3	
X2.17, X2.18	GND		X3.17, X3.18	GND	
X2.19	UI_I_N4		X3.19	UI_Q_N4	
X2.20	UI_I_P4		X3.20	UI_Q_P4	
X2.21, X2.22	GND		X3.21, X3.22	GND	
X2.23	UI_I_N5		X3.23	UI_Q_N5	
X2.24	UI_I_P5		X3.24	UI_Q_P5	
X2.25, X2.26	GND		X3.25, X3.26	GND	
X2.27	UI_I_N6		X3.27	UI_Q_N6	
X2.28	UI_I_P6		X3.28	UI_Q_P6	
X2.29, X2.30	GND		X3.29, X3.30	GND	
X2.31	UI_I_N7		X3.31	UI_Q_N7	
X2.32	UI_I_P7		X3.32	UI_Q_P7	
X2.33, X2.34	GND		X3.33, X3.34	GND	
X2.35	UI_I_N8		X3.35	UI_Q_N8	
X2.36	UI_I_P8		X3.36	UI_Q_P8	
X2.37, X2.38	GND		X3.37, X3.38	GND	
X2.39	UI_I_N9		X3.39	UI_Q_N9	
X2.40	UI_I_P9		X3.40	UI_Q_P9	
X2.41, X2.42	GND		X3.41, X3.42	GND	
X2.43	UI_I_N10		X3.43	UI_Q_N10	
X2.44	UI_I_P10		X3.44	UI_Q_P10	
X2.45, X2.46	GND		X3.45, X3.46	GND	
X2.47	UI_I_N11		X3.47	UI_Q_N11	
X2.48	UI_I_P11		X3.48	UI_Q_P11	

Pin Number	Signal Name	Comment	Pin Number	Signal Name	Comment
X2.49, X2.50	GND		X3.49, X3.50	GND	
X2.51	UI_I_N12		X3.51	UI_Q_N12	
X2.52	UI_I_P12		X3.52	UI_Q_P12	
X2.53, X2.54	GND		X3.53, X3.54	GND	
X2.55	UI_I_N13		X3.55	UI_Q_N13	
X2.56	UI_I_P13		X3.56	UI_Q_P13	
X2.57, X2.58	GND		X3.57, X3.58	GND	
X2.59	UI_I_N14		X3.59	UI_Q_N14	
X2.60	UI_I_P14		X3.60	UI_Q_P14	
X2.61, X2.62	GND		X3.61, X3.62	GND	
X2.63	UI_I_N15		X3.63	UI_Q_N15	
X2.64	UI_I_P15		X3.64	UI_Q_P15	
X2.65, X2.66	GND		X3.65, X3.66	GND	
X2.67	UI_I_N16		X3.67	UI_Q_N16	
X2.68	UI_I_P16		X3.68	UI_Q_P16	
X2.69,X2.70	GND		X3.69,X3.70	GND	
X2.71	UI_I_N17		X3.71	UI_Q_N17	
X2.72	UI_I_P17		X3.72	UI_Q_P17	
X2.73, X2.74	GND	auxiliary signals	X3.73, X3.74	GND	auxiliary signals
X2.75	AUX_IO_N0		X3.75	AUX_IO_N2	
X2.76	AUX_IO_P0		X3.76	AUX_IO_P2	
X2.77, X2.78	GND		X3.77, X3.78	GND	
X2.79	AUX_IO_N1		X3.79	AUX_IO_N3	
X2.80	AUX_IO_P1		X3.80	AUX_IO_P3	
X2.81, X2.82	GND	additional protocol dependent control / signaling	X3.81, X3.82	GND	additional protocol dependent control / signaling
X2.83	GP_N0		X3.83	GP_N4	
X2.84	GP_P0		X3.84	GP_P4	
X2.85, X2.86	GND		X3.85, X3.86	GND	
X2.87	GP_N2		X3.87	GP_N3	
X2.88	GP_P2		X3.88	GP_P3	
X2.89, X2.90	GND		X3.89, X3.90	GND	
X2.91	GP_N1		X3.91	GP_N5	
X2.92	GP_P1		X3.92	GP_P5	

Pin Number	Signal Name	Comment	Pin Number	Signal Name	Comment
X2.93, X2.94	GND	interface clock output	X3.93, X3.94	GND	interface clock input
X2.95	D_CLK_UOUT_N		X3.95	D_CLK_UIN_N	
X2.96	D_CLK_UOUT_P		X3.96	D_CLK_UIN_P	
X2.97, X2.98	GND	indicates valid data blocks	X3.97, X3.98	GND	
X2.99	UI_VALID_N		X3.99	n.c.	
X2.100	UI_VALID_P		X3.100	n.c.	

The signal UI_VALID_P/N must be active in receiver mode. This clock signal is required as a reference for PLL. Therefore, it must be active continuously.

Information on the pinouts of the connectors - Differential breakout board

Find a detailed pin assignment to this breakout board in the appendix of the operating manual, drawing number 3585.7296.00. The drawing covers the user interface, connector X1 as well as the connectors X2 and X3.

10.3.1.3 Breakout Board Cadence Palladium 090002-24x

This breakout board, option R&S EXBOX-Z3 consists of the connector to the R&S EX-IQ-BOX and one connector for adjusting the external user signals.

The breakout board is used for signal transmission between a cadence palladium emulator and R&S measurement equipment. The signals are assigned to a 68-pole SCSI connector.

Type:	**68-pole D Subminiatur SCSI connector**
Manufacturer:	**Tyco Electronics**
Part number:	**787170-7**

Connector Locations

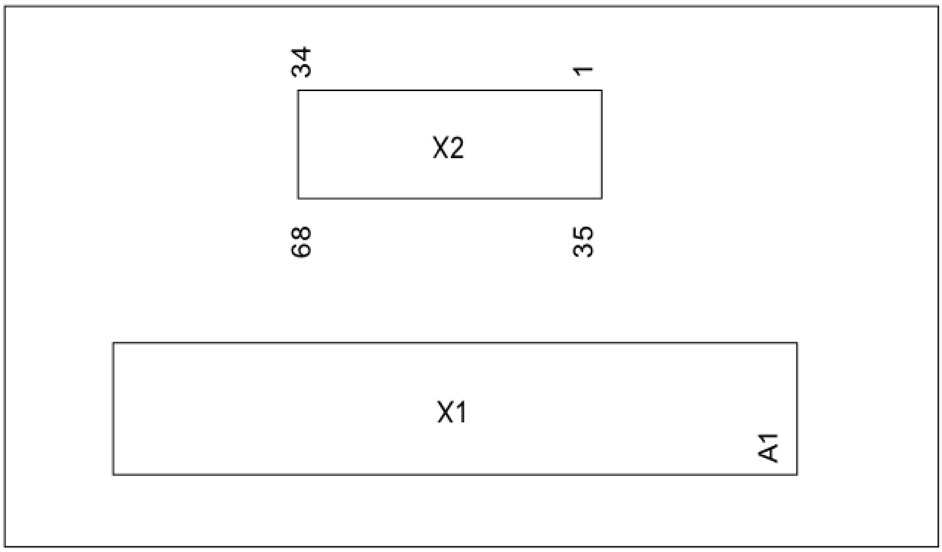


Fig. 10-4: Connector locations on Cadence Palladium breakout board

Pin Description

Table 10-6: Pinout 1 x 68-pin connector

Pin Number	Signal Name	Comment	Pin Number	Signal Name	Comment
X2.1	UI_I_P0	I component	X2.35	GND	
X2.2	UI_I_P1		X2.36	GND	
X2.3	UI_I_P2		X2.37	GND	
X2.4	UI_I_P3		X2.38	GND	
X2.5	UI_I_P4		X2.39	GND	
X2.6	UI_I_P5		X2.40	GND	
X2.7	UI_I_P6		X2.41	GND	
X2.8	UI_I_P7		X2.42	GND	
X2.9	UI_I_P8		X2.43	GND	
X2.10	UI_I_P9		X2.44	GND	
X2.11	UI_I_P10		X2.45	GND	
X2.12	UI_I_P11		X2.46	GND	
X2.13	UI_I_P12		X2.47	GND	
X2.14	UI_I_P13		X2.48	GND	
X2.15	UI_I_P14		X2.49	GND	
X2.16	UI_I_P15		X2.50	GND	

Pin Number	Signal Name	Comment	Pin Number	Signal Name	Comment
X2.17	UI_Q_P0	Q component	X2.51	GND	
X2.18	UI_Q_P1		X2.52	GND	
X2.19	UI_Q_P2		X2.53	GND	
X2.20	UI_Q_P3		X2.54	GND	
X2.21	UI_Q_P4		X2.55	GND	
X2.22	UI_Q_P5		X2.56	GND	
X2.23	UI_Q_P6		X2.57	GND	
X2.24	UI_Q_P7		X2.58	GND	
X2.25	UI_Q_P8		X2.59	GND	
X2.26	UI_Q_P9		X2.60	GND	
X2.27	UI_Q_P10		X2.61	GND	
X2.28	UI_Q_P11		X2.62	GND	
X2.29	UI_Q_P12		X2.63	GND	
X2.30	UI_Q_P13		X2.64	GND	
X2.31	UI_Q_P14		X2.65	GND	
X2.32	UI_Q_P15		X2.66	n.c.	
X2.33	D_CLK_UOUT_P	interface clock output	X2.67	D_CLK_UIN_P	interface clock input
X2.34	D_CLK_UOUT_N		X2.68	UI_VALID_P	indicates valid data blocks

Information on the pinouts of the connectors - Cadence Palladium breakout board

Find the pin assignments of this breakout board in the appendix of the operating manual, drawing number 090101-331-25AEZ00. The drawing covers the user interface, connector X1 and the SCSI connector X2.

10.3.2 Other Customer Breakout Boards

Other connected Customer Breakout Boards always run in "User defined" mode. This mode will only work properly if the beakout board is recognized as a "customer board".

In order for the breakout board to be recognized as a "Customer Breakout Board", the following conditions must be met:

The signals BO_TYPE0, BO_TYPE1 and BOB_SENSE

must be set to **LOW**.

Information on the pinouts of the connectors

Find the pin assignments of the connector X1 in the appendix of the operating manual, drawing number 3585.7280.00.

10.3.3 CPRI - Option R&S EXBOX-B85

The CPRI breakout board performs tests directly at the CPRI interface between the REC (base station radio equipment control) and the RE (base station radio equipment).

The board contains the user interface to the R&S EX-IQ-BOX, two different interfaces for data exchange with the DUT, two interfaces for additional control & management information exchange, and three general purpose interfaces.

On the front panel, two SFP cages support the optical link. The breakout board additionally contains a differential electrical interface, realized by four SMA connectors.

The front panel also provides the connectors for C&M data exchange. For fast C&M, use the Ethernet interface, and for slow C&M, the RS-232-C interface.

Three BNC connectors for general purposes, input or output, enable controlling the DUT, or reading the signals from the DUT, such as for user-specific purposes. These connectors are located on top of the breakout board.

Connect the breakout board directly at the user interface with the R&S EX-IQ-BOX, i.e. without using a cable. Use in all other interfaces the suitable cables and modules to make sure that data transmission works properly.

10.3.3.1 Connector Locations - CPRI Breakout Board

The schematic view shows the location of the connectors of the CPRI breakout board, which are briefly listed after the graphic.

Find detailed information about the specification and properties of the interfaces in the CPRI data sheet.

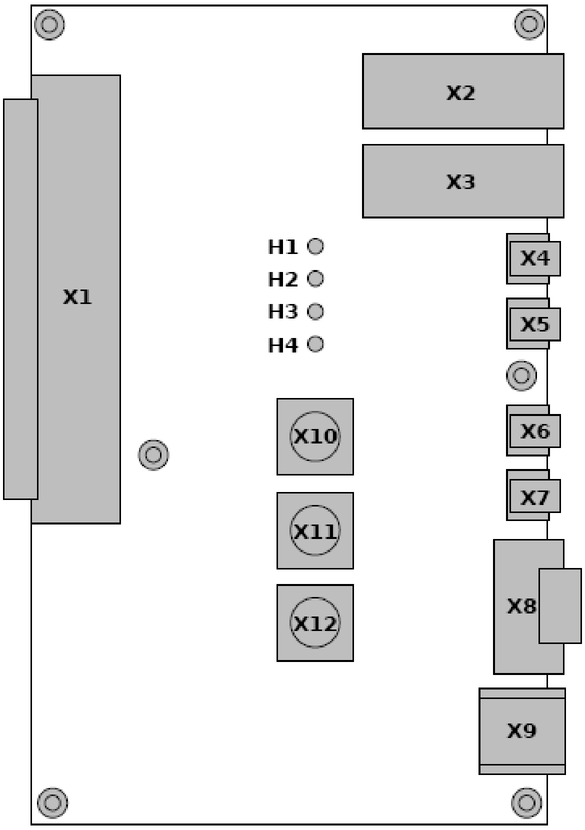


Fig. 10-5: Connector locations on CPRI breakout board

X1	**User interface** This plug is the counterpart of the user interface of the R&S EX-IQ-BOX, i.e. a TYCO Z-Dok adapter board connector with 56 differential pairs.
X2/X3	**SFP interface** The type of these SFP modules depends on the used equipment **Note:** These modules must fit to the transmission characteristics of the DUT.
X4, X5, X6, X7	**SMA Differential Tx/Rx Interfaces** The interface consists of four SMA coaxial connectors.
X8	**Fast C&M Interface** type Ethernet.
X9	**Slow C&M Interface** connector type RS-232-C.
X10, X11, X12	**GPIO Marker & Clock Outputs** BNC connectors.
H1 ... H4	**Multicolor LEDs** indicating the status of the CPRI link.

10.3.4 DigRF - Option R&S EXBOX-B81

The DigRF breakout board performs tests directly at the DigRF interface between the BB-IC (digital baseband chip) and the RF-IC of a mobile terminal.

Connect the breakout board directly at the user interface with the R&S EX-IQ-BOX, i.e. without using a cable. Use in all other interfaces the suitable cables and modules to make sure that data transmission works properly.

10.3.4.1 DigRF Connector Locations

The schematic view shows the location of the connectors of the DigRF breakout board, which are briefly listed after the graphic.

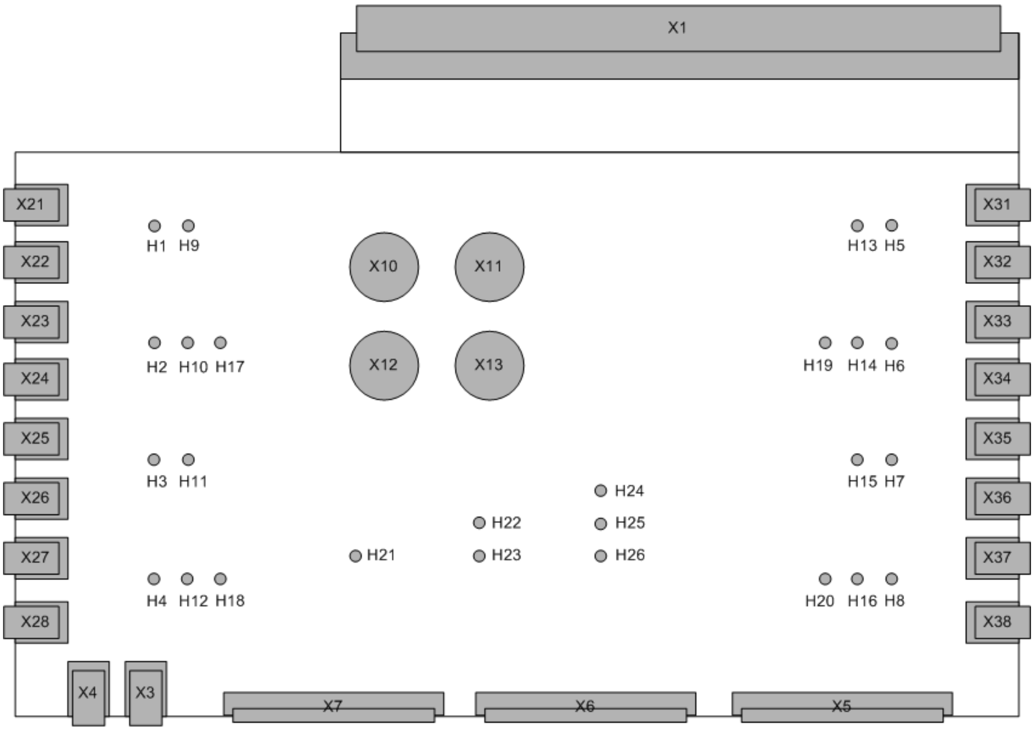


Fig. 10-6: DigRF location of connectors and LEDs on the breakout board

X1 = User interface, counterpart of the user interface of the R&S EX-IQ-BOX
X3, X4 = Clock1 / Clock2, SMA connectors
X5 = GPIO Group, SMC 50-pole connector
X6 = GPIO / SPI / I2C / RFFE, SMC 50-pole connector
X7 = DigRF Control, SMC 50-pole connector
X10...X13 = User I/O, BNC connectors
X21...X28 = Differential Tx/Rx Interfaces DigRF 3G, SMA coaxial connectors
X31...X38 = Differential Tx/Rx Interfaces DigRF v4, SMA coaxial connectors
H1...H8 = Status LEDs, indicate when data transfer in the appropriate Tx/Rx path is running
H9...H16 = Multicolor LEDs, indicate the transmission speed in the corresponding path
H17... H20 = Status LEDs, indicate synchronization of the receiver in the corresponding path

H21 = Status LED, indicates when PLL is locked
H22, H23 = Status LEDs, indicate when a DigRF standard is active
H24...H26 = Status LEDs, indicate: ready for operation, power supplied and occurred error(s)

10.3.4.2 SMA Connectors

Tx/Rx

The DigRF Tx/Rx ports are coaxial SMA (**Sub****M**iniature version **A**) connectors with a differential impedance of 100 Ohm.

Table 10-7: Tx<n>_N/_P, Rx<n>_N/_P (<n> = channel 1/2)

Connector	Signal	Connector	Signal
DigRF 3G connectors		DigRF v4 connectors	
X21	TX1_N	X31	TX1_N
X22	TX1_P	X32	TX1_P
X23	RX1_N	X33	RX1_N
X24	Rx1_P	X34	Rx1_P
X25	Tx2_N	X35	Tx2_N
X26	Tx2_P	X36	Tx2_P
X27	Rx2_N	X37	Rx2_N
X28	Rx2_P	X38	Rx2_P

The signals are set in the "Hardware" > "DigRF 3G/v4" tabs of R&S DigIConf, see chapter 7.3.7.5, "DigRF 3G", on page 230 and chapter 7.3.7.6, "DigRF v4", on page 234.

Clock

At the front, the DigRF breakout board contains two SMA connectors for reference frequency input or output. The board generates an additional synchronous reference frequency from the fed SysClk (RefClk) for auxiliary equipment.

Table 10-8: Clock1 / Clock 2

Connector	Signal	Description
X3	Clock 1	SysClk input or output, bidirectional
X4	Clock 2	Reference clock output for auxiliary instruments, synchronous to SysClk (RefClk)

The signals are set in the "Hardware" > "Clock" tab of R&S DigIConf, see chapter 7.3.7.3, "Clock Settings", on page 223.

10.3.4.3 BNC Connectors

On top, the DigRF breakout board contains four BNC connectors for assigning bi-directional user signals such as trigger or marker signals. Transmission direction is coupled in pairs with two signals each.

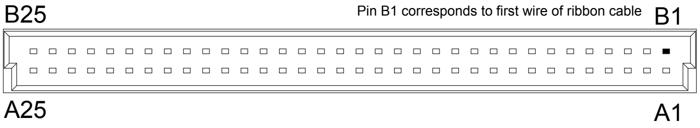
Table 10-9: User I/O

Connector	Signal	Description
X10	USER I/O 1	off, input, output
X11	USER I/O 2	
X12	USER I/O 3	off, input, output
X13	USER I/O 4	

The signals are individually configurable and set in the "Hardware" tab of R&S DigIConf, see "User I/O Settings" on page 229.

10.3.4.4 SMC Connectors

At the front, the DigRF breakout board provides three SMC 50-pole connectors for bidirectional communication with proprietary interfaces.



Type:	SMC-1.27 mm, 50 pins
Manufacturer:	ERNI

Table 10-10: General Purpose Input Output

Connector	Signal	Description
X5	GPIO Group	40 signal wide bidirectional bus, grouped in 5 groups with 8 signals each
X6	GPIO/SPI/I2C/ RFFE ● GPIO ● SPI/I2C ● RFFE	24 signal wide bidirectional bus: ● individually configurable ● for communication with external devices ● for communication with RF front-end components, such as filters, converters, sensors, etc.
X7	DigRF Control	50 pins, SysClkEn, InterfaceEn (DigRF 3G)

The voltage values of the signals at these connectors are determined in the "Hardware" tab of R&S DigIConf, see "GPIO / SPI / I2C / RFFE Voltages" on page 228, "User I/O Settings" on page 229 and "GPIO Group Voltages" on page 229. You can use any voltage level between 1.2 V and 3.3 V for the signals.

The signals, however, are configured with script commands, as briefly shown in the example.

Example:

This command line sets a GPIO Group signal:

`(gpo_grp(grp,pin),gpi_grp(grp,pin),gp_grp_cfg)`

The first parameter determines the gpo_grp (**g**eneral **p**urpose **o**utput_group) signal, i.e. signal output. Just assign the group number to the first variable (`grp`) in brackets, and the pin of the connector to the second (`pin`). repeat the same with the input signal, i.e. `gpi_grp(grp,pin)`. The last command "gp_grp_cfg" applies the settings.

To address the appropriate connector, look at the pin assignments of the appropriate connector.

Pin assignment

Table 10-11: X5 - GPIO Group

Pin	Signal	Pin	Signal
A1	GPIO_GRP0[0]	B1	GPIO_GRP0[1]
A2	GPIO_GRP0[2]	B2	GPIO_GRP0[3]
A3	GPIO_GRP0[4]	B3	GPIO_GRP0[5]
A4	GPIO_GRP0[6]	B4	GPIO_GRP0[7]
A5	GND	B5	GND
A6	GPIO_GRP1[0]	B6	GPIO_GRP1[1]
A7	GPIO_GRP1[2]	B7	GPIO_GRP1[3]
A8	GPIO_GRP1[4]	B8	GPIO_GRP1[5]
A9	GPIO_GRP1[6]	B9	GPIO_GRP1[7]
A10	GND	B10	GND
A11	GPIO_GRP2[0]	B11	GPIO_GRP2[1]
A12	GPIO_GRP2[2]	B12	GPIO_GRP2[3]
A13	GPIO_GRP2[4]	B13	GPIO_GRP2[5]
A14	GPIO_GRP2[6]	B14	GPIO_GRP2[7]
A15	GND	B15	GND
A16	GPIO_GRP3[0]	B16	GPIO_GRP3[1]
A17	GPIO_GRP3[2]	B17	GPIO_GRP3[3]
A18	GPIO_GRP3[4]	B18	GPIO_GRP3[5]
A19	GPIO_GRP3[6]	B19	GPIO_GRP3[7]
A20	GND	B20	GND
A21	GPIO_GRP4[0]	B21	GPIO_GRP4[1]
A22	GPIO_GRP4[2]	B22	GPIO_GRP4[3]
A23	GPIO_GRP4[4]	B23	GPIO_GRP4[5]

Pin	Signal	Pin	Signal
A24	GPIO_GRP4[6]	B24	GPIO_GRP4[7]
A25	SENSE_GPIO	B25	GND

Note: SENSE_GPIO is activated in the appropriate DigRF standard of the hardware tab, see "General" on page 231, or in "General" on page 235 section of DigRF v4, respectively.

Table 10-12: X6 - GPIO / SPI / I2C / RFFE

Pin	Signal	Pin	Signal
A1	RFFE_SCLK1	B1	3V3 (max. 50mA)
A2	RFFE_SDATA1	B2	GND
A3	RFFE_SCLK2	B3	V_RFFE (max. 50mA)
A4	RFFE_SDATA2	B4	GND
A5	GND	B5	GND
A6	USER_SPI_SCK	B6	USER_SPI_MOSI
A7	USER_SPI_SS1	B7	USER_SPI_MISO1
A8	USER_SPI_SS2	B8	USER_SPI_MISO2
A9	I2C_SCLK	B9	I2C_SDATA
A10	GND	B10	GND
A11	GPIO_[0]	B11	GPIO_[1]
A12	GPIO_[2]	B12	GPIO_[3]
A13	GPIO_[4]	B13	GPIO_[5]
A14	GPIO_[6]	B14	GPIO_[7]
A15	GND	B15	GND
A16	GPIO_[8]	B16	GPIO_[9]
A17	GPIO_[10]	B17	GPIO_[11]
A18	GPIO_[12]	B18	GPIO_[13]
A19	GPIO_[14]	B19	GPIO_[15]
A20	GND	B20	GND
A21	GPIO_[16]	B21	GPIO_[17]
A22	GPIO_[18]	B22	GPIO_[19]
A23	GPIO_[20]	B23	GPIO_[21]
A24	GPIO_[22]	B24	GPIO_[23]
A25	SENSE_AUX	B25	GND

Table 10-13: X7 - DigRF Control

Pin	Signal	Pin	Signal
A1	GND	B1	V1_RXTX_DATA
A2		B2	V1_RXTX_EN
A3		B3	n.c.
A4		B4	V1_CTRL_DATA
A5		B5	GND
A6		B6	V1_CTRL_CLK
A7		B7	V1_CTRL_EN
A8		B8	V1_STROBE
A9		B9	V1_SYSCLK_EN
A10		B10	GND
A11		B11	V1_SENSE
A12		B12	reserved
A13		B13	n.c.
A14		B14	n.c.
A15		B15	GND
A16		B16	V3_SYSCLK_EN
A17		B17	V3_INTERFACE_EN
A18		B18	n.c.
A19		B19	V3_SENSE
A20		B20	GND
A21		B21	V4_REFCLK_EN
A22		B22	V4_DIGRF_EN
A23		B23	V4_DIGRF_EN_REM1
A24		B24	V4_SENSE
A25	n.c.	B25	GND
	n.c.: not connected		

A Annex

The annex contains a list of abbreviations, an overview of automatically assigned file extensions and tables of preset values to the respective transmission protocols.

A.1 Abbreviations

The following lists contain some common abbreviations used in this manual. For more abbreviations that relate to CPRI, see the CPRI specification at http://www.cpri.info/spec.html, and for DigRF interface specification refer to www.mipi.org, respectively.

Table 1-1: Abbreviations and acronyms used in the CRPI protocol

Abbreviation	Term
ACP	Adjacent Channel Power
AGC	Automatic Gain Control
AxC	Antenna-carrier
BBMUS	BBM Unspecified
BPNC	Backplane Not Connected
C&M	Control and Management
ceil	ceiling function
CML	Current Mode Logic
CPRI	Common Public Radio Interface
CRC	Cyclic Redundancy Check)
DL	Downlink
DUT	Device Under Test
ESD	End-of-Stream Delimiter
EVM	Error Vector Magnitude
FCS	Frame Check Sequence
FL	Forward Link, synonym to downlink
FP	Fabric Port
FPGA	Field Programmable Array
GBps	Giga Byte per second [GB/s]
GND	Ground Digital Ground
HDLC	High-level Data Link Control
Iub	Interface between Radio Network Controller and UMTS radio base station (Node B)
IP	Internet Protocol

Abbreviation	Term
LAN	Local Area Network
LOF	Loss of Frame
LOS	Loss of Signal
LVDS	Low Voltage Differential Signal
MA	Module Address
MBps	Mega Byte per second [MB/s]
MGT	Multi-Gigabit Transceiver
MNC	Module Not Connected
RAI	Remote Alarm Indication
RCLK	Reference Clock
RE	Radio Equipment
REC	Radio Equipment Control
RL	Reverse Link, synonym to uplink
RP3L	Reference Point 3 Link
Rx	Receive
SA	Shelf Address
SAP	Service Acces Point
SCLK	System Clock
SDI	SAP Defect Indication
SFP	Small Form-factor Pluggable
SMA	SubMiniatur version A
SYNC	Synchronization Signal
Tc	CPRI basic frame length = UTRA FDD Chip period = 1/3.84MHz
Tx	Transmit
UE	User Equipment
UL	Uplink
Uu	Interface between the radio equipment of the UMTS radio base station (Node B) and the user equipment (UE)
XAUI	X Attachment Unit Interface (10 Gigabit)

Table 1-2: Abbreviations and acronyms used in the DigRF protocol

Abbreviation	Term
BBIC	Baseband Integrated Circuit
BER	Bit Error Rate

Abbreviation	Term
CDR	Clock Data Recovery
CLC	Control Logical Channel
CMOS	Complementary Metal Oxide Silicon
CRC	Cyclic Redundancy Check
CRCLC	Configuration Read Control Logical Channel
CRI	Cyclic Running Index
CTS	Clear To Send
CWCLC	Configuration Write Control Logical Channel
DCH	Dedicated Channel
DLC	Data Logical Channel
DigRF	Digital RF
HS	High Speed
HS1P	High Speed 1x Primary
HS1S	High Speed 1x Secondary
HWS	Harware Scheduler
HW	Hardware
HS2P	High Speed 2x Primary
HS2S	High Speed 2x Secondary
IC	Interface Control
ICLC	Interface Control Logical Channel
IF	Interface
IFC	Interface Control
LS	Low Speed
LSB	Least Significant Bit
LVDS	Low Voltage Differential Signaling
Mbps	Megabits per second
MIMO	Multiple Input, Multiple Output
MIPI	Mobile Industry Processor Interface
MSB	Most Significant Bit
PLL	Phae Locked Loop
RACLC	Rx not Acknowledge Control Logical Channel
RBCLC	Read Back Control Logical Channel
RDS	Running Digital Sum

Abbreviation	Term
RF	Radio Frequency
RFIC	Radio Frequency Integrated Circuit
RHLCLC	Rx High Level Control Logical Channel
RICLC	Rx Interface Control Logical Channel
RNCLC	Rx informatioN Control Logical Channel
RSCLC	RX Sub Control Logical Channel
RTI	Retransmission Indicator
RX	Receiver
SLVS	Scalable Low Voltage Signaling
SOF	Start Of Frame
SOT	Start Of Transmission
TACLC	Tx not Acknowledge Control Logical Channel
TAS	Time Accurate Strobe (Logical Channel)
TASLC	TAS Logical Channel
THLCLC	Tx High Level Control Logical Channel
TICLC	Tx Interface Control Logical Channel
TSCLC	TX Sub Control Logical Channel
TX	Transmitter

A.2 Extensions for User Files

The following table list all available file extensions for user files. The currently available files on the instrument depend on the installed options.

Table 1-3: List of the automatically assigned file extensions in R&S DigIConf

Function/Digital Standard	List type	Contents	File suffix
CPRI	Settings	CPRI configuration, vendor data included Instrument settings	`*.cpri`
	Waveform	Waveforms and multi segment waveforms	`*.wv`
DigRF	Settings	DigRF configuration	`*.digrf`
	Data streams	I/Q data streams	`*.wv`
		Raw data streams	`*.drf3` `*.drf4`
	Scripts	DigRF scipts files	`*.p`

Function/Digital Standard	**List type**	**Contents**	**File suffix**
		compiled script files	`*.amx`
		script parameters	`*.par`
		user memory data	`*.mem`
User Defined	Settings	User Defined Protocol configuration	`*.iqbox`
Configuration Software	Settings	R&S DigIConf settings	`*.savrcl`

A.3 Preset

The following lists give an overview of the key preset values of the corresponding protocols.

A.3.1 User Defined Default Settings

This section contains the default settings of the parameters for user defined protocols, sorted by the tabs in R&S DigIConf.

Main Controls

Parameter	**Default value**
State	Off
Logic Type	3.3 V CMOS
Direction	Transmitter

Protocol

Parameter	**Default value**
Format	Parallel
Data Rate	SDR
Interleaving	Not Interleaved

Data

Parameter	Default value
Word Size	16 Bit
Word Alignment	LSB

Bit Order	LSB
Numeric Format	2's Complement

Clock

Clock Rate	10 MHz
Clock Source	Internal (BNC REF IN)
Clock Phase	0 deg
Clock Skew	0 ns
Sample/Clock Rate Ratio	1
Source	REF IN
Frequency	10 MHz

Test

Parameter	**Default value**
Tx Test	Off
Test Signal	PRBS
IQ Words (Rec)	0
Rx BER (Rec)	0.00 E+00
Wave File (ARB)	None
Sample Rate (ARB)	0
Number of Samples (ARB)	0

A.3.2 CPRI Default Settings

This section contains the default settings of the parameters for CPRI, sorted by the tabs in R&S DigIConf.

Main Controls

Parameter	**Default value**
State	Off
Mode	CPRI RE Test

Hardware

Parameter	Default value
CPRI Line Bit Rate	2x (1228.8 Mbit/s)
FPGA Internal Loopback	None
Input	SFP1
Output	SFP1
Differential Output Swing	0.800 Vpp
Equalizer	0 dB

Downlink / Uplink

Parameter	Default value
Signal table/ - name	signal_1
Signal State	Off
Standard	3GPP FDD
Physical Source (downlink)	DIG IQ IN 1
Signal Output (uplink)	DIG IQ OUT 2
Sample Rate	3,84 MHz
Pattern Length	16
Oversampling	1 (Downllink), 2 (Uplink)
I/Q Resolution	16
Downscale	0
AxC Allocation	Packed
AxC(s) / Data Rate	1 / 122.88 Mbit/s
(Assigned)	1 / 122.88 Mbit/s
Number of Groups	1
Groups Table Repetition	1
Groups Table AxC<index> State	On
Groups Table AxC<index> Pattern	0x0000
Available Data Rate (I/Q)	921.30 MBit/s
Assigned Data Rate (AxC)	0.00 MBit/s
AxC Table Source	signal_1
AxC Table Word Address	1
AxC Table Bit Address	0
AxC Table Size / bits	32

Control & Management

Parameter	Default value
State - Slow C&M (HDLC)	Off
Bit Rate	240 kbit/s
Source	Terminal
Mode	HDLC EN/DE Coding
State - Fast C&M (Ethernet)	Off
Ethernet Pointer	20
Pref. Eth. Pointer	20
Bit Rate (Ethernet)	42.l24 MBit/s

Vendor Data

Parameter	Default value
State	Off
Line Bit Rate	2x (1228.8 Mbit/s)
Direction	Downlink
Word Width	16
Ethernet Pointer	20
Z.aa.0,1/Z.bb.0,1/Z.cc.0,1/Z.dd.0,1	0

Test and Diagnostic

Parameter	Default value
GPIO Direction (1...3)	Off
GPIO Signal (1...3)	Constant Low
SDI	Off
RE Reset	Off
PRBX Test Tx/Rx	Off

ARB

Parameter	Default value
File (ARB 1 ... ARB 4)	None
Option(s)	
Sample Rate/Samples	0

Parameter	Default value
State	Off
Total Samples	0.00 / 128 MSamples

Recorder

Parameter	Default value
Data Source	(signal_1)
Recording Length	100 Samples
State	Off
Trigger Source	Software
Trigger Position	0 Samples

A.3.3 DigRF Default Settings

This section contains the default settings of the parameters for DigRF 3G and DigRF v4, sorted by the tabs in R&S DigIConf.

Main controls

Parameter	Default value
State	Off
Mode	RF-IC Test

Operation

Parameter	Default value
Script File	None
Download parameters at Script Start	On
User Memory	User Memory 1
Memory File	None

Script Console

Parameter	Default value
State	On
Trace Level	None

Hardware

Table 1-4: DigRF > Hardware > Clock default settings

Parameter	Default value
Reference Source	CLOCK1
RefClk Frequency	26 MHz
Function - Clock1	RefClk In
Input Termination - Clock1	Off
Vdd Coupling with - Clock1	DigRF 3G
Ref Out Frequency - Clock2	10 MHz
Slow Slew Rate - Clock2	Off
Vdd - Clock2	1.8 V

Table 1-5: DigRF > Hardware > GPIO/SPI/RFFE/USER default settings

Parameter	Default value
GPIO, SPI and GPIO_GRP 0...4 Vdd	1.8 V
Direction - USER 1...4	Off
Signal - USER 1...4	No Signal

Table 1-6: DigRF > Hardware > DigRF 3G default settings

Parameter	Default value
Mode	Channel 1
Vdd Sense	Off
Interface Standard	1.8 LVDS
Inverted Polarity TX / RX	Off
Slow Slew Rate	Off

Table 1-7: DigRF > Hardware > DigRF v4 default settings

Parameter	Default value
Mode	Channel 1
Vdd Sense	Off
Interface Standard	1.2 SA
Inverted Polarity TX / RX	Off
Slow Slew Rate	Off

IQ Sources

Parameter	Default value
ARB File 1...4	None
Sample Rate	0
Samples	0.000
Level dBFS	0.00
PEP dBFS	0.00
State	Off
Virtual Sample Rate	3.840000 MHz
Frequency	1.000000 MHz

Recorder

Parameter	Default value
Data Source	DigRF 3G RX Stream
Recording Length	100 Samples
Trigger Source	Software
Trigger Position	0 Samples
Recording Time	1 s

Marker

Parameter	Default value
Source	DigRF 3G RX
Enable Marker	Off

Test

Parameter	Default value
Interface	DigRF 3G
Interface Mode	LS
Test Signal - Interface BER Test	PRBS 16
TX Test Signal	Off
RX BER Measurement	Off
Test Signal - Low Level Payload BER Test	PRBS 16

A.4 Drawings

The following appendix contains the customer drawings of the user defined breakout boards, where you can find the location of the connectors and the corresponding pin assignments. See chapter 10, "Interfaces", on page 441 for description on the interfaces and breakout boards.

Included drawings:

- C-6367557
  Tyco Z-Dok Adapter Board Connector, (56 differential pairs), see also chapter 10.1, "User Interface of the R&S EX-IQ-BOX", on page 441.
- 3585.7280.00
  Single Ended Breakout Board with connector X1, the User Interface, and the connectors X2 and X3 (2x25 pole), see chapter 10.3.1.1, "Breakout Board Single Ended 3585.7280.00", on page 445.
- 3585.7296.00
  Differential Breakout Board, with connector X1, the User Interface, and the connectors X2 and X3 (2x50 pole), see chapter 10.3.1.2, "Breakout Board Differential 3585.7296.00", on page 447.
- 090101-331-25AEZ00
  Cadence Palladium Breakout Board with connector X1, the User Interface, and the connector X2 (1x68 pole SCSI), see chapter 10.3.1.3, "Breakout Board Cadence Palladium 090002-24x", on page 450.

THIS DRAWING IS UNPUBLISHED. RELEASED FOR PUBLICATION 2005

LOC	DIST
GP	00

REVISIONS

P	LTR	DESCRIPTION	DATE	DWN	APVD
	A	DRAWN	09SEPT05	WVS	EB
	A1	REV PER ECO-06-002399	01FEB2006	EDB	EDB

1. HOUSINGS; POLYESTER, UL 94V-0 RATED,NATURAL
SIGNAL AND SIGNAL GROUND CONTACTS: COPPER ALLOY
UTILITY CONTACTS: PHOSPHOR BRONZE

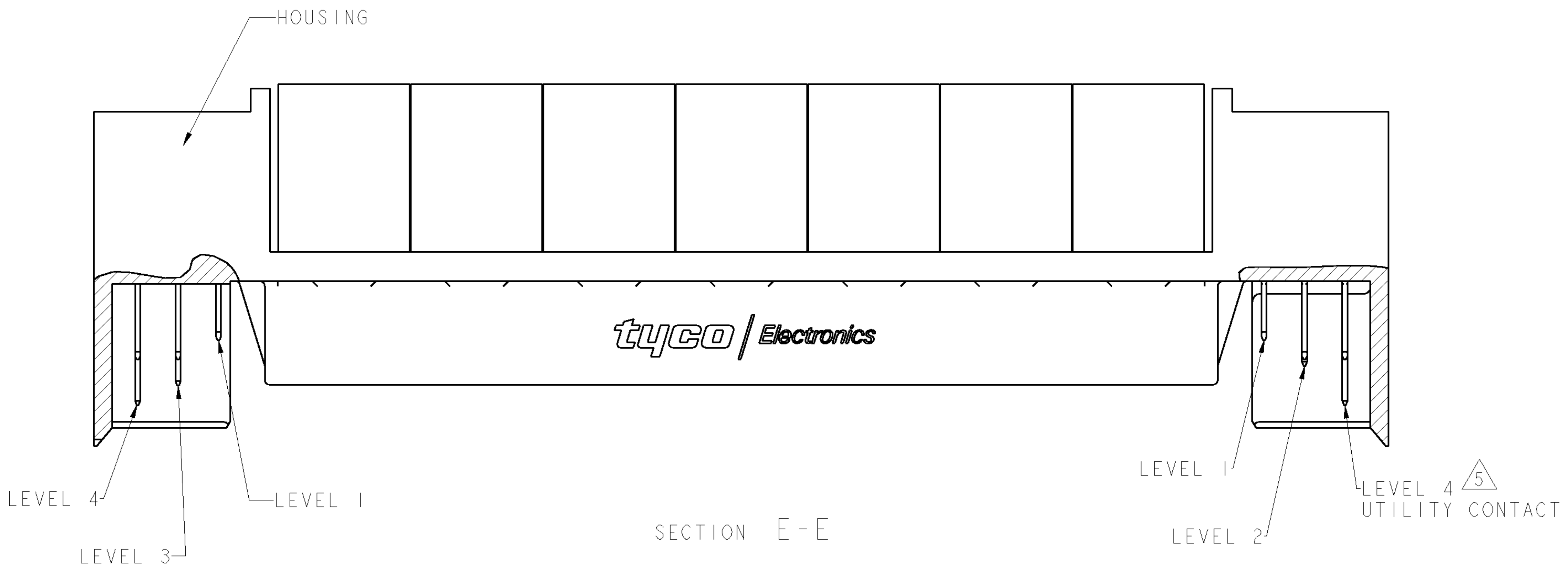
2. UTILITY CONTACTS: 0.76μm MIN GOLD IN CONTACT AREA,
2.54μm MIN TIN-LEAD ON PCB TAILS, OVER 1.27μm MIN NICKEL OVER ALL.
SIGNAL AND SIGNAL GROUND CONTACTS: 0.76μm MIN GOLD IN CONTACT AREA,
2.54μm MIN TIN-LEAD ON PCB TAILS, OVER 1.27μm MIN NICKEL OVER ALL.

3. ROWS A, C, D, AND F ARE SIGNAL CONTACTS. ROWS B AND E ARE SIGNAL GROUND CONTACTS.

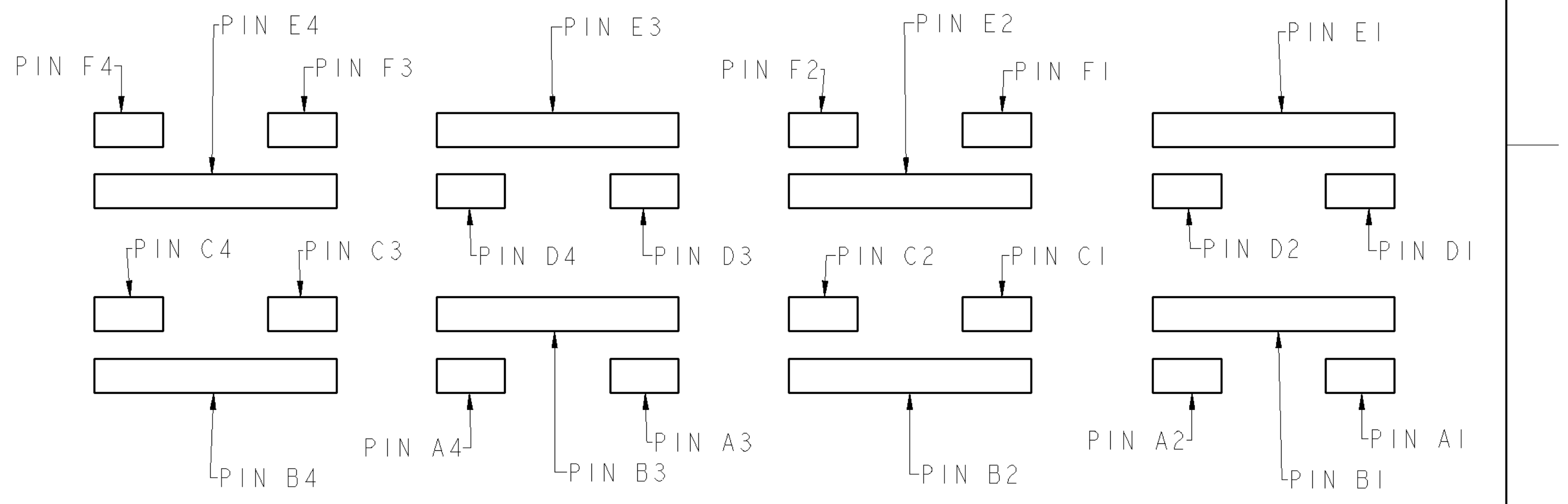
4. DIMENSIONS PER CUSTOMER BOARD LAYOUT.

5. SEE UTILITY CONTACT SEQUENCE TABLE FOR LOCATION AND LEVEL/LENGTH OF UTILITY CONTACTS FOR EACH PRODUCT PART NUMBER. UTILITY LEVEL 1 CAN BE USED FOR SENSING. UTILITY LEVELS 2, 3, AND 4 CAN BE USED FOR POWER, GROUND, OR ESD. SEQUENCING SHOWN IN SECTION E-E SHOWS THREE LEVELS FOR COMPARISON. UTILITY LEVEL 2 EQUALS THE SIGNAL GROUND CONATCT LEVEL. SIGNAL LEVEL IS BETWEEN UTILITY LEVELS 1 AND 2.

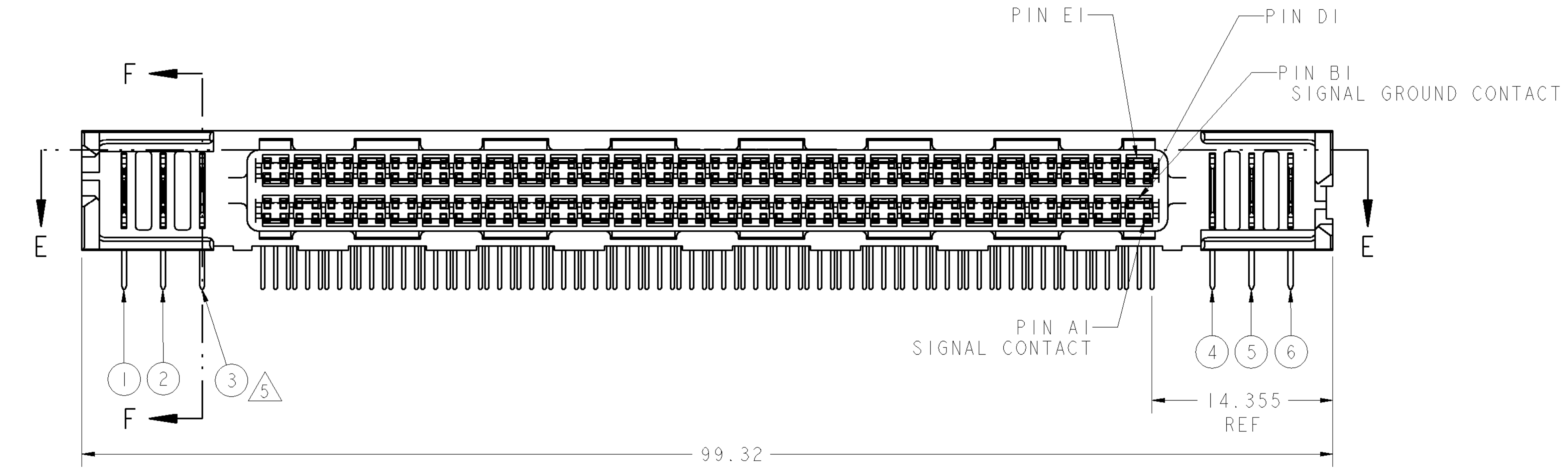
6. BLOCK DIAGRAM AND CONTACT IDENTIFICATION APPLY TO COPLANAR NON-INVERTED APPLICATION ONLY. CONTACT IDENTIFICATION REVERSES FOR INVERTED APPLICATIONS, I.E COPLANAR OR MID-BOARD INVERTED.

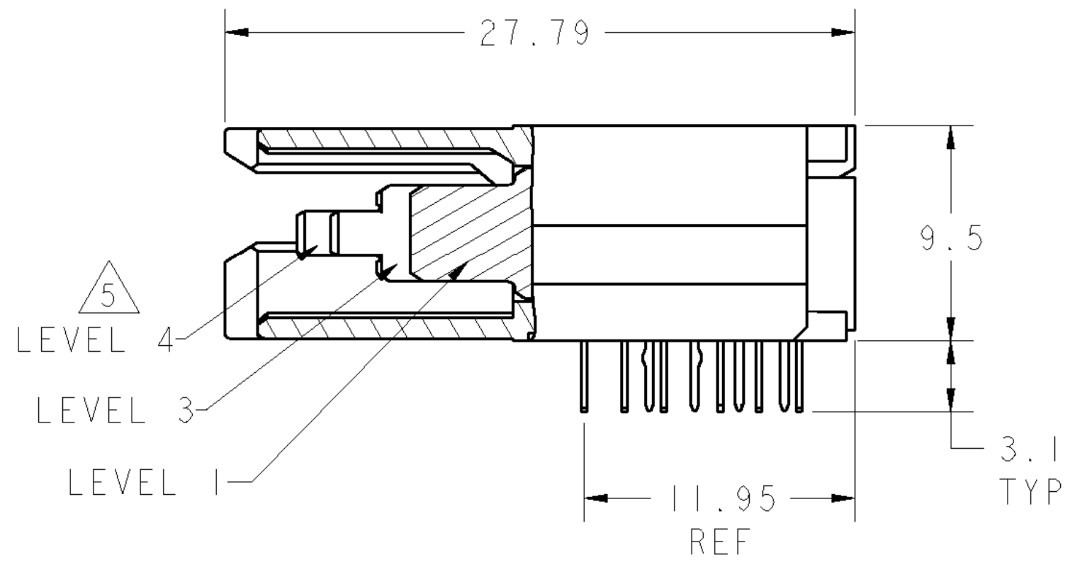


SECTION E-E

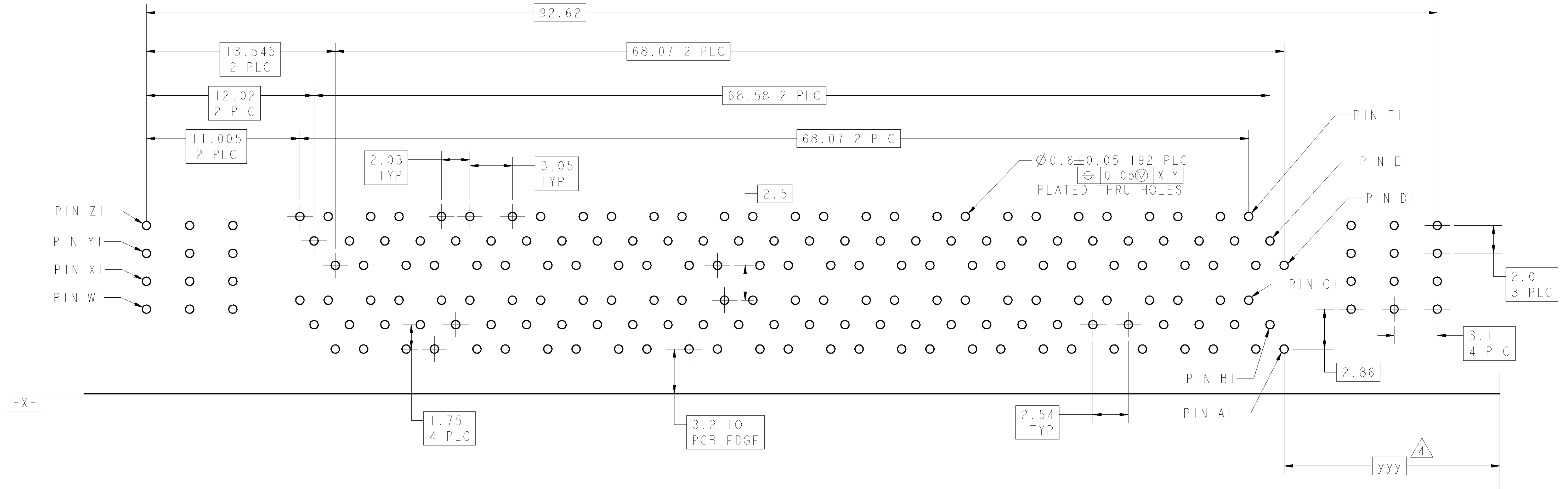


BLOCK DIAGRAM
MATING FACE CONFIGURATION





SECTION F-F



RECOMMENDED PC BOARD FOOTPRINT
COMPONENT SIDE SHOWN
SCALE 5:1

UTILITY CONTACT SEQUENCE TABLE ⚠5
UTILITY CONTACT LEVEL 1, 2, 3, OR 4

UTILITY CONTACT LOCATION ①	②	③	④	⑤	⑥	PART NUMBER
4	3	1	2	2	4	6367557-5
2	3	4	4	3	2	6367557-4
4	3	1	1	3	4	6367557-3
4	2	2	2	2	4	6367557-2
4	3	2	2	3	4	6367557-1

DIMENSIONS:
mm

TOLERANCES UNLESS OTHERWISE SPECIFIED:
0 PLC ±-
1 PLC ±0.3
2 PLC ±0.25
3 PLC ±-
4 PLC ±-
ANGLES ±-

MATERIAL
- ⚠1
-

FINISH
- ⚠2
-

DWN W. VAN SCYOC 09SEPT05
CHK E. BRIANT 09SEPT05
APVD E. BRIANT 09SEPT05
PRODUCT SPEC 108-1985
APPLICATION SPEC 114-13068
WEIGHT -

CUSTOMER DRAWING

tyco Electronics
Tyco Electronics
Harrisburg, PA 17105-3608

NAME
Z-DOK+ ADAPTER BOARD CONNECTOR
ASSEMBLY, 56 SIGNAL DIFF. PAIR,
3 UTILITY CONTACTS PER SIDE

SIZE	CAGE CODE	DRAWING NO	RESTRICTED TO
A1	00779	C-6367557	-

SCALE 3:1 SHEET 1 OF 1 REV A1

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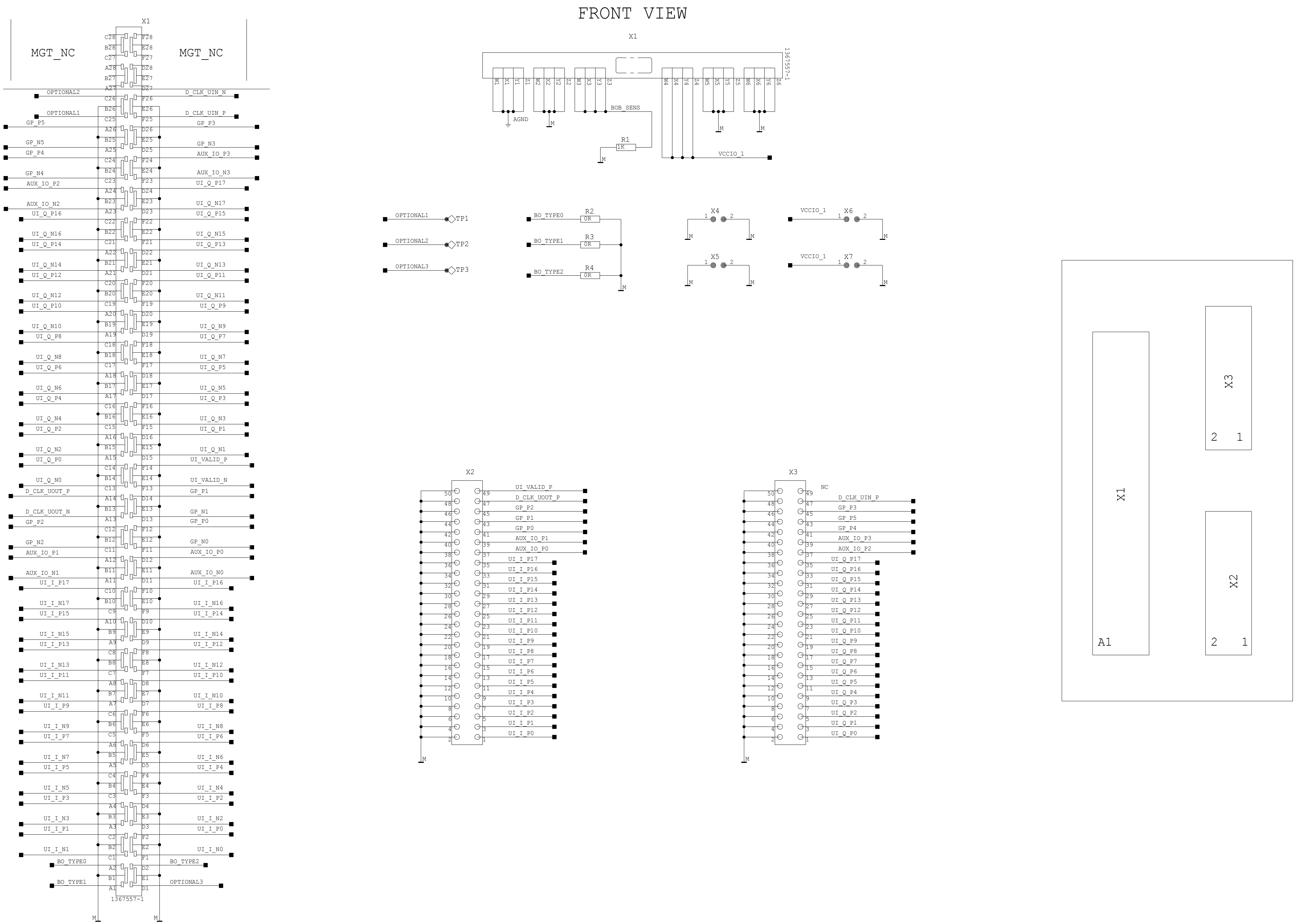


Bindende Angaben ueber Varianten,
Trimmwerte, Bauteile und
nicht bestueckte Bauteile siehe ST.
For binding information on models,
trimming and components values and
nonfitted components see parts list.
Electrostatic sensitiv devices
require a special handling.
Elektrostatisch gefaehrdete
Bauelemente erfordern eine
besondere Handhabung.

ACHTUNG: ESD!

ATTENTION: ESD!

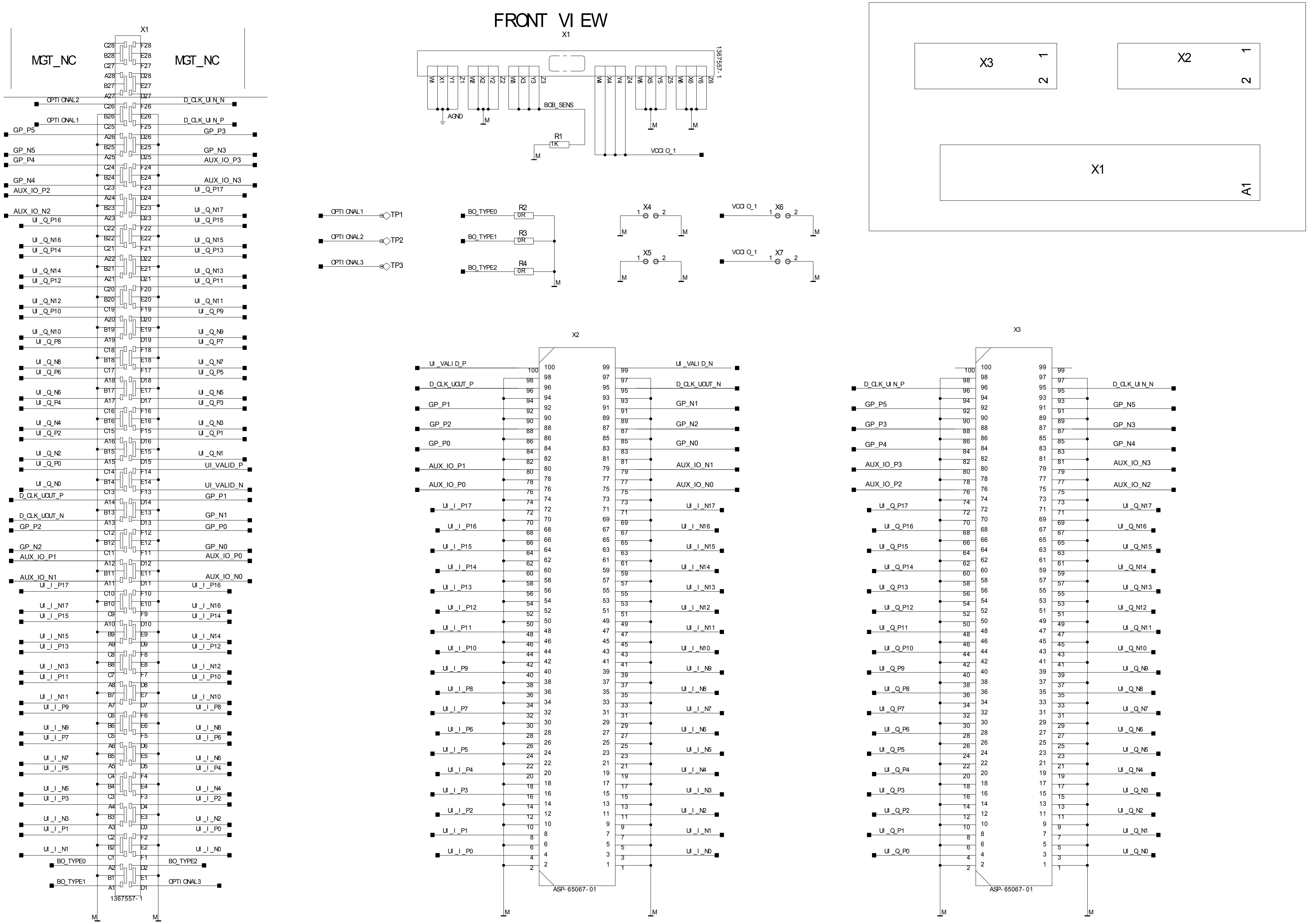
ROHDE&SCHWARZ

Benennung / Designat.:
BreakOut-Board Single Ended

Spr.:/Lang.: de en
Aei:/C.I.: 01.00
Blatt:/Sh.: 1 -

Zeichn.Nr.:/Drawing No.:
3585.7280.00
090002-222-25(SP)(3)

Datum:
Date: 29.07.2007
Abteilung:
Dept.:
Name:
Name:



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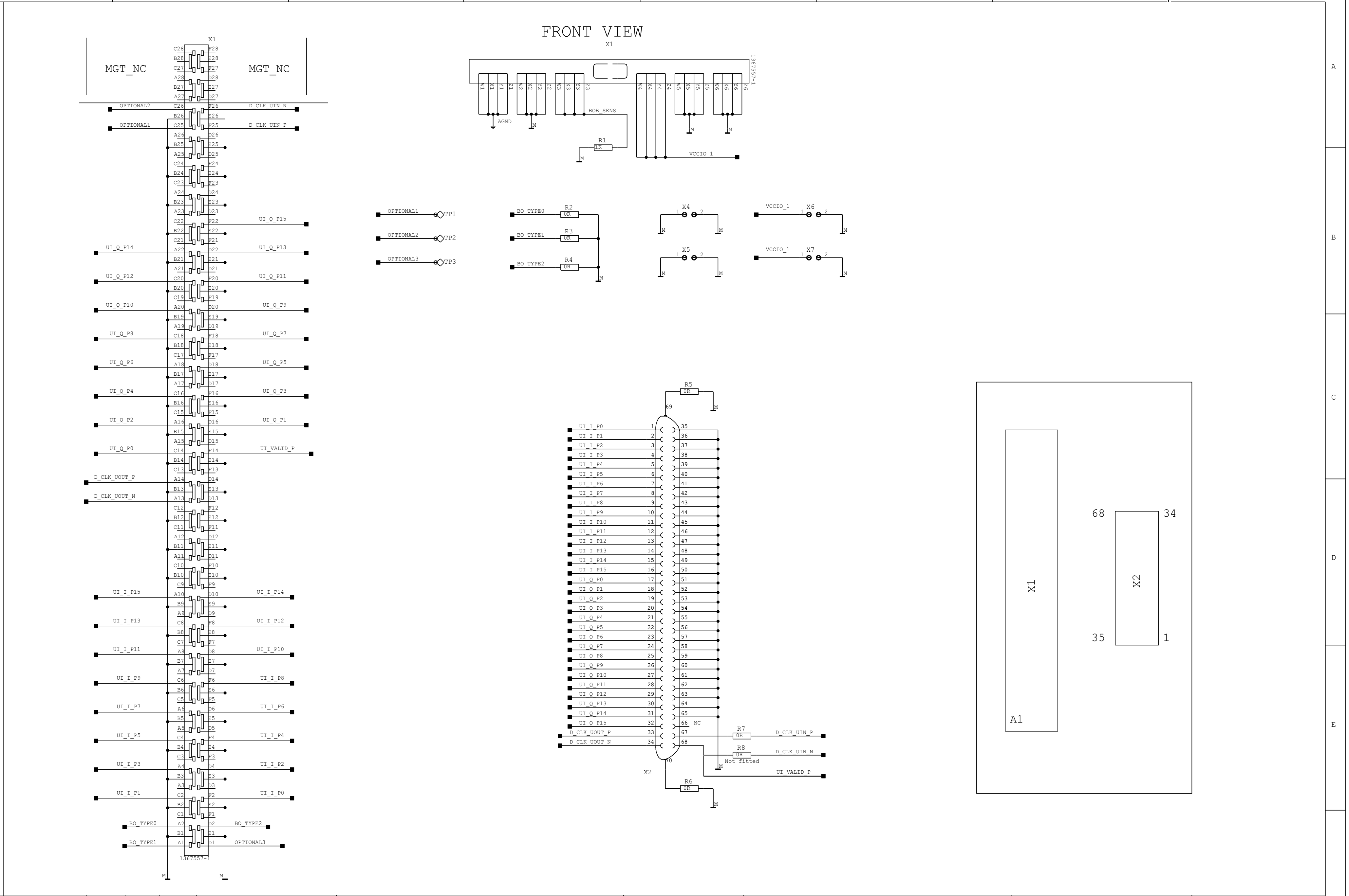
ACHTUNG: ESD!

ATTENTION: ESD!

ROHDE&SCHWARZ	Benennung / Designat.: BreakOut-Board Differential	Spr.:/Lang.: de en	Aei:/C.I.: 01.00	Blatt:/Sh.: 1 -
	Datum: Date: 22.11.2005	Abteilung: Dept.:	Name: Name:	Zeichn.Nr.:/Drawing No.: 3585.7296.00 090002-231-25(SP)(3)



			DATUM	11-22-2005_10:51
			BEARB.	Mattasch
			GEPR.	
ZUSTAND	AENDERUNG	DATUM	NAME	NORM

090101-331-25AEZ00

ZEICHNUNGSNUMMER

URSPR./ERS.F./ERS.D.

MAZeT

BreakeOut-Board SCSI

BENENNUNG

DATEINAME: cg211 1

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Ex-Box

BLATT
ANZ. NR.
1 1

List of Commands

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