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

1409.5570.32 – 03

Test & Measurement

Operating Manual

ROHDE&SCHWARZ

The Operating Manual describes the following R&S®EX-IQ-BOX models and options:

- R&S®EX-IQ-BOX 1409.5505K04
- R&S®EX-IQ-BOX 1409.5505.02
- all **Options** provided with the R&S®EX-IQ-BOX 1409.5505K04 and R&S®DigIConf:

Standardized protocols	R&S®EXBOX-B85	CPRI Breakout Board
	R&S®EXBOX-K10	CPRI RE Test
	R&S®EXBOX-K11	CPRI REC Test
	R&S®EXBOX-B81	DigRF Breakout Board
	R&S®EXBOX-K13	DigRF v3RF-IC
	R&S®EXBOX-K14	DigRF v3BB-IC
	R&S®EXBOX-K15	DigRF v4RF-IC
	R&S®EXBOX-K16	DigRF v4RF-IC
Waveform Memory	R&S®EXBOX-K90	Waveform Memory 64 MS
Multi Waveform Playback	R&S®EXBOX-K91	Multi Waveform Playback
Recording Memory	R&S®EXBOX-K94	Recording Memory 512 MByte

In conjunction with the waveform memory functions, the R&S®EX-IQ-BOX additionally provides R&S®EXBOX-K2xx options for digital standards from R&S®WinIQSIM2™. These 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™. Refer also to the data sheet of the R&S EX-IQ-BOX for details on available options.

The firmware of the instrument makes use of valuable open source software packages. The package is listed below, together with its corresponding open source license. The verbatim license texts are provided on the user documentation CD-ROM (included in delivery).

Package	Link	License
OpenSSL	http://www.openssl.org	OpenSSL/SSLeavy

The product OpenSSL 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. The source code of the open source packages is available on request.

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Abbreviations used throughout this manual:
Throughout this manual R&S® is abbreviated as R&S and applied to the following R&S products:
R&S®EX-IQ-BOX, R&S®DigIConf, R&S®AMU200A, R&S®SMU200A, R&S®SMJ200A, R&S®FSQ, R&S®FSG, R&S®FMU36, R&S®FSV, R&S®CMW500 and R&S®WinIQSIM2.

Contents of this Operating Manual

Basic Safety Instructions

Always read through and comply with the following safety instructions!

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

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

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

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

Symbols and safety labels

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

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

Tags and their meaning

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

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!

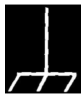
El principio del grupo de empresas Rohde & Schwarz consiste en tener nuestros productos siempre al día con los estándares de seguridad y de ofrecer a nuestros clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas 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	Adver-tencia: superficie caliente	Conexión a conductor de protección	Conexión a tierra	Conexión a masa	Aviso: Cuidado en el manejo de dispositivos sensibles a la electrostática (ESD)

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

Palabras de señal y su significado

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

PELIGRO	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.

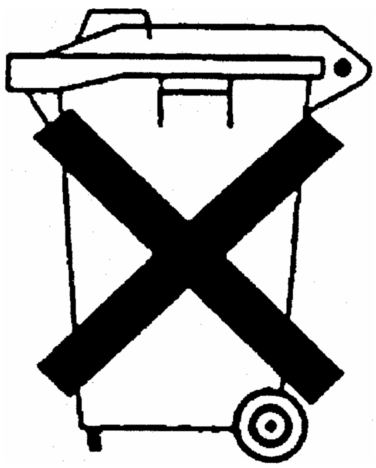
Kundeninformation zur Batterieverordnung (BattV)

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)

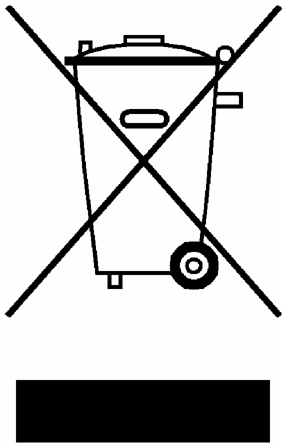
Cet appareil est équipé d'une pile comprenant des substances nocives. Ne jamais la jeter dans une poubelle pour ordures ménagéres.

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.

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

1171.0200.11 V 04.01

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

CE

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

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.

USA & Canada

Monday to Friday (except US public holidays)
8:00 AM – 8:00 PM Eastern Standard Time (EST)

Tel. from USA 888-test-rsa (888-837-8772) (opt 2)
From outside USA +1 410 910 7800 (opt 2)
Fax +1 410 910 7801

E-mail CustomerSupport@rohde-schwarz.com

East Asia

Monday to Friday (except Singaporean public holidays)
8:30 AM – 6:00 PM Singapore Time (SGT)

Tel. +65 6 513 0488
Fax +65 6 846 1090

E-mail CustomerSupport@rohde-schwarz.com

Rest of the World

Monday to Friday (except German public holidays)
08:00 – 17:00 Central European Time (CET)

Tel. +49 89 4129 13774
Fax +49 (0) 89 41 29 637 78

E-mail CustomerSupport@rohde-schwarz.com

ROHDE&SCHWARZ

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Information to R&S®EX-IQ-BOX 1409.5505K04

Digital Interface Module

The new R&S EX-IQ-BOX 1409.5505.04 offers extended functionalities like standardized protocols and digital standards with WinIQSIM2, that are not yet supported in the current release.

Extensions to be expected

The extensions are estimated to be available in 2010.

The R&S EX-IQ-BOX and the configurator software R&S DigIConf are delivered in the latest versions available on the R&S EX-IQ-BOX CD ROM.

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:

www.rohde-schwarz.com/en/products/test_and_measurement/signal_generation/EX-IQ-Box

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

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**.

The **R&S EX-IQ-BOX1409.5502.02** provides only user-defined protocols.

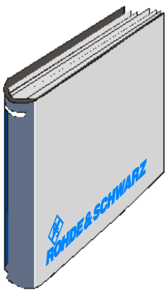
Documentation Overview

The user documentation describes the R&S EX-IQ-BOX and all related components. It includes a printed Quick Start Guide with a CD-ROM, covering the Operating Manual, a Service Manual, an online help file and the configuration software R&S DigIConf.

The user documentation for the R&S EX-IQ-BOX consists of the following parts:

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

Quick Start Guide



The Quick Start Guide is delivered with the R&S EX-IQ-BOX in printed form and 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 manual 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, 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 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 a few application examples.

Interfaces

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

> **Note:** For start-up the chapter "Interfaces" was taken up in the printed Quick Start Guide. 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

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.

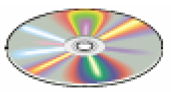
The help files (*.chm) are also available on the CD-ROM and can be used as a standalone help.

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.

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 different useful sites in the R&S internet.

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.

`DigIConfSetup.exe`

The installation software for R&S EX-IQ-BOX.

Online Help

The standalone help file `eqiqbox.chm`.

Manuals

Quick Start Guide, Operating Manual and Service Manual in printable form (*.pdf).

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 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.

> **Note:** After this overview, "Conventions Used in the Documentation" informs about the conventions that are used in the entire documentation.

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 a few 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 on 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.

Service Manual

The service manaul describes some service functions provided for the R&S EX-IQ-BOX. Additionally, this section contains information for customer support and service.

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

Service

This chapter contains information on testing the user interface, firmware update and service support.

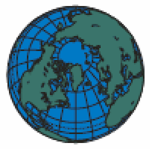
Maintenance

Points to maintenance and environmental conditions.

Index

Contains an index of the service manual.

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.

www.rohde-schwarz.com/en/products/test_and_measurement/signal_generation/EX-IQ-Box

Conventions Used in the Documentation

The following conventions are used throughout the R&S EX-IQ-BOX Operating Manual:

Typographical conventions

Convention	Description
“Graphical user interface elements”	All names of graphical user interface elements both on the screen and on the front and rear panels, such as dialog boxes, softkeys, menus, options, buttons etc., are enclosed by quotation marks.
“KEYS”	Key names are written in capital letters and enclosed by quotation marks.
Input	Input to be entered by the user is displayed in italics.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
"Links"	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.
<variables>	Variables are enclosed by angle brackets.

Other conventions

- **Remote commands**: Remote commands may include abbreviations to simplify input. In the description of such commands, all parts that have to be entered are written in capital letters. Additional text in lower-case characters is for information only.

The terms "**select**" and "**press**" may refer to any of the described methods, i.e. using a mouse pointer in the display, or a key on the device or on a keyboard.

Table of Contents

1 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 these are the digital I/Q signals that meter. The utilization of digital I/Q signals leads to the employment of different transmission protocols and still involves the development of diverse interface types with 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 protocol 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 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 4G**.

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, 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 4G 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**.

Note: 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 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, either from the PC or from a remote computer on the 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 gets 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.

Note: 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.

Note: 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 "Options" on page 20.

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:

www.rohde-schwarz.com/en/products/test_and_measurement/signal_generation/EX-IQ-Box

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.

2 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 form a DUT and transfers it to an R&S instrument for analyzing. For further configuration examples refer to "Application Examples" on page 47.

An overview of instruments, working with the R&S EX-IQ-BOX is given in "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 "Options" on page 20.

2.1 Basic Operating Modes

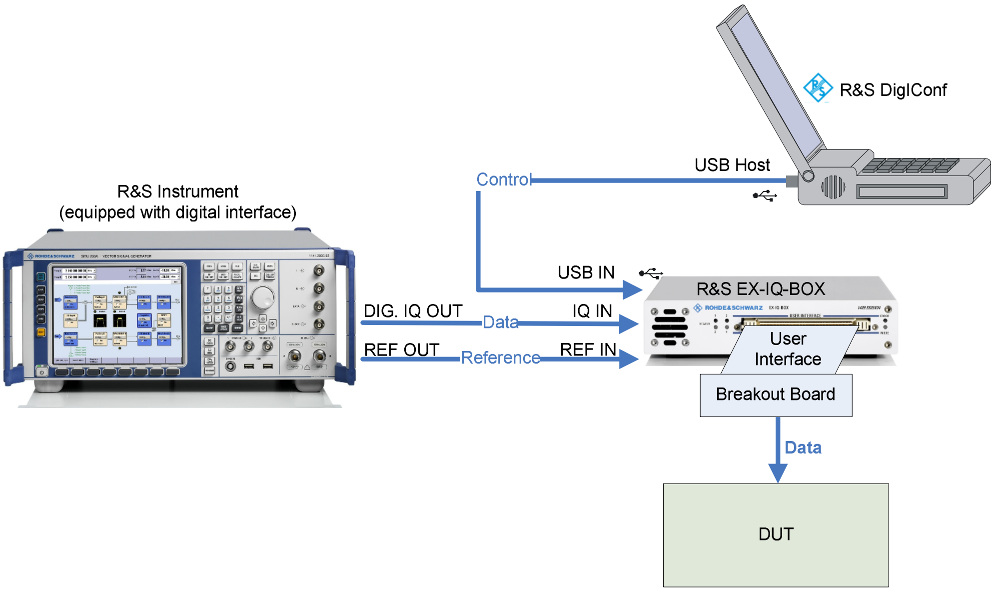
In this chapter you get an overview of the various configurations, including the following modes for controlling the R&S EX-IQ-BOX:

- 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

2.1.1 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.

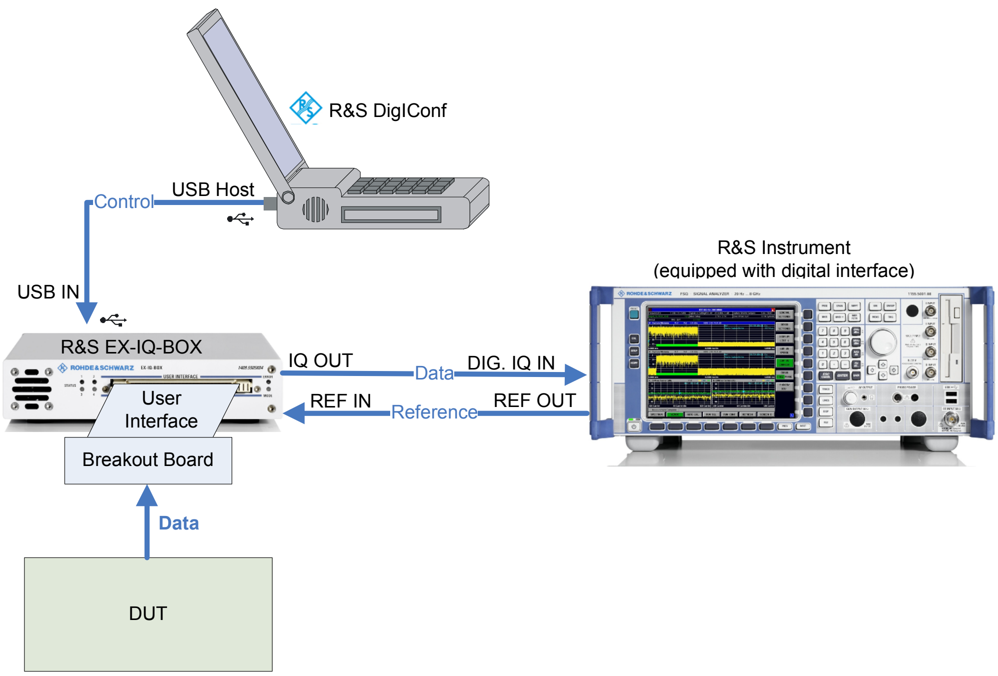


Configuration example with R&S DiglConf

The example represents a basic configuration of the R&S EX-IQ-BOX, operated by the configuration software R&S DiglConf 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:

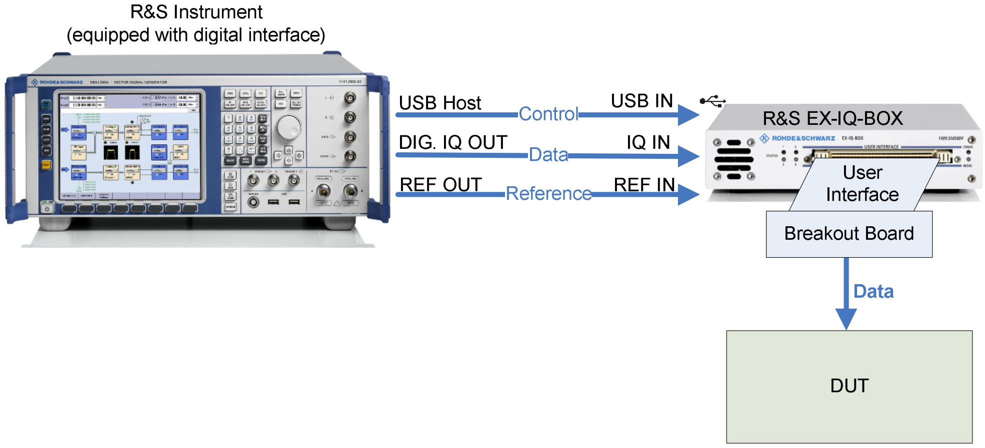


R&S EX-IQ-BOX and R&S instrument working in receiver mode, controlled by R&S DiglConf

2.1.2 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.



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.

2.1.3 Remote Control

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 provide the automation of repeating settings. Access is possible either with the PC that also covers R&S DigIConf, or any PC in the network.

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

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

Tip: If you use a VISA library, the access is more convenient to operate.

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 purposes and it is not possible to directly remote-control the R&S EX-IQ-BOX via the LAN interface.

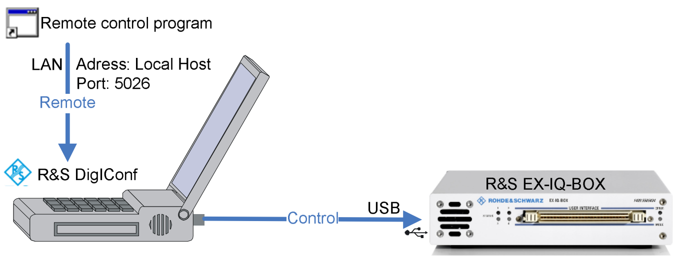
For the control, **SCPI** (**S**tandard **C**ommands for **P**rogrammable **I**nstruments) commands are used. Basics to the structure and to the syntax of SCPI commands are described in the operating manual of the R&S EX-IQ-BOX, see "Remote Control Basics".

2.1.3.1 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 or any PC in a network.

Examples of the remote controlled R&S DigIConf

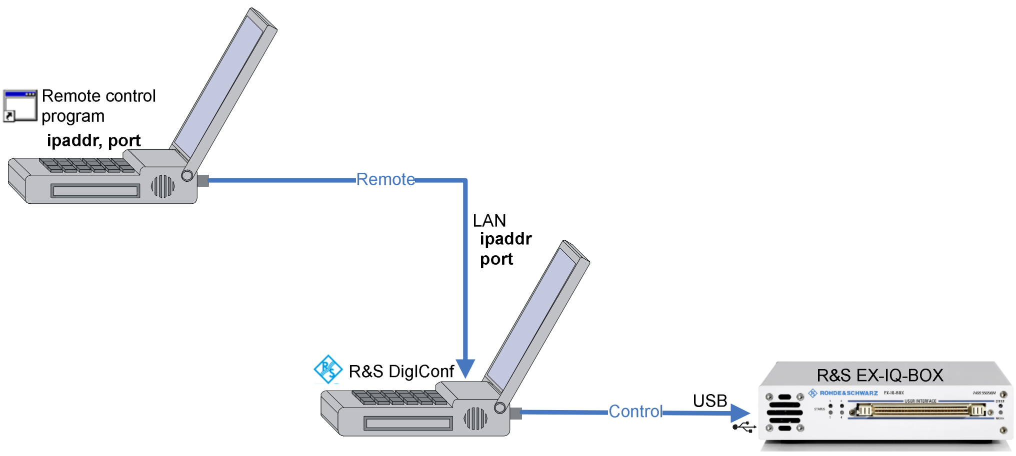
- The remote computer covers the remote control program and R&S DigIConf.



Example of 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 and can be set.

- The remote control program runs on a different computer as R&S DigIConf.



Example of 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 "Remote Control Basics" in the Operating Manual of the R&S EX-IQ-BOX.

2.1.3.2 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.

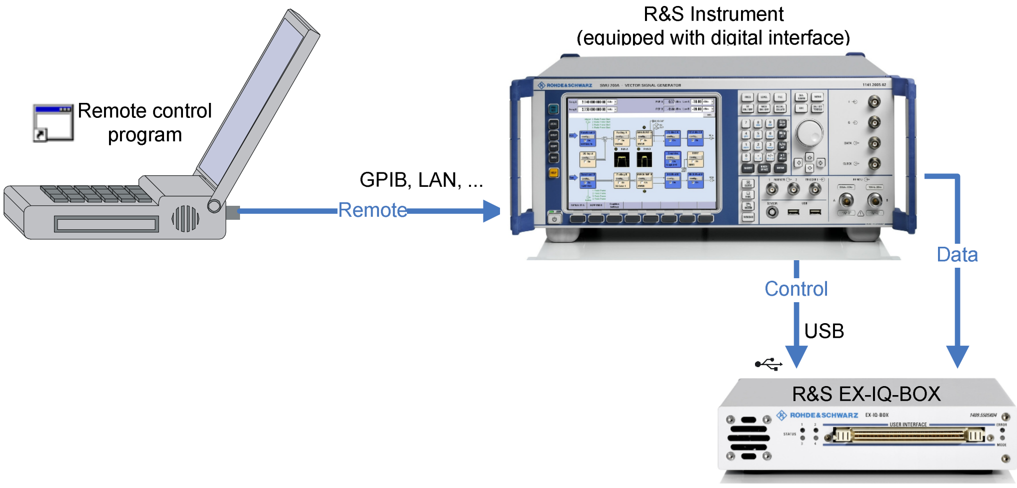
If the R&S EX-IQ-BOX 1409.5502.02 works directly with an **R&S instrument**, i.e. without R&S DigIConf, the box is accessed by the instrument via the USB interface. Remote control is executed via the instrument, i.e. all remote control interfaces of the instrument can be usesd, as well as all remote-control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

Operation and the instructions how to set up a connection for remote control are described in the operating manual of your R&S instrument, in the following chapters:

- 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
- "Remote Control - Description of Commands" lists all the remote commands defined for the instrument

The description of the remote control commands for setting the parameters of the R&S EX-IQ-BOX is provided in its operating manual; see "User Defined Remote Control Commands".

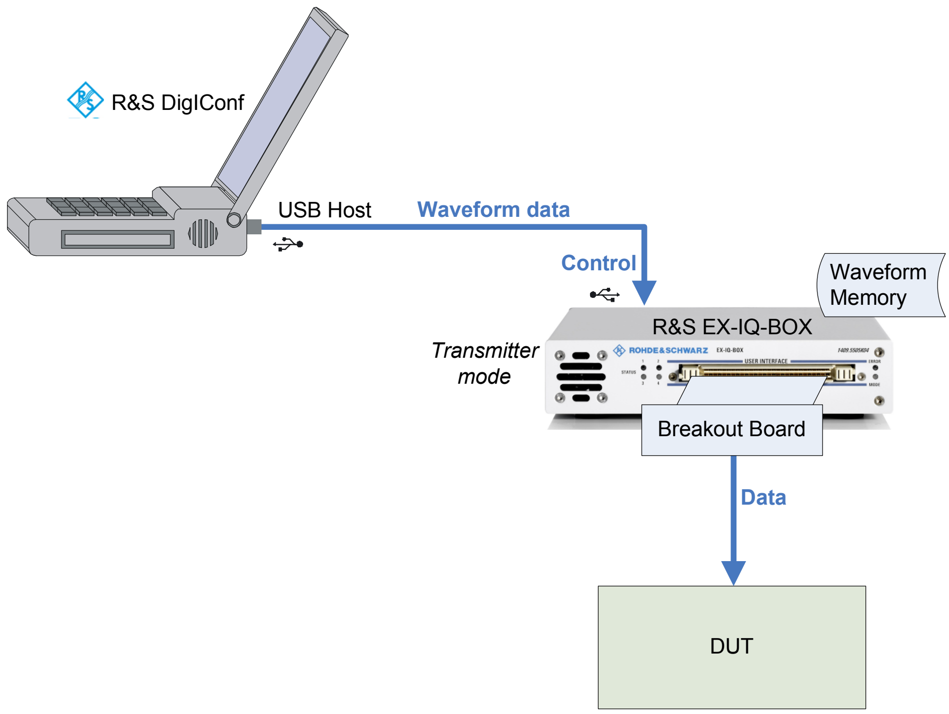


Example of remote control of an R&S instrument with a connected R&S EX-IQ-BOX

2.1.4 Waveform Memory, Multi Waveform Playback and Recording Memory

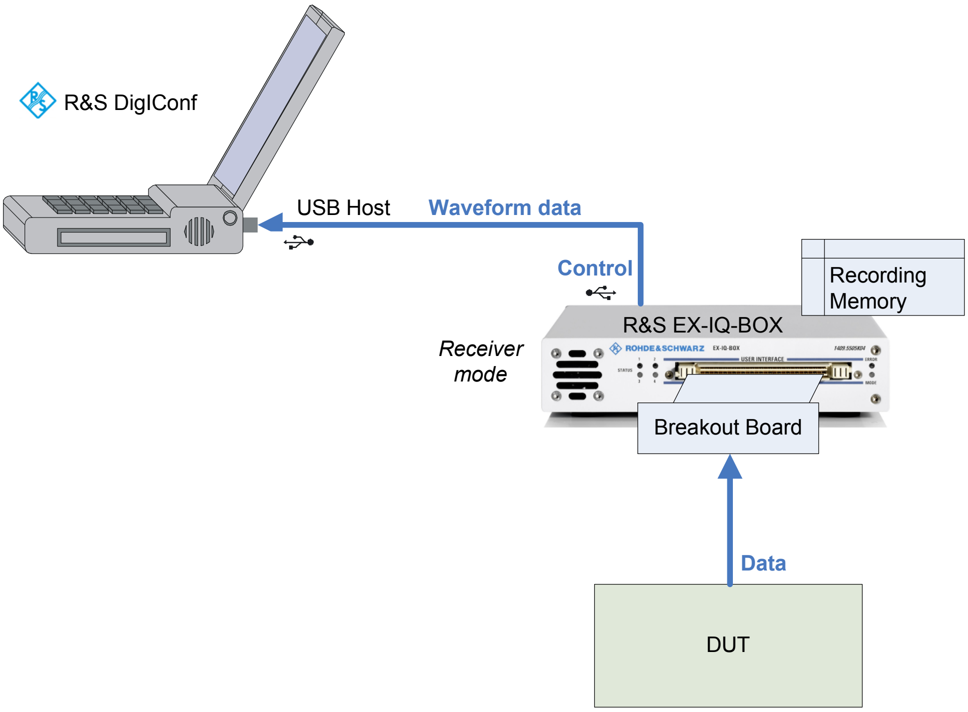
Waveform Memory, Multi Waveform Playback and Recording Memory are performed with R&S DigIConf and standardized protocols.

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.



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.



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.

2.2 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.

Note: Ordering information as well as latest software and firmware versions are also provided on the internet at the R&S website:

www.rohde-schwarz.com/en/products/test_and_measurement/signal_generation/EX-IQ-Box-|-Ordering_Information-|-90-|-4267

2.2.1 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

2.2.2 Options

Option Dependencies

In order to provide a consistent option concept, note the following dependencies:

- 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 always require R&S DigIConf.

2.2.2.1 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 includes an option key code for authentification.

2.2.2.2 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.

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.

2.2.2.3 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

2.2.2.4 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 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 (WiMAX™)	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
EUTRA/LTE	EXBOX-K255	1417.1140.02
HSPA+	EXBOX-K259	1417.1157.02

2.2.3 R&S DigIConf - Configuration Software

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 "Options" on page 20.

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

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

www.rohde-schwarz.com/en/products/test_and_measurement/signal_generation/EX-IQ-Box

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

For information on installation of R&S DigIConf refer to "Installing R&S DigIConf" on page 34. Operating R&S DigIConf is described in the operating manual, section "R&S DigIConf Configuration Software".

How to proceed for setting up an option refer to "Installing R&S EX-IQ-BOX Options" on page 45.

Simulation mode

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

2.2.4 Accessories

Various accessories support specific test configurations or modifications.

For example, if you want to connect the R&S EX-IQ-BOX with 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-BOX devices. It is used e.g. for demo purposes, while an R&S signal generator sends an I/Q signal to an R&S EX-IQ-BOX which forwards this signal to the second R&S EX-IQ-BOX. The breakout board leads the signals of the transmitter, i.e. the first box, to the according receiver's signals, so that the second box recognizes the signal correctly. The signal then can be received from 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

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

The following section lists the R&S instruments that are currently working 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 about 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 the 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

3 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.

3.1 Safety Instructions

General Precautions

WARNING

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

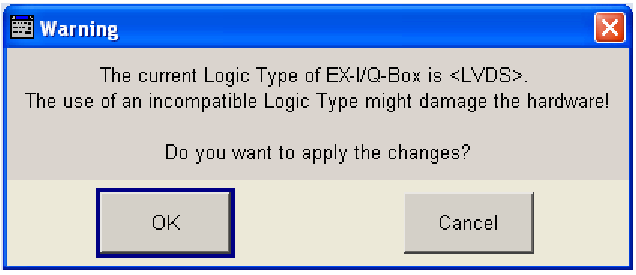
Avoid connector overload

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 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**

Note: 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.

3.2 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

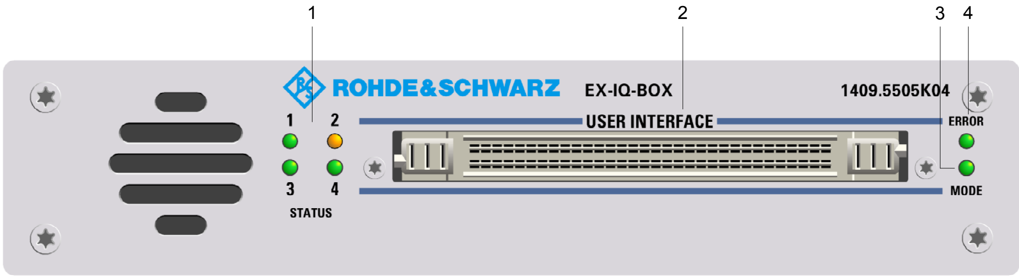
Retain the original packing material. If the R&S EX-IQ-BOX needs to be transported or shipped at a later date, you can use the material to prevent control elements and connectors from being damaged.

3.3 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.

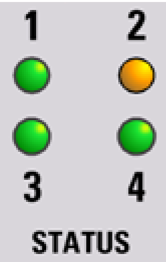
3.3.1 Front Panel View

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.



Front panel view

1 "STATUS" - LEDs



The four LEDs indicate the status of the digital interfaces, as well as the user interface and the internal PLL (**P**hase **L**ocked **L**oop).

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.

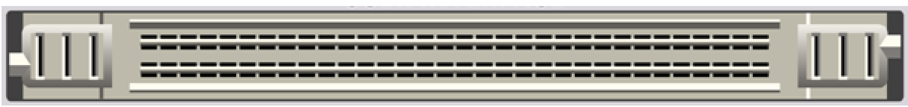
3 Status LED for PLL (**P**hase **L**ocked **L**oop)

- **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.

2 User Interface



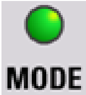
TYCO Z-Dok adapter board connector, 56 differential pairs

see Z-Dok Adapter Board connector

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.

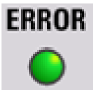
3 "MODE"- LED



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

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

4 "ERROR"- LED

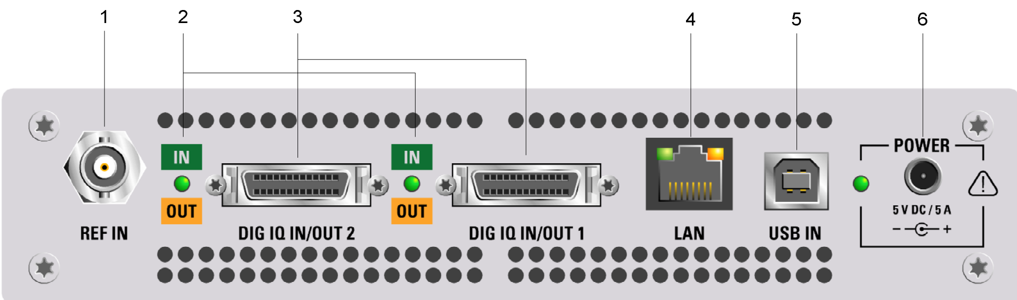


The ERROR LED indicates an error of the R&S EX-IQ-BOX.

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

3.3.2 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.



Rear panel view

1 "REF IN"- Reference signal input

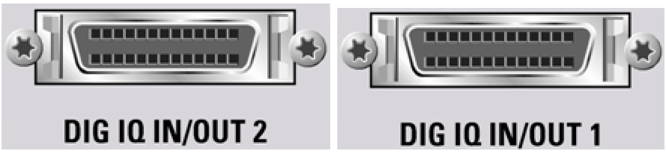
BNC connector for input of a reference signal provided by the R&S instrument.

2 "IN / OUT"- LED

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

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

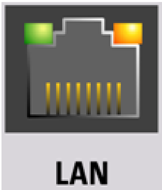
3 "DIG I/Q IN/OUT2, 1" - Digital interfaces



Connector 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 "Accessories" on page 24 for the R&S part number of the associated cable.

4 "LAN" - Interface



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

- **Green** indicates an active link.
- **Yellow** indicates transmission activity.

  Note: The LAN connector is intended for future purposes 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.

5 "USB IN" - USB interface type B

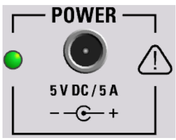
Universal **S**erial **B**us interface of type B (device USB). This port is used for communication with the host instrument.

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.

6 POWER - Power supply



The R&S EX-IQ-BOX is supplied with an external power supply unit and a separate power cable.

see also "Connecting the R&S EX-IQ-BOX" on page 43

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

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

3.4 Installing R&S DigIConf

This section describes how to install the software R&S DigIConf (Digital Interface Configurator), 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 installing.

Software and Hardware Requirements

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

	Minimum
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.

Note: Some R&S instruments, as e.g. the R&S CMW500 provide also installing R&S DigIConf on the instrument directly. Check in the operating manual to see if your instrument supports this mode of operation. To install, proceed as described below.

Prerequisites

- Uninstall an old software version, as described in "Uninstalling" on page 41.
- Close running applications before installing.

3.4.1 Installing

The setup file `DigIConf_x.xx.xxx.exe` for installing the R&S DigIConf is included in delivery of your R&S EX-IQ-BOX or can be downloaded from the R&S website:

www.rohde-schwarz.com/en/products/test_and_measurement/signal_generation/EX-IQ-Box.

Destination Location

By default the software is installed in the directory
%Program Files%/Rohde-Schwarz/DigIConf,
unless another directory is selected.

Start installation

► Execute

`DigIConf_x.xx.xxx.exe`

in the windows explorer and follow the installation instructions of the R&S DigIConf setup wizard.

During installation the program creates various subdirectories needed from the application. In the last installation window the R&S DigIConf setup wizard provides a shortcut to the desktop.

The version number x.xx.xxx in the filename stands for the current version and varies with each update.

Important note to Windows login after locked display or on PC startup!

If an R&S EX-IQ-BOX is connected during a login, a message in terms of "**Invalid Smart Card**" appears. This message is caused by the fact that Windows interprets the SmartCard of the R&S EX-IQ-BOX as a medium for login.

Thereby the login might be blocked, depending on a certain setting in the registry. Refer to chapter "Known Restrictions on SmartCard Related Issues" on page 36 for detailed information.

To solve this issue, refer to the description in chapter "Solution for Login Conflict During Installation" on page 38.

3.4.1.1 Known Restrictions on SmartCard Related Issues

If the R&S EX-IQ-BOX **is already connected** during a login, the following message concerning the SmartCard appears:

This message is caused by the fact that Windows interprets the SmartCard of the R&S EX-IQ-BOX as a medium for login.

With confirming the message, the system reacts in different ways, depending on the setting of the "DisableCAD" parameter in the registry.

Function of DisableCAD (CTRL+ALT+DEL)

The DisableCAD parameter determines whether you must press the CTRL+ALT+DEL security attention sequence to log on to windows.

- If the value of this entry is 1, the "Unlock Computer" dialog is displayed as soon as the system starts, or after the desktop has been locked. The windows dialog "Computer Locked" is suppressed.

- If the value is 0, the "Locked Computer" dialog is displayed. Only after pressing CTRL+ALT+DEL the "Unlock Computer" dialog opens.

- If the CTRL+ALT+DEL is 1, i.e. DisableCAD=1, the system returns to the SmartCard error message and blocks the login.

  ► The R&S EX-IQ-BOX must be disconnected to enable login. After login the R&S EX-IQ-BOX can be connected again.

  To solve this issue, refer to the description in chapter "Solution for Login Conflict During Installation" on page 38.

- If the DisableCAD=0, the connection to the R&S EX-IQ-BOX may remain.

  ► Press CTRL+ALT+DEL to unlock the computer and then continue login.

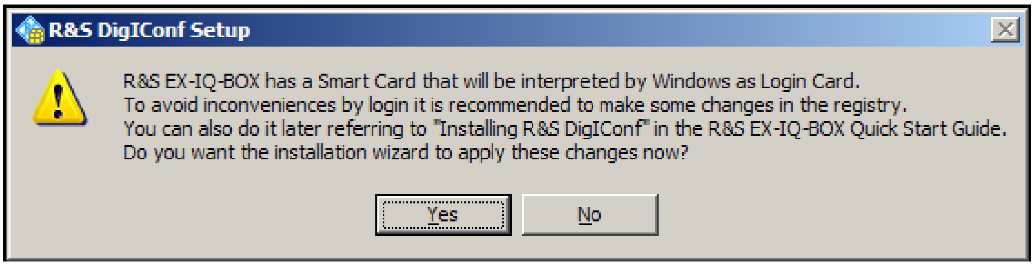
Note: If the R&S EX-IQ-BOX is **connected while the computer is locked**, login can be performed without any inconvenience.

3.4.1.2 Solution for Login Conflict During Installation

As by default the CTRL+ALT+DEL security attention sequence on logon is 1, the installation wizard of R&S DigIConf queries the parameter and provides to automatically change the setting to 0.

Automatically modify CTRL+ALT+DEL security attention sequence

The following message pops up during installation, informing about the possible login conflict:



It is recommend that you allow to set CTRL+ALT+DEL security attention sequence to 0, but it is also possible to change the parameter manually. In any case, the installation wizard prepares the respective entries for a later modification. Refer to section "Manually modify CTRL+ALT+DEL Security Attention Sequence" on page 38 for description in detail.

Yes Accept modification.

The installation wizard sets DisableCAD=0 in the registry.

```
[HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\
      Windows\CurrentVersion\policies\system]
      "DisableCAD"=dword:00000000
```

Note: Set to "0" the parameter determines that you must press CTR+ALT+DEL to log on to windows.

No Reject modification.

The parameter DisableCAD remains "1" and the R&S EX-IQ-BOX must be disconnected before every login and be connected afterwards again.

3.4.1.3 Manually modify CTRL+ALT+DEL Security Attention Sequence

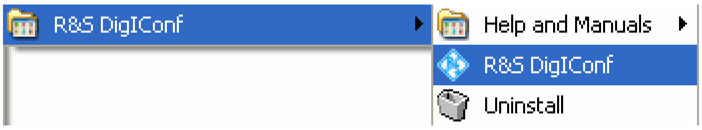
During installation of R&S DigIConf, the installation wizard stores the files "DisableCAD.reg" and "EnableCAD.reg" in the installation directory **%Program Files%/Rohde-Schwarz/DigIConf\Registry/**.

► Execute the according file either to switch on the CTRL+ALT+DEL security attention sequence, or to switch it off.

3.4.2 Starting

R&S DigIConf can either be started via:

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

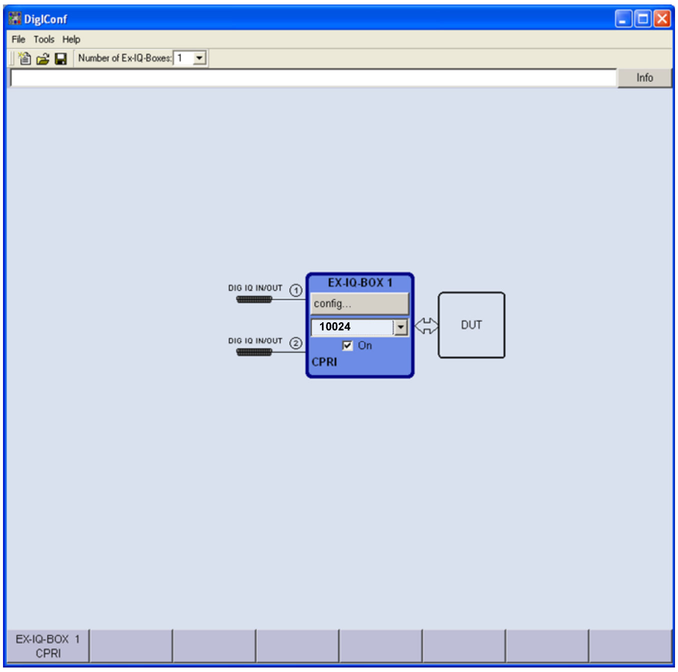


- by starting **DigIConf_start.cmd** in MS®Windows explorer, located in the application directory,

or

- 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.

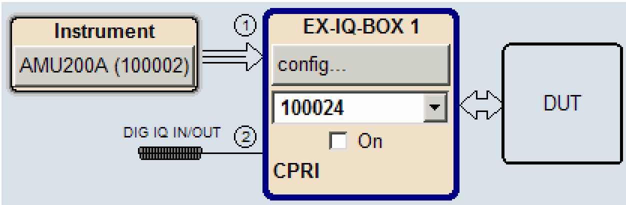


R&S DigIConf main application window

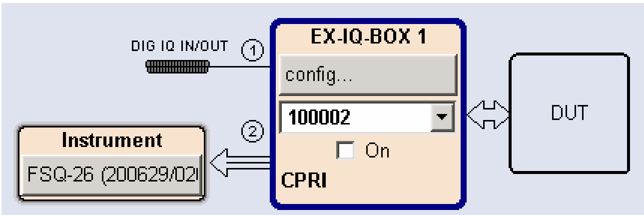
The main application window shows the current configuration and the signal flow in form of a block diagram.

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.

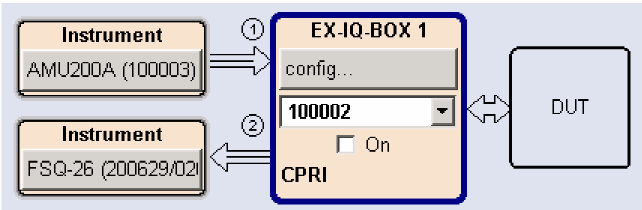
The following pictures show, for example how R&S DigIConf adjusts the display according to the test configuration. If several boxes are connected, the respective test configuration is indicated for every R&S EX-IQ-BOX.



R&S DigIConf display of the R&S EX-IQ-BOX connected to an R&S AMU 200A



R&S DigIConf display of the R&S EX-IQ-BOX connected to an R&S FSQ-26



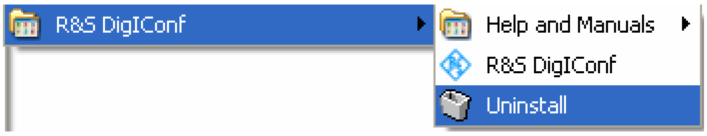
R&S DigIConf display of the R&S EX-IQ-BOX operating in bidirectional mode

For a detailed description on the application window and its elements refer to the operating manual, section "R&S DigIConf Software".

3.4.3 Uninstalling

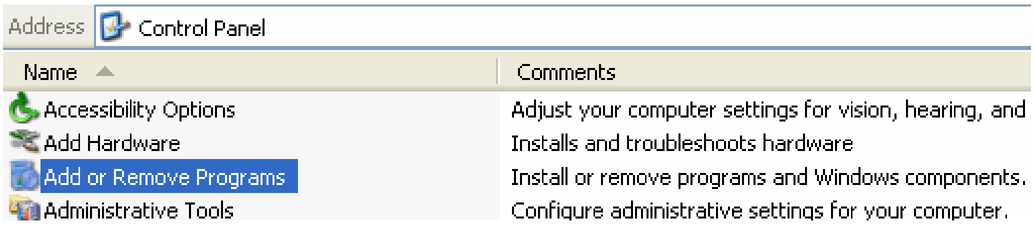
Uninstall a version of the software with the aid of R&S DigIConf uninstaller,

► **Start > Programs > R&S DigIConf > Uninstall**



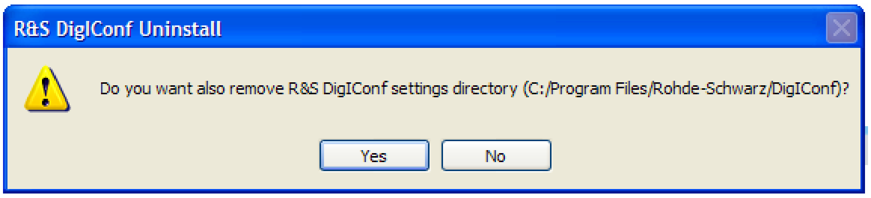
or the PC's control panel,

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

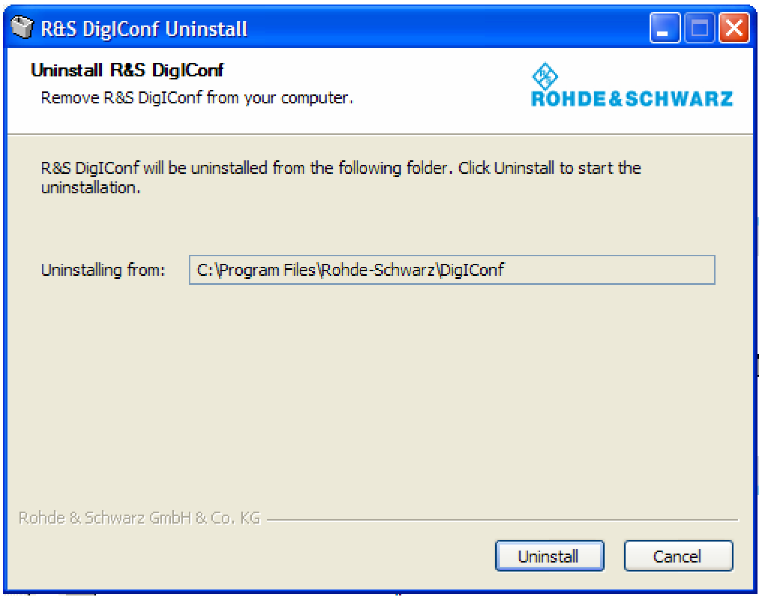


The uninstall routine identifies all currently installed R&S DigIConf components, including the relevant files, such as files with user-specific settings.

Before uninstalling, the program asks whether to delete the settings directory as well.



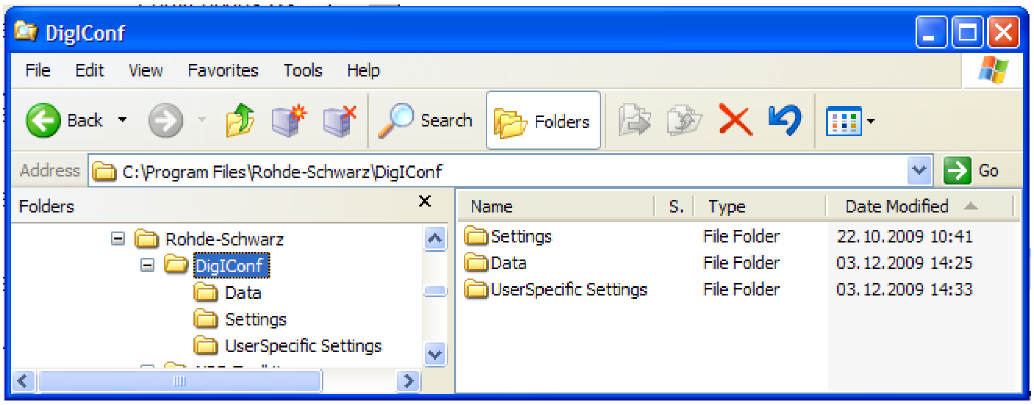
► Confirm or reject, and then start uninstalling.



The uninstaller removes all currently installed R&S DiglConf 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 DiglConf remain.



3.5 Connecting the R&S EX-IQ-BOX

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

Important note to Windows login after locked display or on PC startup!

If an R&S EX-IQ-BOX is connected during a login, a message in terms of "**Invalid Smart Card**" appears. This message is caused by the fact that Windows interprets the SmartCard of the R&S EX-IQ-BOX as a medium for login.

Thereby the login might be blocked, depending on a certain setting in the registry. Refer to chapter "Known Restrictions on SmartCard Related Issues" on page 36 for detailed information.

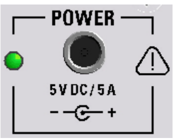
To solve this issue, refer to the description in chapter "Solution for Login Conflict During Installation" on page 38.

Connecting

Note: In the following instructions the name in brackets always refers to the connectors of the R&S EX-IQ-BOX. Connectors of R&S instruments or PC are pointed out clearly.

1. Power supply

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



► 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. The external power supply unit provides all required voltages of the hardware.

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

After power up, the R&S EX-IQ-BOX is in **ready state**, if USB is already connected. Without USB connection the device is in **standby state**.

The color of the power LED indicates the operating states:

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

Note: 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 accordingly (R&S EX-IQ-BOX 1409.5502.02), proceed as follows:

- Connect the USB cable plug B to the R&S EX-IQ-BOX (USB IN)
- Connect the USB cable plug A to the PC, or to the instrument

Device driver

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

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

Note: 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 to have a driver installed.

3. Data signal connection

► Establish the connection for the reference frequency (REF IN, BNC connector)

- Connect the coaxial cable to REF IN of the R&S EX-IQ-BOX
- Connect the coaxial cable to REF OUT of the instrument

► Establish the digital interface connection.

Transmitter Mode

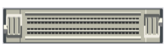
- Connect the LVDS cable between the R&S EX-IQ-BOX (DIG I/Q IN/OUT 1) and the BASEBAND DIGITAL OUT of the R&S instrument

Receiver 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

On connecting the LVDS cable the R&S instruments and the R&S EX-IQ-BOX detect the connection established between them. According to the instrument the connection is indicated differently in the instrument and in R&S DigIConf, i.e. either as a short message in the info line, or also graphically.

4. Connection to the DUT



- Connect the respective breakout board (USER INTERFACE).
- Establish the appropriate connection to the DUT.

3.6 Installing R&S EX-IQ-BOX Options

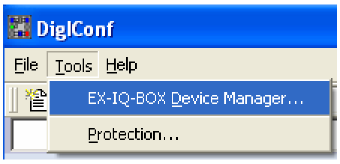
This section explains how to install an option of the R&S EX-IQ-BOX.

Prerequisites

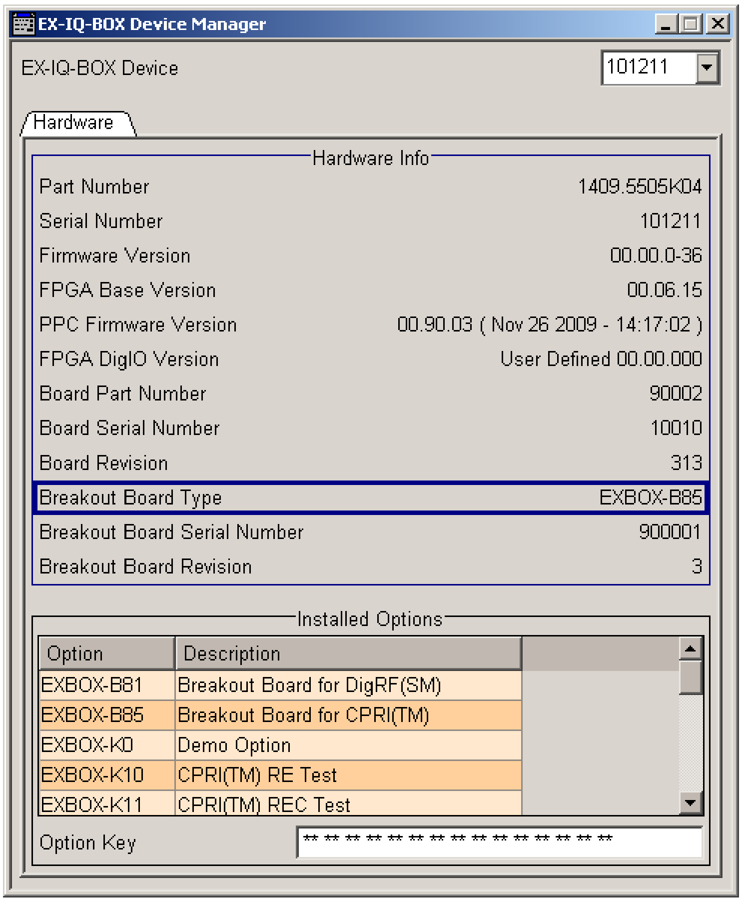
Before installing an option, make sure that the R&S EX-IQ-BOX is power supplied and USB connection is established.

In delivery of an option, you received a software option with a key code. This software option must be installed on the R&S EX-IQ-BOX using R&S DigIConf.

► Start R&S DigIConf and select "EX-IQ-BOX Device Manager…" menu item located on Tools menu.



The "EX-IQ-BOX Device Manager" dialog opens, indicating information about the currently connected R&S EX-IQ-BOX devices:



The selection field "EX-IQ-BOX Device" lists each connected device. The hardware tab below indicates various information on the selected device, like, e.g. part number, serial number, firmware version, etc. and the installed options. For detailed description on this dialog refer to "EX-IQ-BOX Device Manager" in the operating manual.

Installing

To install an option proceed as follows:

1. Select the R&S EX-IQ-BOX from “EX-IQ-BOX Device”.

   Section **Hardware Info** shows information on the selected device, and in section **Installed Options** already installed options are indicated.

2. Enter the key code provided with the option in the “Option-Key” field and confirm with "Enter".

   Tip: The code can also be entered by using "Copy" and "Paste".

Installing several options

Just repeat step 2 to install more options on the same device or steps 1 and 2 to install options on other devices.

Indicating

To indicate the installed options proceed as follows:

3. Open the “EX-IQ-BOX Device Manager” dialog.
4. Select the R&S EX-IQ-BOX from “EX-IQ-BOX Device”.

   The installed options will be displayed in the “Installed Options” table.

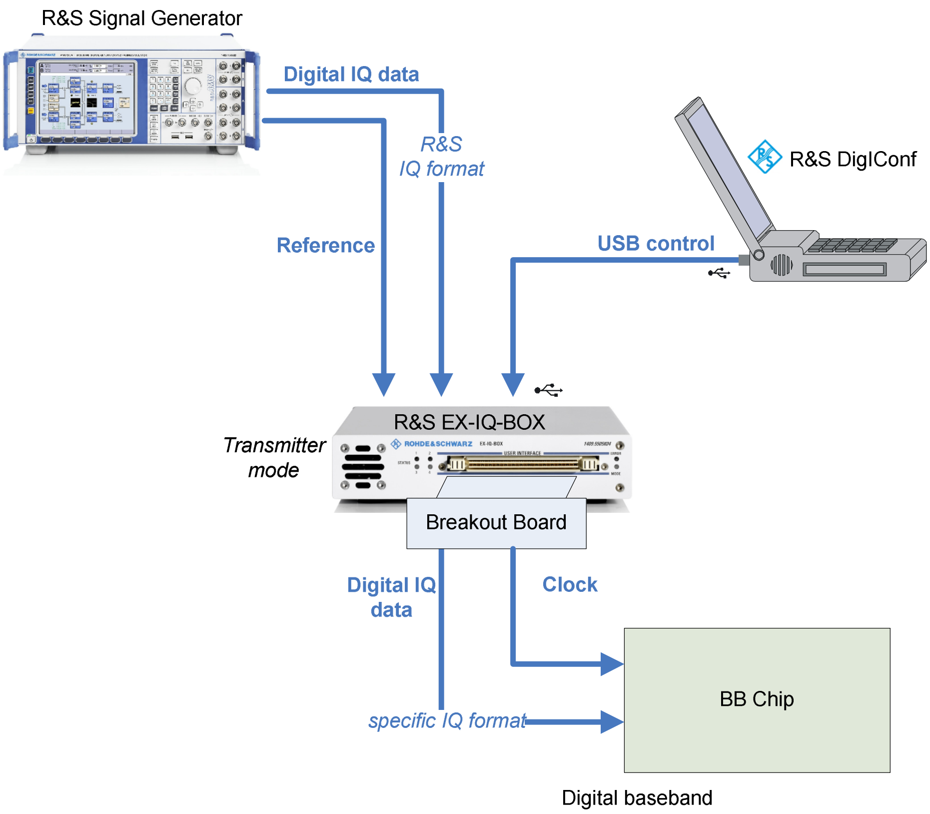
4 Application Examples

This chapter describes a few application examples.

Note: In the following, all examples show measurement setups of the R&S EX-IQ-BOX, controlled by R&S DigIConf. If User Defined interface transmission protocols are required the measurements can also be done with instruments controlling the R&S EX-IQ-BOX directly. If the application uses standardized interface protocols, the R&S EX-IQ-BOX must be controlled by R&S DigIConf.

4.1 Baseband Receiver Chip Test

The following example shows the generation of e.g. standard-compliant digital baseband signals for testing the quality of a receiver:



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.

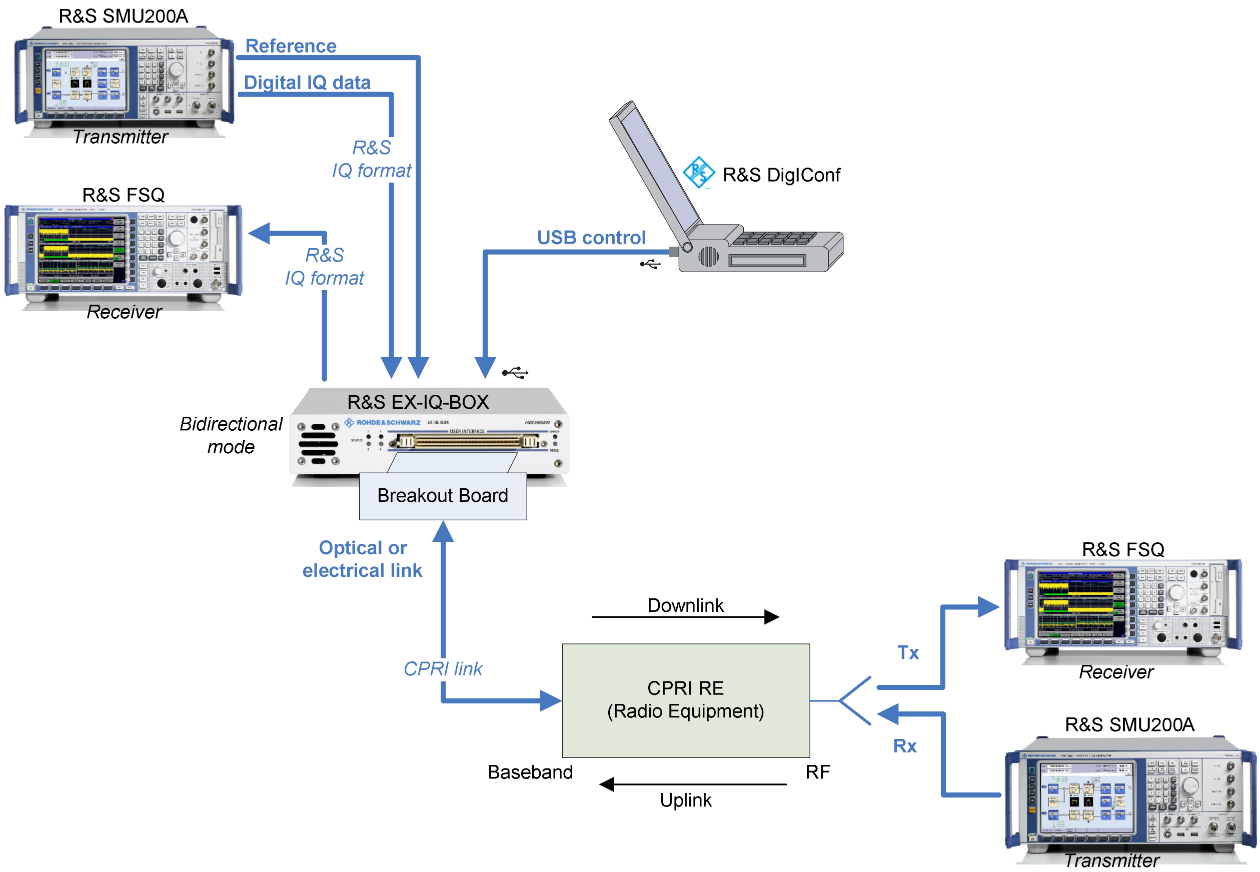
4.2 CPRI Test Setup

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.

4.2.1 Typical CPRI RE Test Setup

This application example shows 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 example 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 "Standardized protocols" on page 21.



Application example of a RE test setup with the digital interface protocol CPRI

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 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 to the 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, e.g., I/Q mapping or link settings are controlled by the configurator software R&S DigIConf, which runs on a Windows PC.

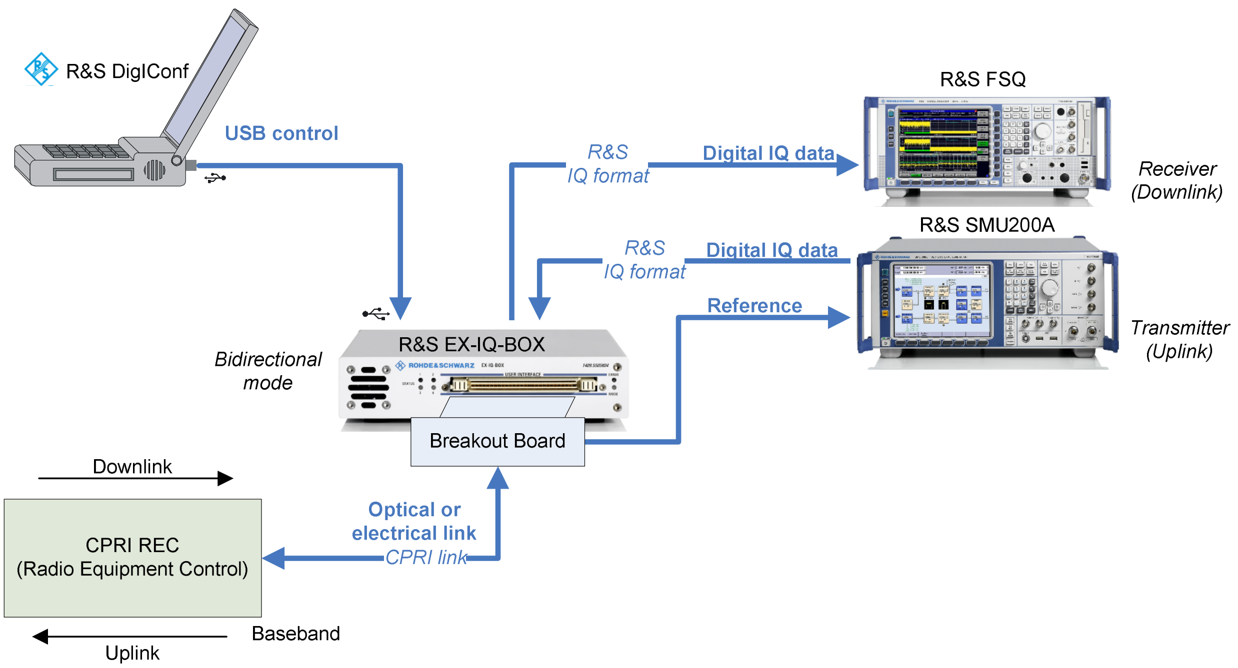
In addition to the I/Q data, C&M (**C**ontrol and **M**anagement) information is embedded in the CPRI protocol. These parameters are also set with the aid of R&S DigIConf.

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

4.2.2 Typical CPRI REC Test Setup

This application example shows 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** (**R**emote **E**quipment).

The test setup example 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 "Standardized protocols" on page 21.



Application example of a REC test setup with the digital interface protocol CPRI

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 downlink signal flow:

The DUT, 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, e.g., I/Q mapping or link settings are controlled by the configurator software R&S DigIConf, which runs on a Windows PC.

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.

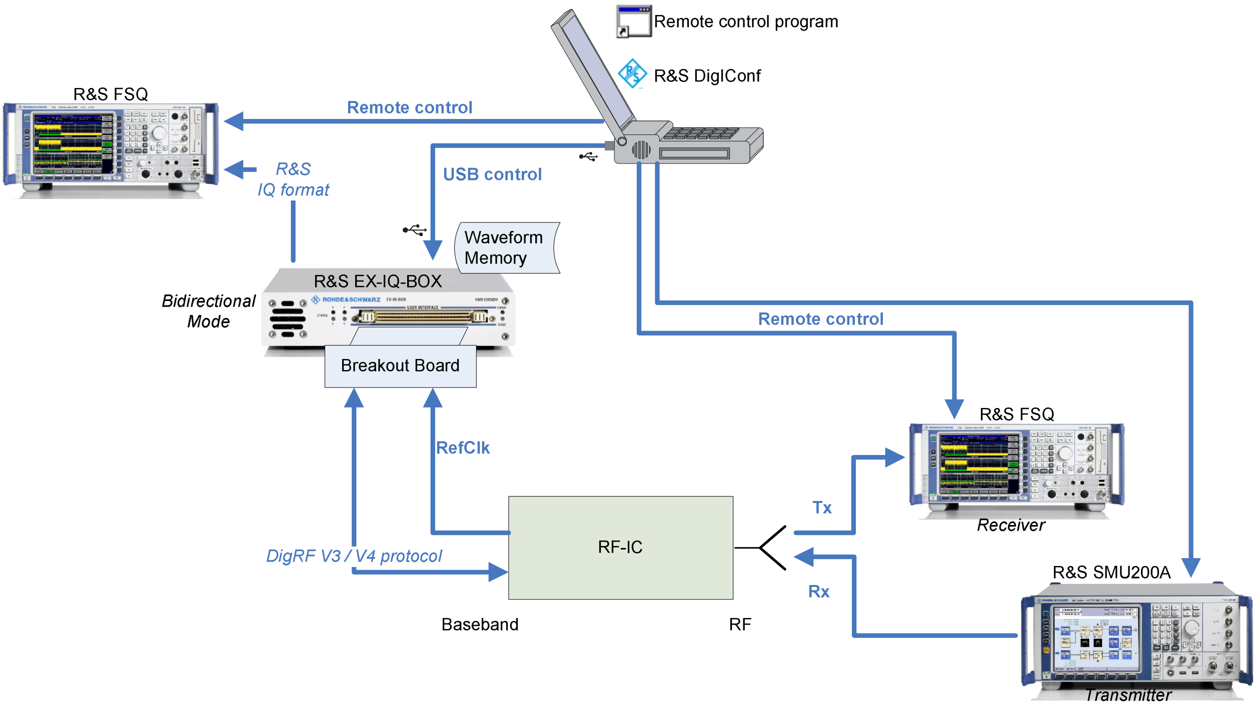
An Ethernet connector provides fast C&M, and a RS-232-C connector provides slow C&M in real time.

4.3 DigRF Test Setup

In this setup the R&S EX-IQ-BOX emulates a BB-IC which controls the RF-IC via the DigRF V3/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 v3RF-IC option R&S EXBOX-K13, or the DigRF v4RF-IC option R&S EXBOX-K15. The parameters are set with the configuration software R&S DigIConf.

For details on available options, see "Standardized protocols" on page 21.



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 V3/4 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 a script in realtime.

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.

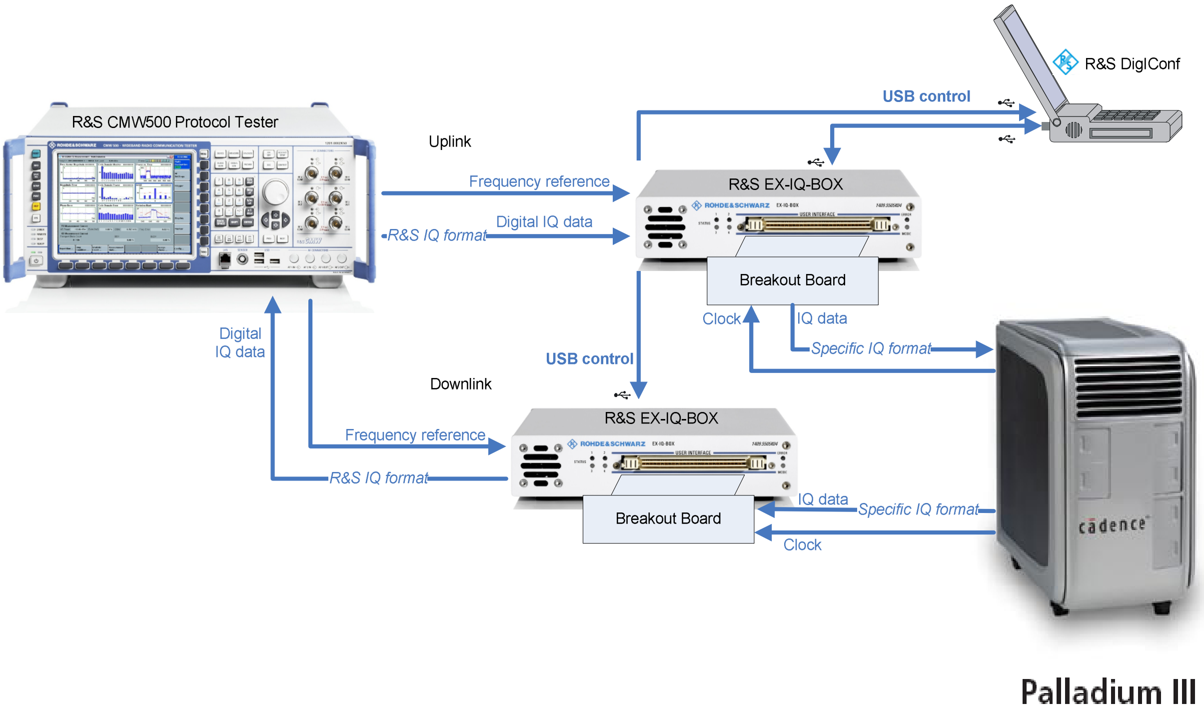
> **Note:** In future extensions, the R&S EX-IQ-BOX will be able to emulate the RF-IC. Refer to the supplementary sheet at the beginning of this manual.

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.

4.4 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:



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 about this application refer to the operating manual of the protocol tester.

5 R&S EX-IQ-BOX Configuration

The R&S EX-IQ-BOX provides the adjustment of different digital interfaces and transmission protocols by the support of hardware and software functions. Digital I/Q signals can be transmitted either with **User Defined** protocols or **Standardized** protocols.

The R&S EX-IQ-BOX is operated from a PC by using the configuration software **R&S DigIConf**. Some R&S instruments, as e.g. the R&S CMW500 provide also 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 "Basic Operating Modes" for description in detail.

> **Note:** The R&S EX-IQ-BOX, model **1409.5505.02**, also provides 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 operated exclusively by R&S DigIConf. R&S DigIConf supports all applications.

In the following documentation, the configuration software R&S DigIConf and settings for User Defined or Standardized applications are described:

- "R&S DigIConf Configuration Software" on page 56, 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:

  www.rohde-schwarz.com/en/products/test_and_measurement/signal_generation/EX-IQ-Box
- "Configuration via R&S Instruments" on page 97 covers all specific characteristics of an R&S instrument in conjunction with an R&S EX-IQ-BOX 1409.5505.02, 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.

Protocol settings of the specific operating modes are described in separate chapters:

- "User Defined" covers the parameters and settings for serial or parallel transmission of I/Q signals, including clock modes, data rates and logical signal levels.
- "CPRI" covers explanations and the description to this standardized protocol.

5.1 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.

5.1.1 Graphical User Interface - Overview

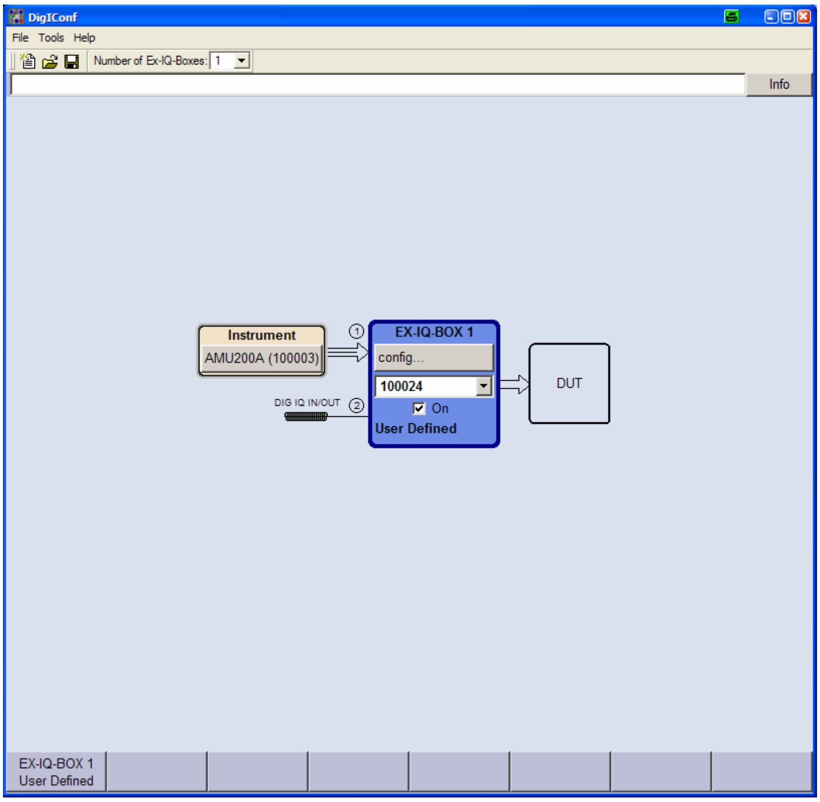
After starting the R&S DigIConf software the main application window opens.

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 **menu bar** 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.



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.

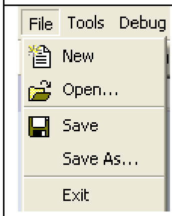
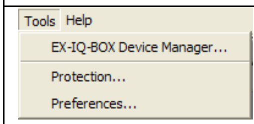
5.1.1.1 Menu Bar

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 section "Toolbar" on page 57.

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:

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.	"File Menu" on page 68
	Open dialogs for accessing information on R&S EX-IQ-BOX devices and to set protection levels for test and service purposes.	"Tools Menu" on page 69
	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.	"Help Menu" on page 70

5.1.1.2 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:

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 "File Menu" on page 68.

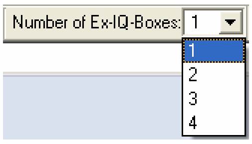
5.1.1.3 Info

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 "Info Line and Window" on page 70.

5.1.1.4 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.

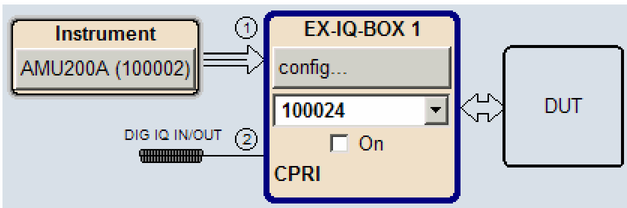
R&S DigIConf may handle up to four R&S EX-IQ-BOX devices simultaneously. The number of R&S EX-IQ-BOXes to be configured is set in the entry field "Number of R&S EX-IQ-BOXes" located in the toolbar.



Remote-control command:

`SOUR:EBOX:COUN 2`

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 AMU 200A.



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.

5.1.1.5 Winbar

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

If several menus are open, the button of the currently active dialog is displayed in a lighter color. Up to eight dialogs may be open simultaneously. When the ninth dialog is opened, the dialog that was opened first is automatically closed.

5.1.1.6 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 panels.

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 section "Configuration Dialogs" on page 78.
- For **settings dialogs** of your specific application, comprising signal and interface parameters refer to the respective section under "Protocol Settings".

5.1.1.7 Softkeys

R&S DigIConf covers a key emulation to enable execution of specific application functions. The emulation is called by a right mouse click inside the R&S DigIConf application window.

The key functions are executed by a mouse click on the associated button. The following table briefly explains the functions:

Soft key	Function	Find description under ...
File	Activates the dialog for storing and loading files.	"File" on page 61
Diagram	Displays the block diagram in the foreground.	"Diagram" on page 62
Preset	Sets all parameters of R&S DigIConf and the protocols on default.	"Preset" on page 62
Menu	Opens the menu tree.	"Menu" on page 63
Setup	Opens the setup path in the menu tree.	"Setup" on page 63
WinBar	Displays the block diagram in the foreground and highlights the last used softkey in the Winbar.	"WinBar" on page 64
Hardcopy	Opens the dialog for configuring and starting a hard copy.	"Hard Copy" on page 64

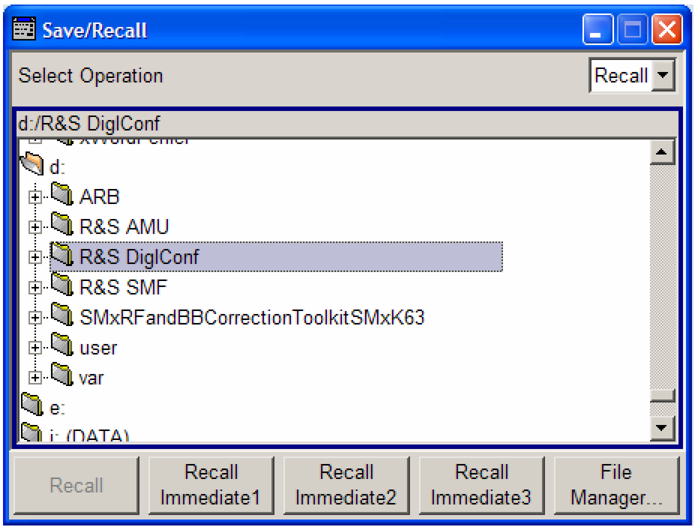
Soft key	Function	Find description under ...
Info	Opens the info window containing a detailed description of every message displayed in the info line.	"Info Line and Window" on page 70
Help	Opens a browser window containing the complete description of the R&S EX-IQ-BOX including the contents of the Quick Start Guide. Additionally an index table provides searching for specific words and phrases.	"Help System" on page 74

The softkeys in the emulation panel provide some specific application functions. The key emulation is called by a right mouse click inside the main application window. Clicking a softkey opens the respective dialog.

File

The "File" softkey opens a dialog used to store and load application settings.

The file dialog is divided into several areas. On top of the dialog save or recall are selected, and below last used files are listed. The area on the left side lists the available drives and directories, and the right side indicates all files of the selected directory. Only the relevant files without file extensions are displayed.



Select Operation

Located on top of the dialog, either save or recall can be selected:

- **Save** provides to store the current application settings of R&S DiglConf in a file.
- **Recall** opens previously stored setting files.

Recent data sets

Displays the files last used. A maximum of ten files is displayed.

%/DiglConf

The currently selected path is indicated above the left window. If the area is opened several times, the path last selected is displayed.

Select directory and path in the left window. The window besides lists all relevant files.

File Name

For saving your settings, enter the name for the file without file extension. The file name is user-selectable, but the extension is assigned automatically.

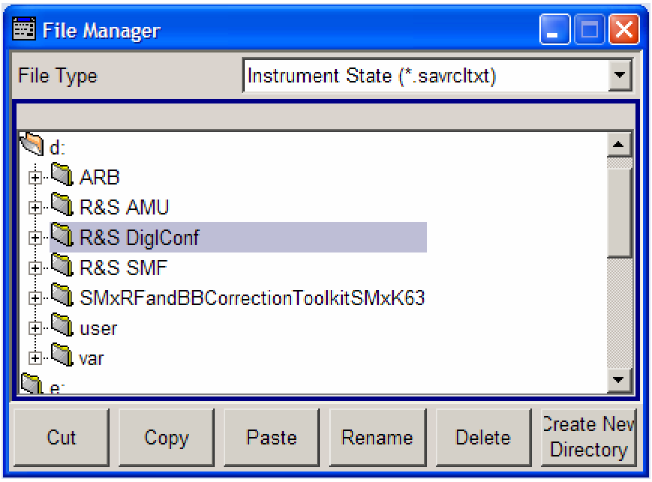
For recall, load the selected configuration file.

Save/Recall

Store the current application settings in the specified path, or load the selected file.

File Manager Dialog

The **File Manager** dialog provides all the functions required for file management. Directories can be created, and files copied, deleted and moved between the directories on the drives.



Notes:

- The dialog consists of known functions of file management as e.g. Cut, Copy, Paste, etc. and are therefore not further explained.
- It is only to be marked that a settings file is always stored/loaded with the extension *.savrcltxt. This file type cannot be changed.

Diagram

Displays the block diagram in the foreground.

Preset

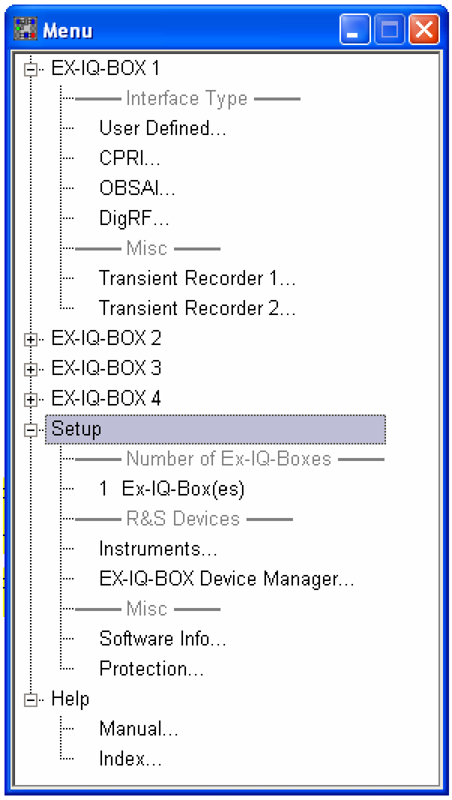
"Preset" executes a default application setup. All parameters and switching states are preset (also those of inactive operating modes). The default application settings provide a reproducible initial basis for all other settings.

Menu

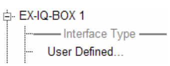
The "Menu" softkey in the key emulation panel opens the **Menu** dialog. The dialog contains several items grouped by functions.

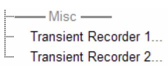
Setup

The "Setup" softkey in the key emulation panel opens the **Setup** directory in the menu dialog.



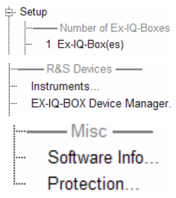
Except of "Setup - Software Info" all items are alternatively available either in the menu bar, the toolbar or the tools menu. The following overview briefly explains the menu tree sections and refers to the respective descriptions.





Entries under EX-IQ-BOX<n> contain either the interface types or additional options which are available in the respective R&S EX-IQ-BOX. For detailed description on the respective dialogs refer to the chapters listed below:

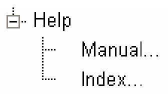
- "User Defined"
- "CPRI"
- "Transient Recorder" on page 83



The menu entry "Setup" is structured into several sections, such as **Number of R&S EX-IQ-BOX(es)**, **R&S Devices** and **Misc**ellaneous.

Find the appropriate descriptions under:

- "Instrument" on page 74
- "EX-IQ-BOX Device Manager" on page 78
- "Software Info" provides information on firmware version of R&S DigIConf as well as installed software and loaded modules. This is not further explained.
- "Protection" on page 81



These entries open a browser window containing the complete description of the R&S EX-IQ-BOX including the contents of the Quick Start Guide. Additionally an index table provides searching for specific words and phrases.

Refer to "Help System" on page 74.

WinBar

Displays the block diagram in the foreground and highlights the last used softkey in the Winbar.

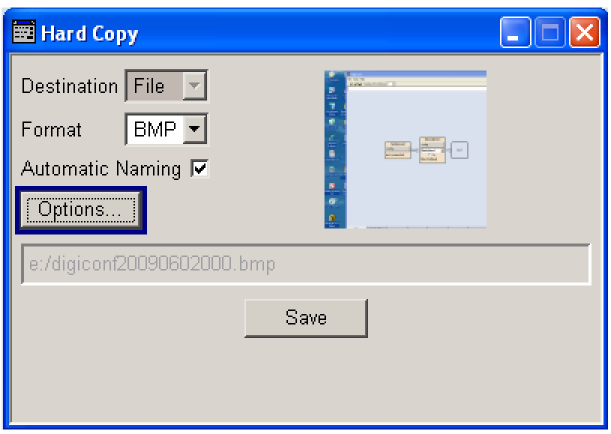
Hard Copy

The Hard Copy function generates a hard copy of the display for storing in a file. The "Hard Copy" key, provided in the key emulation panel opens a window for configuring hard copy settings like output file format or path and file name.

Additionally, the function allows to generate the file name including a time stamp and a running number automatically. Select the respective parameters are in the dialog "Hard Copy Options" on page 65.

Hard Copy Dialog

The dialog is accessed with the options button in the "Hard Copy" dialog, see "Hard Copy" on page 64.



Destination

Selects the destination to which the hard copy (snapshot) should be transferred to. The hard copy either can be printed out by selecting printer or can be saved in a file by selecting **File**, respectively.

Note: At the moment a hard copy is always stored in a file. For future extensions, hard copy will also be printable directly.

Format

Selects the image format to store the hard copy. This entry field is also embedded in the "Hard Copy Options" dialog, where the image size can be defined additionally. Refer to "Hard Copy Options" on page 65.

Automatic Naming

Activates or deactivates automatic generation of the file name. This checkbox is also embedded in the "Hard Copy Options" dialog.

Automatic naming is configured under "Hard Copy Options" on page 65.

Options

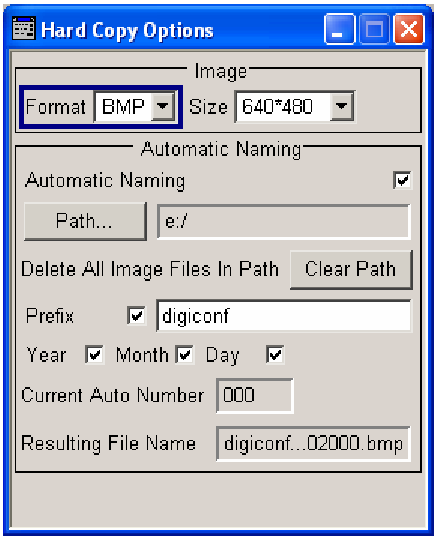
Opens the **Hard Copy Options** dialog for configuring the hard copy parameters, see "Hard Copy Options" on page 65.

Save

Executes the hard copy generation to the selected destination.

Hard Copy Options

"Hard Copy Options" provides configuring the hardcopy parameters like image format and size, and the automatic naming parameters. The dialog is accessed with the options button in the "Hard Copy Dialog" on page 64.



The "Image" section contains file format and size for configuring the hard copy image.

Format

Set the image format to store the hard copy. The following file formats are supported:

File Format	Description
BMP	**B**it **Map** file format is an image file format used to store bitmap digital images, especially on Microsoft®Windows and OS/2 operating systems.
JPG	JPEG is a commonly used method of compression for mainly photographic images. The degree of compression can be adjusted, allowing a selectable tradeoff between storage size and image quality. JPEG typically achieves 10:1 compression with little perceptible loss in image quality.
XPM	**X Pi**x**m**ap is an ASCII-text-based image format used by the X Window System.
PNG	**P**ortable **N**etwork **G**raphics is a bitmapped image format that employs lossless data compression.

Size

Select the image size from the available entries in the list. Available image sizes are 320*240, 480*360, 640*480, 800*600, and 1024*768.

The "Automatic Naming" section covers the parameters for assembling the file name.

Design the file name

As default the automatically generated file name is composed of:
<path>:/<prefix><YYYY><MM><DD><number>.<format>

Each component can be activated or deactivated separately to individually design the file name.

Automatic naming

Activates that the file name of the hard copy is automatically generated.

Path

Opens the "Select Hard Copy Destination Path" dialog to select the storage destination for the hard copy.

Notes: For selecting the destination path a file name must be entered as well. Otherwise the error message " The name of a list may not be empty" is displayed and the dialog is closed.

This dialog is very similar to the file dialog of R&S DigIConf, therefore refer to "File Menu" on page 68 for detailed description.

Clear Path

Deletes all image files in the path wheere the hard copy files are stored.

Before deleting a warning message is displayed, which requires the confirmation of deleting. If confirmend, all files with the extensions "bmp", "jpg", "xpm" and "png" are deleted.

Prefix

Appends the parameter <*prefix*> to the file name of the hard copy. The parameter is defined in the selection field on the right from the checkbox.

Year / Month / Day

Appends a time stamp to the file name. If activated year, month and day are assigned to the file name.

Current Auto number

Assigns a running number with a maximum of 3 digits to the file name.

Note: On initially switching on R&S DigIConf the number will be reset to the lowest possible value. Starting with number 0 the hard copy directory will be scanned for already existing files. As long as files with the same name are existing the number will be increased by 1 automatically. The resulting file name will be unique within the selected path. For all following files, the number is raised.

Resulting File name

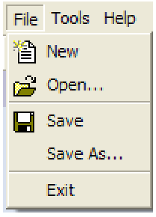
Indicates the automatically generated file name.

Info

"Info" in the key emulation window opens a log window with status information and messages. See also "Info Window" on page 71.

5.1.2 Menus

5.1.2.1 File Menu



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

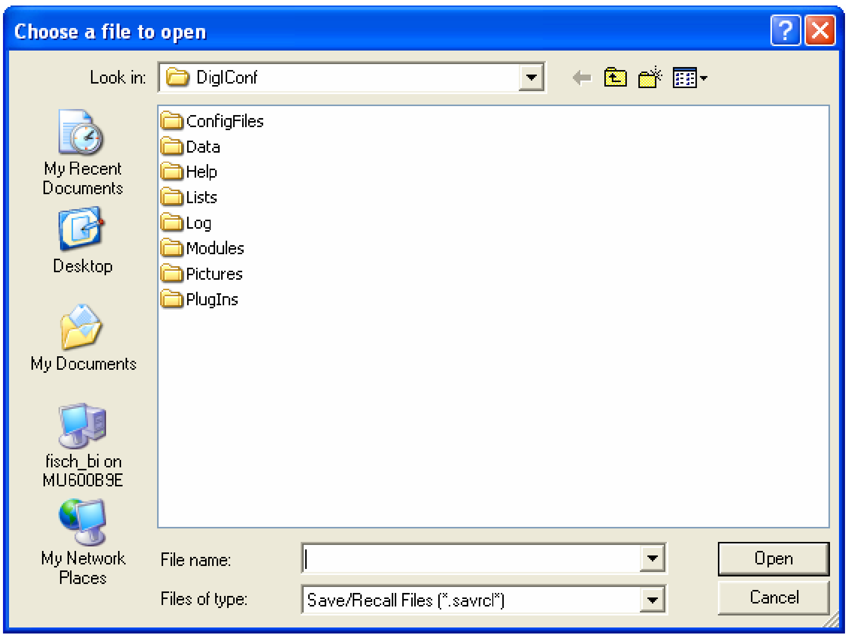
Operation of file management is very similar to operation of Windows user interfaces. Menus and dialogs are made up of known elements, such as selection lists, check boxes and entry fields.

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.



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.

Note: 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.

> **Note:** The extension of a settings file is *.savrcl and cannot be changed. By default settings files are stored in the R&S DigIConf application directory, for example %Program Files%\Rohde-Schwarz\DigIConf\... .

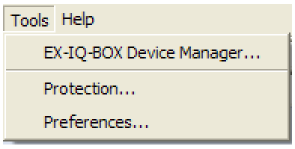
File > Exit

Quits the R&S DigIConf.

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

5.1.2.2 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 "EX-IQ-BOX Device Manager" on page 78.

> **Note:** For installing options refer to Installing R&S EX-IQ-BOX Options.

Tools > Protection...

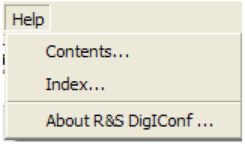
Opens the protection dialog, which is described under "Protection" on page 81.

Tools > Preferences...

Opens the preferences dialog, covering the default settings directory and displays the SCPI server port. See chapter "Preferences" on page 81.

5.1.2.3 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.



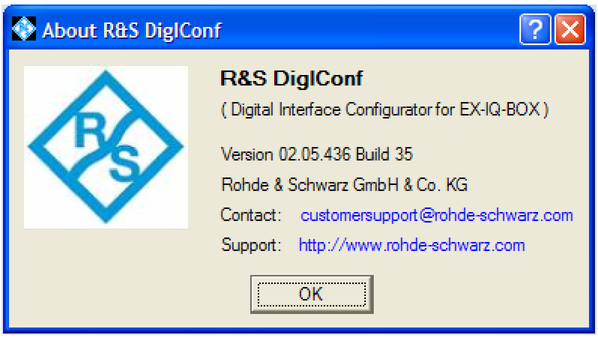
Help > Contents...

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 DiglConf...



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

5.1.3 Info Line and Window

5.1.3.1 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, inforamtion 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.

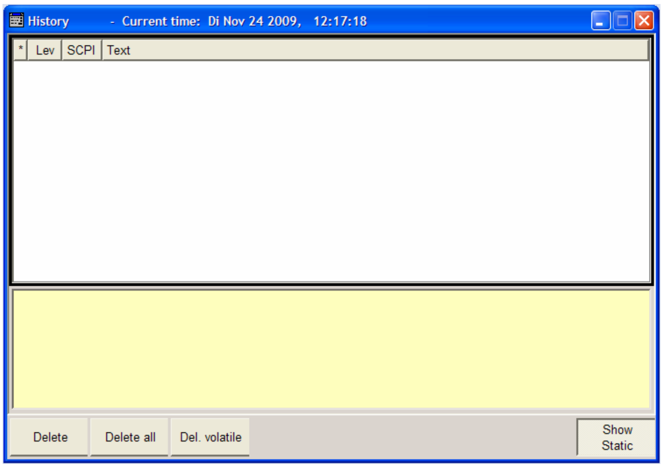
Permanent Messages

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.

5.1.3.2 Info Window

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



List of current messages with short mesasage text

Detailed description of the highlighted message

Softkeys

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 button. 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 softkey buttons, 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 button is pressed again, the list of current messages is displayed.

5.1.4 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 **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.

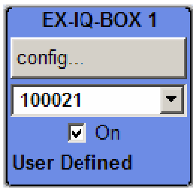
An **instrument** block contains a button, that indicates name and ID of the connected instrument. The button leads to a configuration dialog for setting network parameters.

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

5.1.4.1 R&S EX-IQ-BOX

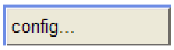
The R&S EX-IQ-BOX is configured in settings dialogs which are opened in the respective function block. R&S DigIConf may handle up to four R&S EX-IQ-BOX devices, which are differentiated in the label of the block by a counter. Each device is set separately.

Config ...

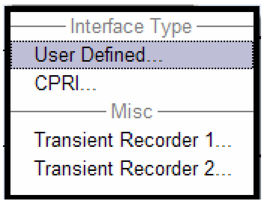


In this block, a R&S EX-IQ-BOX is configured and activated. User Defined and standardized protocols are listed in the configuration menu. The connected R&S EX-IQ-BOX and the selected interface type are displayed in the block.

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

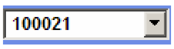


Opens a menu list with all available interface types and other options, as e.g. Transient Recorder. Select an item to open the respective configuration dialog.



Note: A settings dialog can only be activated, if the corresponding option is installed and the respective breakout board is connected. Refer to "EX-IQ-BOX Device Manager" on page 78 for installed options.

Chapters "User Defined" and "CPRI" describe the parameters of the specific protocols.
See also "Transient Recorder" for details on data monitoring using the R&S EX-IQ-BOX.



Indicates a list of all connected R&S EX-IQ-BOX devices. The list shows the serial number of the devices, or "undefined" if no device is connected. Select a serial number to assign the R&S EX-IQ-BOX to the block.

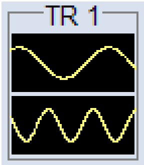
Note: If a device is assigned to a block, its serial number is disabled (grayed out) in the list of other blocks. Refer to "EX-IQ-BOX Device Manager" on page 78 for connected devices.

Switches On/Off signal input or output of the R&S EX-IQ-BOX.

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

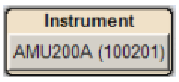
5.1.4.2 Smart Graphic Display

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 "Transient Recorder" on page 83, 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.

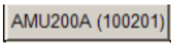


To quickly open the transient recorder dialog, just double click on the smart graphic.

5.1.4.3 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 "Instrument on R&S EX-IQ-BOX" on page 82.



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

5.1.5 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.

A context-sensitive help page is available for each parameter and can be called any time during operation.

► Open a help page with the "F1" function key.

  F1 opens a browser window containing the description of the highlighted parameter. It is possible to move from this context-sensitive page to any page of the help system.

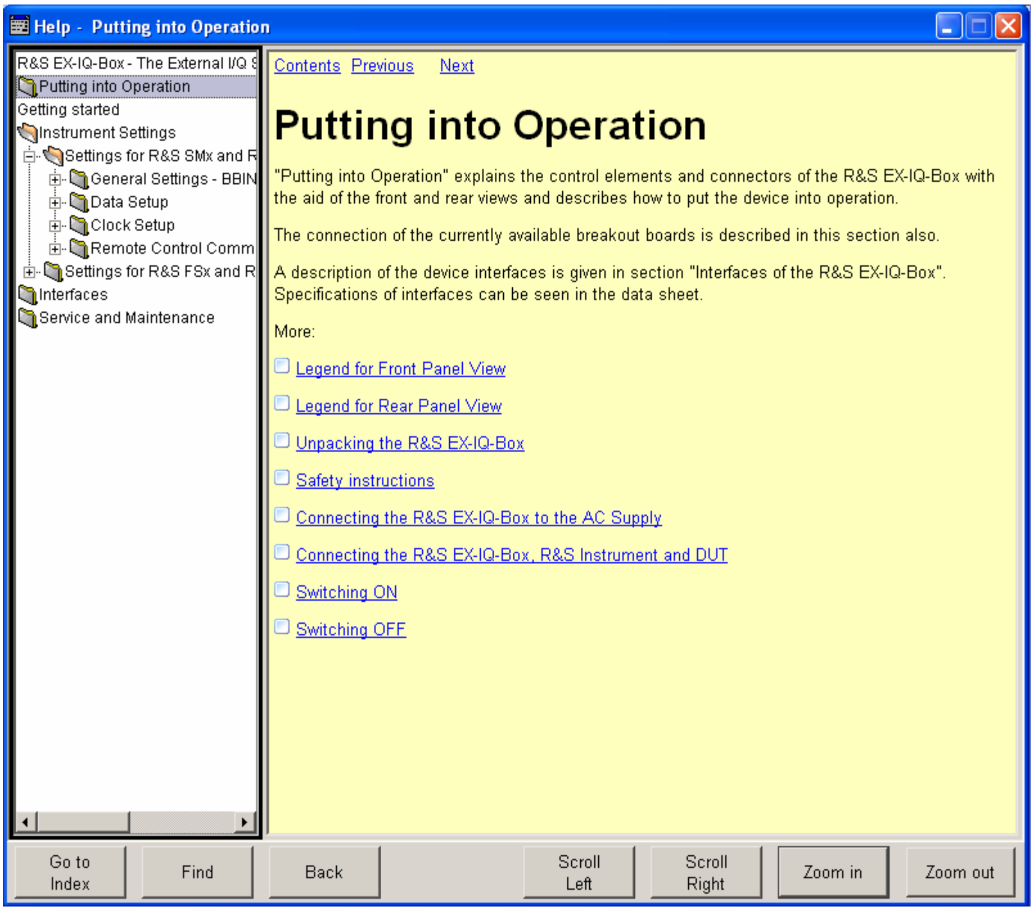
  Note: The help files (*.chm) are also available on the CD-ROM and can be used as a standalone help.

Alternatively, help can either be opened in the help menu or in the menu tree.

► Select the appropriate item in the help menu, or right-click on the application window. Then click on the softkey Menu and select the appropriate help item.

A browser window opens, tiled into three panels. On the left, the contents panel lists all topics, and the text panel aside describes the selected topic. Below, several softkeys are available, either for the search for text or for modifying the display.

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



Contents panel

The topics list is used to open the individual help pages. It has a hierarchical structure. The highlighted line indicates where the currently displayed page is within the topics list.

Text panel

Navigation links on top of the panel provide either switching to the contents panel or browsing through the help pages.

- Contents link

  Switches from text panel to contens panel.

- Previous/Next links

  Previous/Next scroll through the help pages. The sequence of the pages corresponds to their position in the dialogs.

- Internal links in the text

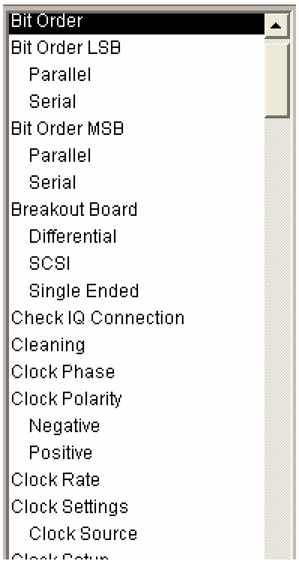
  They open pages which are directly linked to the described function. In this way it is possible, for example, to call up the description of the IEC/IEEE-bus command for any particular function.

Softkeys

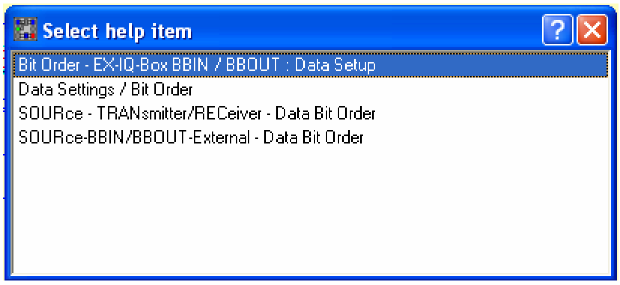
- "Got to Index"

  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.

Index terms

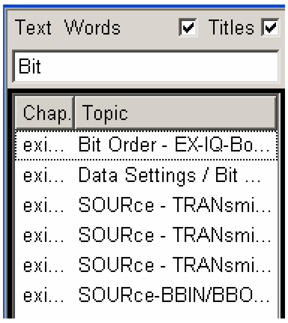


Pages containing a selected term



- "Find"

  Opens the search panel.



  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.

- "Back"

  The Back softkey calls up the page last viewed.

- "Scroll Left" / "Scroll Right"

  Shifts the indicated area of the navigation window.

- "Zoom In" / "Zoom Out"

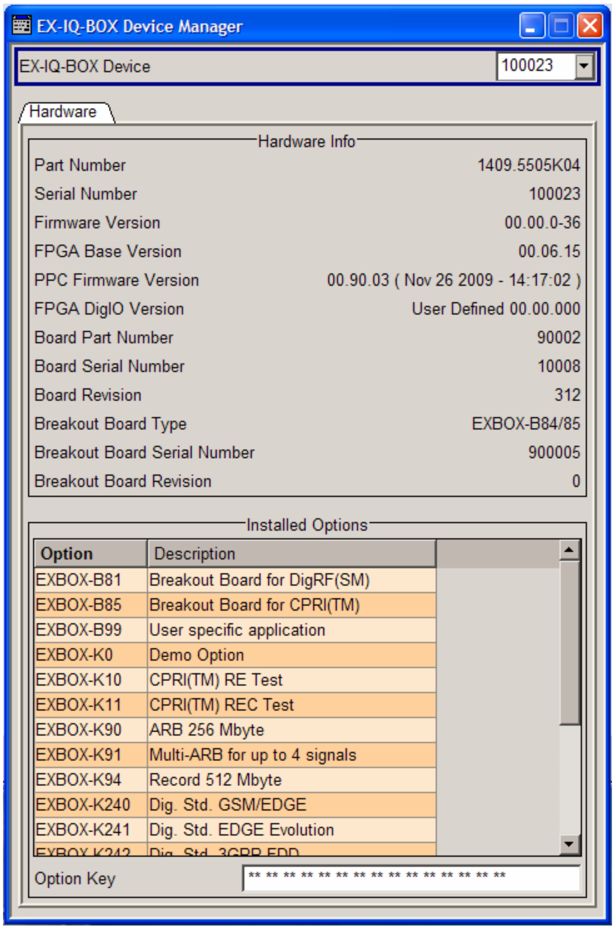
  Increases and reduces the font size of the help text.

5.1.6 Configuration Dialogs

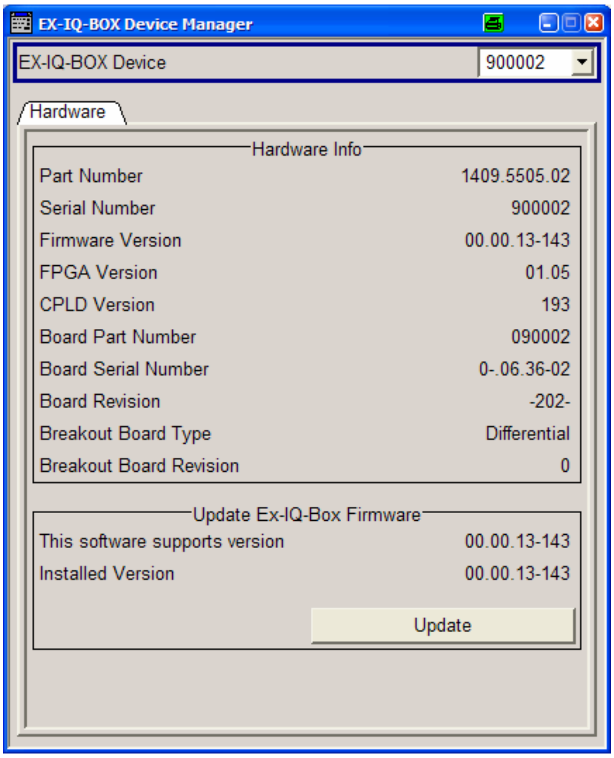
5.1.6.1 EX-IQ-BOX Device Manager

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.

Due to the fact that the new options like standardized protocols or waveform memories are supported only since R&S EX-IQ-BOX **1409.5505K04**, the dialog of the device manager varies in dependence of the variant.



R&S EX-IQ-BOX 1409.5505K04



R&S EX-IQ-BOX 1409.5505.02

EX-IQ-BOX Device

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

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 Connecting the R&S EX-IQ-BOX.

Remote-control command:

`SOUR:EBOX:DEV:SELect 100112`

Hardware Info

Part Number

The part number of the R&S EX-IQ-BOX.

Serial Number

The serial number of the R&S EX-IQ-BOX.

Firmware Version

The firmware version installed in the R&S EX-IQ-BOX.

FPGA (Base) Version

The version of FPGA (**F**ield **P**rogrammable **G**ate **A**rray) basic design.

PPC Firmware Version

The version of the built-in power PC.

Note: This parameter applies to R&S EX-IQ-BOX **1409.5505K04**.

FPGA DigIO Version

The version of the digital interface standard.

Note: This parameter applies to R&S EX-IQ-BOX **1409.5505K04**.

CPLD Version

The version of CPLD (**C**omplex **P**rogrammable **L**ogic **D**evice).

Note: This parameter applies to 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 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.

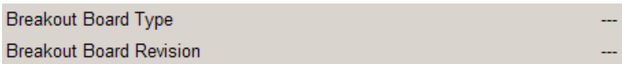
Breakout Board Serial Number

The serial number of the connected breakout board.

Breakout Board Revision

The revision number of the connected breakout board.

> **Note:** The breakout board might be unplugged while the R&S EX-IQ-BOX is operating. 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.



Installed Options

The list of already installed options of the selected R&S EX-IQ-BOX.

Note: This section refers to R&S EX-IQ-BOX **1409.5505K04**.

Option Key

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

For description on how to install a new option refer to Installing R&S EX-IQ-BOX Options.

Remote-control command:

`SOUR1:EBOX:OPT?`

Response: `"EXBOX-B85, EXBOX-K10, EXBOX-K90, EXBOX-K242, ..."`

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.

This software supports version

Indicates the firmware available in the current software of the R&S DigIConf.

Installed version

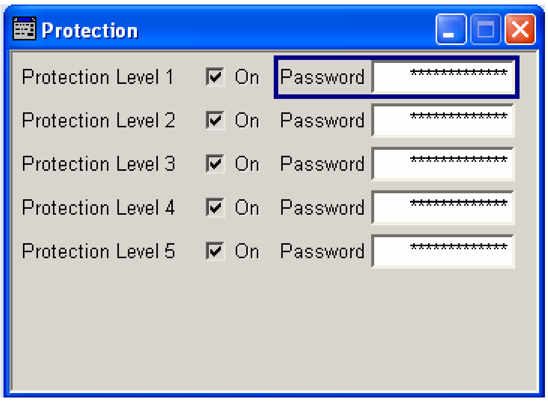
Indicates the currently installed firmware version in the R&S EX-IQ-BOX.

Update

Executes an update of the firmware supported by the R&S DigIConf software. After a few seconds the update will be performed.

5.1.6.2 Protection

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



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

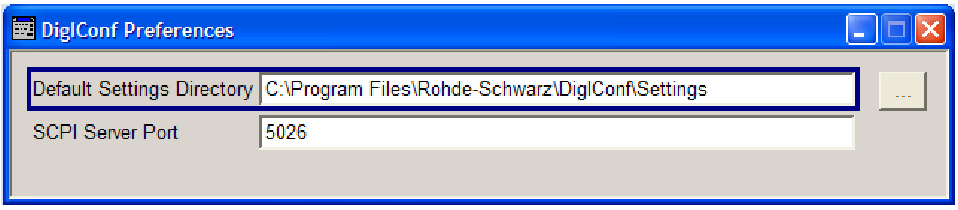
Unlock, for example, some self test routines, while you switch protective level 1 to unprotected. The password is 123456.

Notes:

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

5.1.6.3 Preferences

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



Default Settings Directory

Select the directory that contains application-specific settings files.

Notes:

- During installation, R&S DiglConf 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 Diglconf, you can keep these files. The same applies if you update R&S DiglConf.

SCPI Server Port

Select the port address of the server for remote control.

OK / Cancel

Confirm your changes, or cancel your inputs with the appropriate button.

5.1.6.4 Self Test

Self test functions are not yet supported in the current release.

5.1.6.5 Instrument on 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.

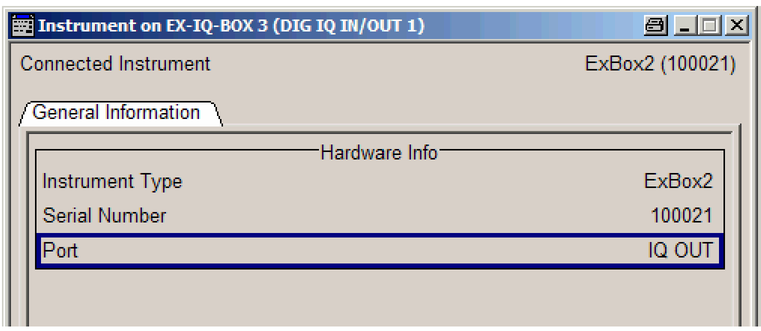
The instruments block and the configuration dialog are available, if an R&S instrument is connected.

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 DigIConf into the instruments via SCPI commands, which are entered in the SCPI Interactive tab or the SCPI Scripting tab.

> **Note:** 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.



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.

Instrument Type < General Information

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.

Serial Number < General Information

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

Port < General Information

The digital interface, to which the R&S instrument is connected.

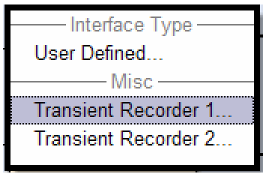
5.1.6.6 Transient Recorder

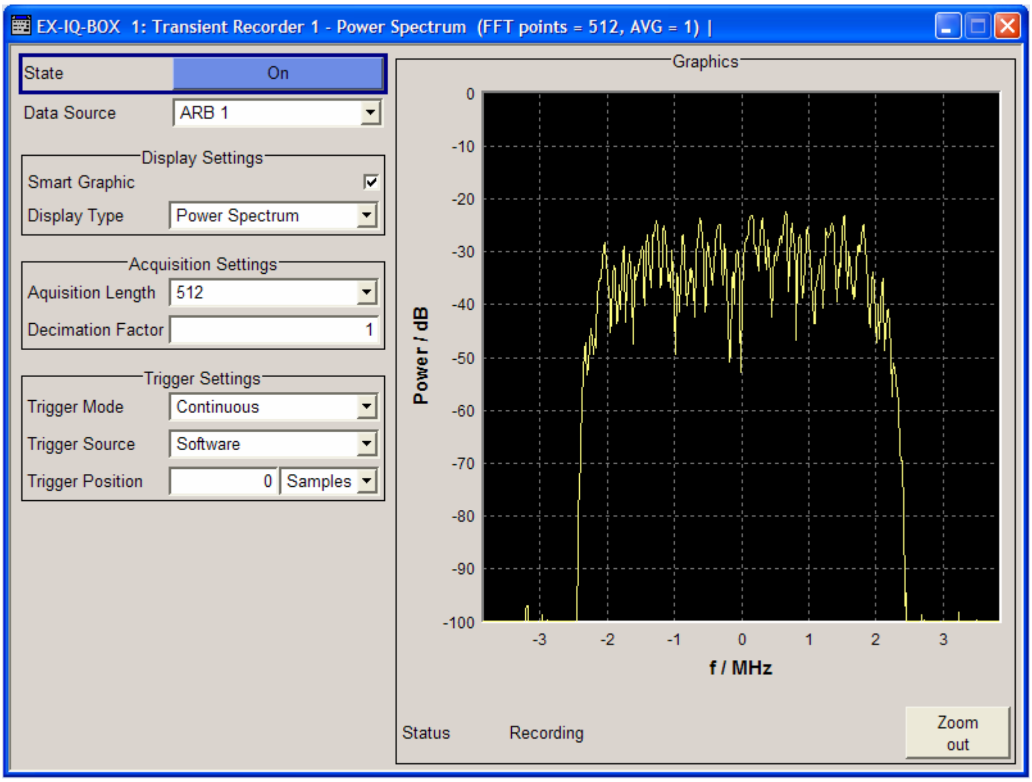
Two independent transient recorders provide monitoring the I/Q data flow through the R&S EX-IQ-BOX. Input signals, output signals and signals of the Waveform Memory can be recorded. A graphical display allows to quickly view and check the current signal characteristics.

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

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

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





This dialog comprises all parameters required for recording, as:

- **State** for activating,
- **Data Source** to select the signal,
- **Display Settings** to determine the type of display,
- **Acquisition Settings** for setting the capture length,
- **Trigger Settings** to configure the triggering mechanism for data acquisition.

Zooming the signal permits a detailed evaluation of any signal segment, and the Status line indicates the when recoring is activated.

State

Activates the selected transeient recorder.

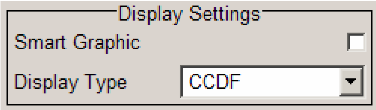
Note: Note that the R&S EX-IQ-BOX must be switched on for data recordings.

After activation, the diagram selected with **Display Type** is displayed in the Graphis window. At the bottom of each graphics window a Zoom button provides zooming the display.

Data Source

Selects the signal source of the I/Q data to be recorded. Data of the signal sources DIG IQ IN or DIG IQ OUT can be recorded.

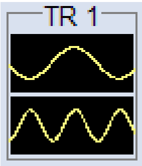
Section **Display Settings** enables to indicate a smart graphic in the main application window and offers different dispaly types for graphical signal display.



Smart Graphic

Activates the display of a smart graphic.

Additionally to the graphics window in the dialog, the graphic can also be shown in a small window ("smart graphic") in the main application window.



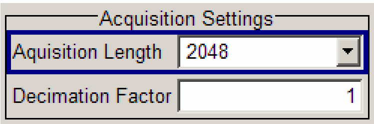
A smart graphic is fitted into the block diagram as a block, directly below the corresponding EX-IQ-BOX block. It can be used for basic checking purposes.

> **Note:** Double click on the smart graphic also opens 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 the following sections under "Graphical Signal Displays" on page 88.

Section **Acquisition Settings** provides setting the length for recording or selecting a specific sample to be recorded.



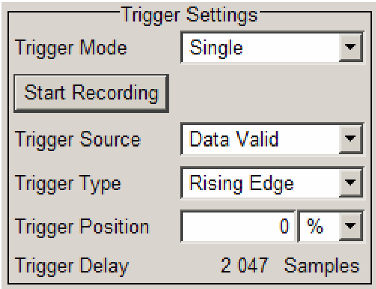
Aquisition Length

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

Decimation Factor

Selects a certain sample to be recorded, i.e. only the n^{th} sample is recorded.

Section **Trigger Settings** contains the parameters for triggering the signal to be recorded.



Trigger Mode

Selects the mode for triggering.

Continuous Recording is automatically initiated and continues until the process is stopped manually. Recording is retriggerd 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 is relevant for Single Trigger mode only.

Trigger Source

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

Software R&S DigIConf initiates the trigger event for recording. Recording of signals is started 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. This control signals is part of the complete I/Q signal and transmitted via the digital I/Q interface of the R&S instrument.

GP_0 (Marker 0) Marker GP_0 determines the starting point for recording a signal. This control signals is part of the complete I/Q signal and transmitted via the digital I/Q interface of the R&S instrument.

GP_1 (Marker 1) Marker GP_0 determines the starting point for recording a signal. This control signals is part of the complete I/Q signal and transmitted via the digital I/Q interface of the R&S instrument.

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_0/1**. The trigger source **Software** does not need 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 corresponds to a logical "0".

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

Trigger Position

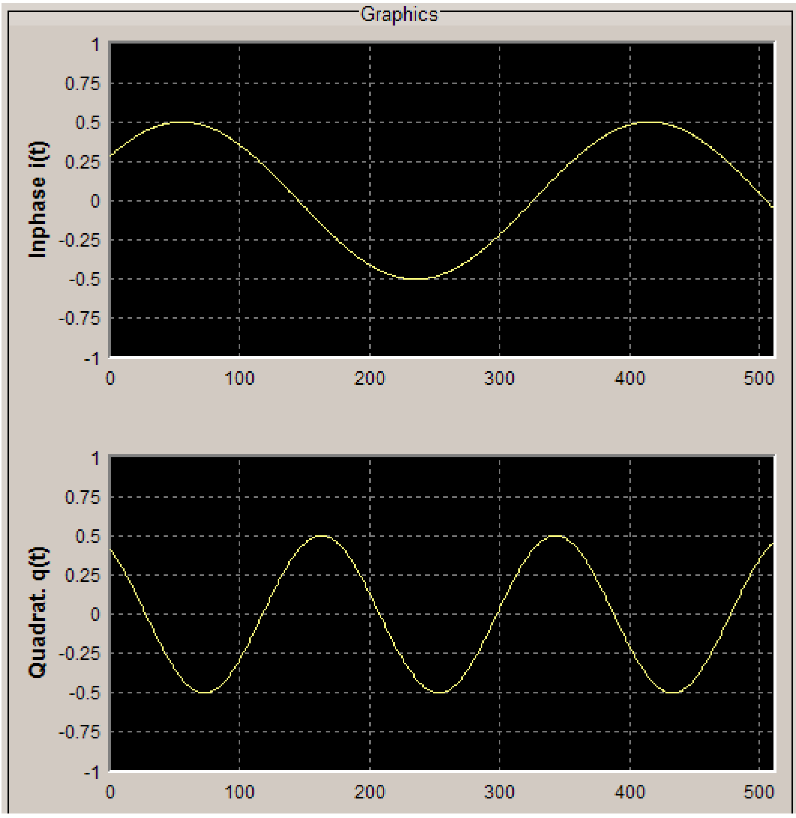
The trigger position determines the position of the trigger event on the time-scale. The value is set in samples while a positiv number n means the trigger event is at sample number n, a negativ value means the trigger event was before the first sample.

5.1.6.7 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

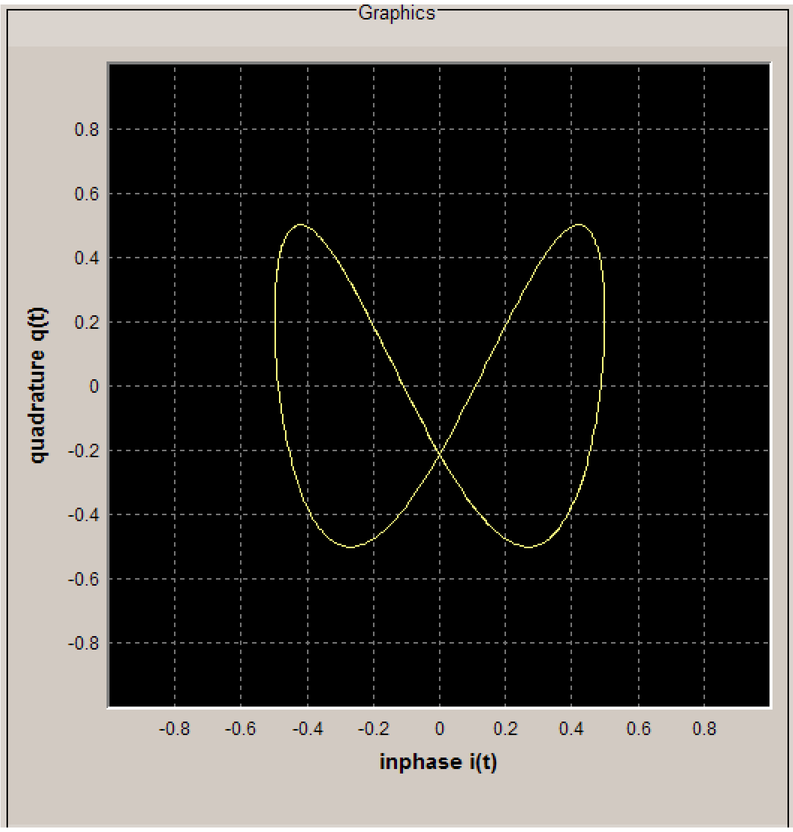
The I/Q diagram displays the inphase component (i[t]) and quadrature component (q[t]) of the I/Q signal over time. The diagram is displayed in a window with two separate coordinate systems. The coordinate systems have identical X and Y axes. The time in number of samples is plotted on the X axes, and 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.



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).

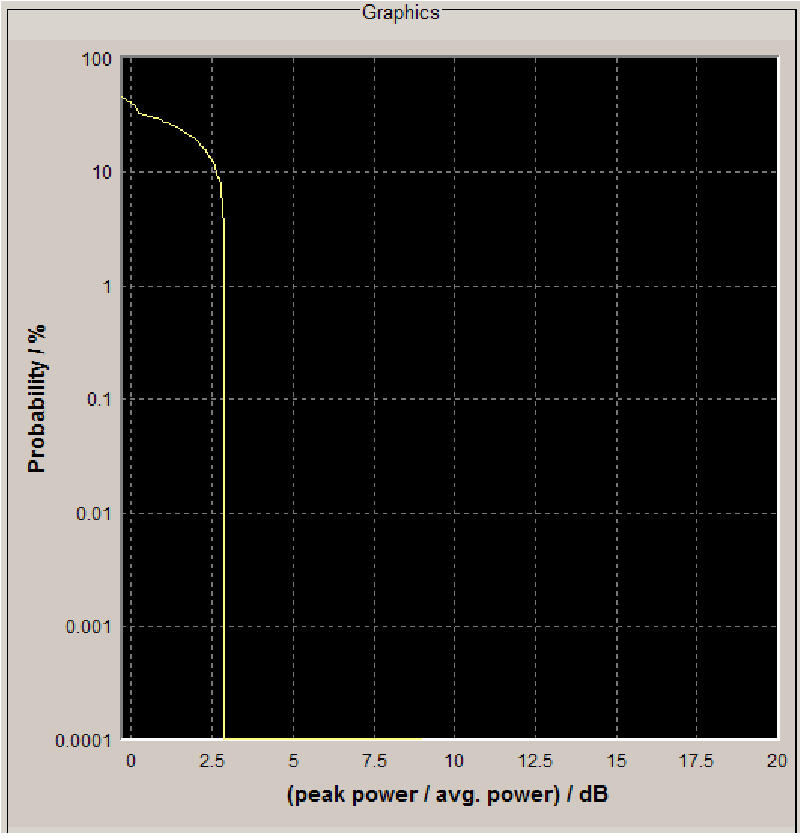
This display shows the curves between the various states of modulation mapping. The recording depth is 1 kSamples.



CCDF Display

The **C**omplementary **C**umulative **D**istribution **F**unction 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 8kSamples.

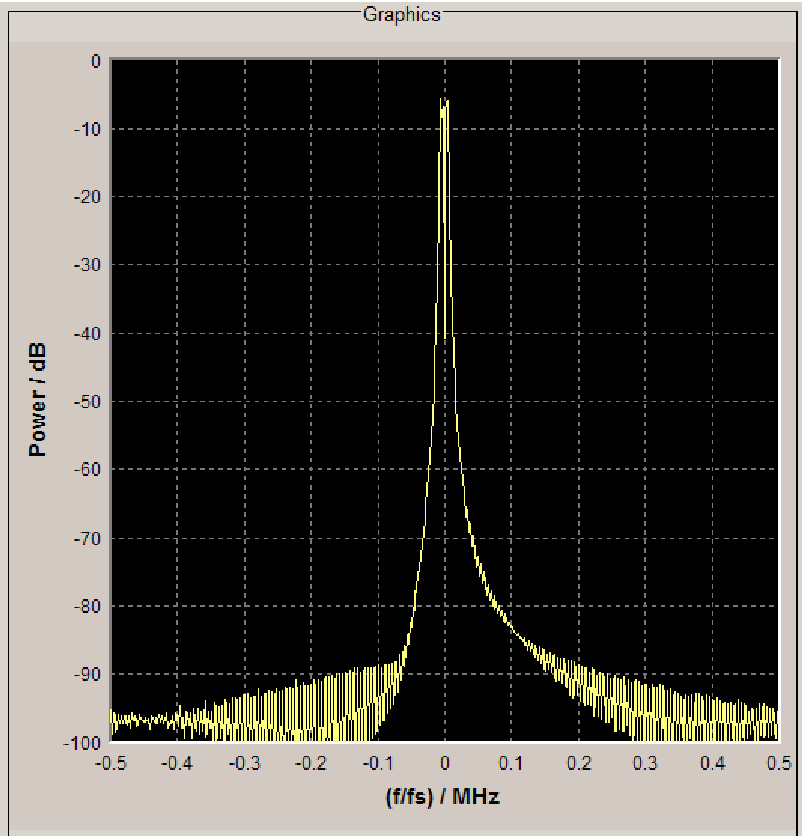
The point at which the CCDF curve intersects the X axis gives the crest factor of the signal.



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 8kSamples.

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



5.1.7 Connected R&S EX-IQ-BOX

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

5.1.7.1 Connection

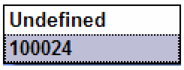
For controlling the R&S EX-IQ-BOX with R&S DigIConf, the R&S EX-IQ-BOX must be connected to the PC via USB. The connection of the R&S EX-IQ-BOX to the PC and the instrument is described in detail in chapter Connecting the R&S EX-IQ-BOX.

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

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

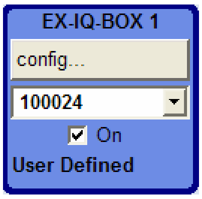
R&S DigIConf appends the serial number of the R&S EX-IQ-BOX to the list of connected devices, which is shown in every R&S EX-IQ-BOX block.

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

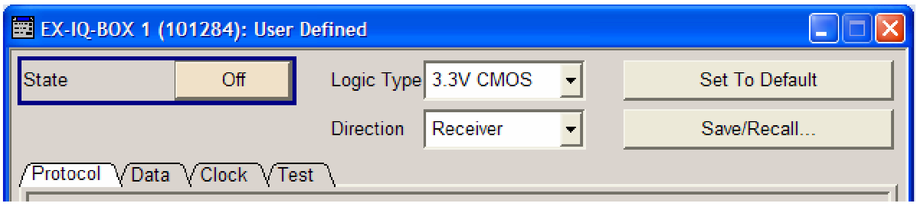


Note: If a device is already assigned to a block, its serial number is disabled (grayed out) in the list of other blocks. If no R&S EX-IQ-BOX is connected or an assigned R&S EX-IQ-BOX is disconnected, "Undefined" is indicated automatically.

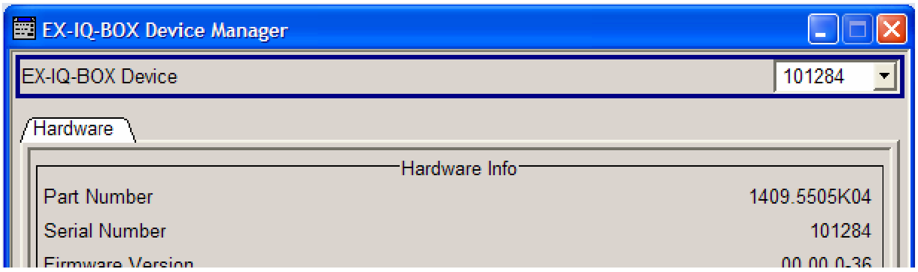
- After assigning the serial number, it is shown in the R&S EX-IQ-BOX **function block**.



- R&S DigIConf indicates serial number of the assigned R&S EX-IQ-BOX in the title of **all settings dialogs**.



- Detailed information about the connected R&S EX-IQ-BOX is displayed in the **device manager dialog**:



5.1.7.3 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.

5.1.8 Connected R&S Instruments

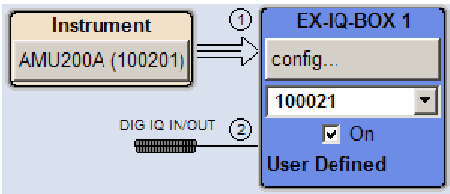
A test setup usually requires an R&S instrument for data transmission. The connection to an R&S instrument is established via the digital I/Q interface DIG IQ IN/OUT.

> **Note:** An R&S instrument has to be equipped with an option for digital baseband input or output, respectively. Refer to the respective internet site of your instrument for information about available options.

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

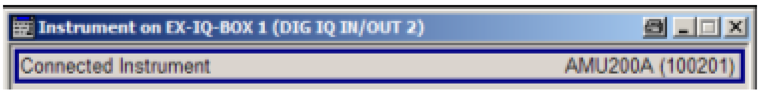
- R&S DigIConf shows a **separate function block** with information on the connected instrument. Input/Output symbols in the block diagram show the currently used inputs and outputs and the lines indicate the signal flow.

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



► Clicking on the <instrument> button opens the "Instrument on EX-IQ-BOX <n>" **configuration dialog**.

  Name and the device ID of the connected instrument are also indicated in this dialog described under "Instrument on R&S EX-IQ-BOX" on page 82.



Remote-control commands:

`SOUR1:EBOX:INST1:NAME?`
Response: `"AMU 200A (100201)"`

`SOUR2:EBOX:INST2:PORT?`
Response: `"IN", "OUT"`

`SOUR1:EBOX:INST1:SER?`
Response: `"100201"`

`SOUR1:EBOX:INST1:TYPE?`
Response: `"100201"`

Indication of an R&S EX-IQ-BOX in an 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 input/output dialogs. Analyzers indicate the respective R&S EX-IQ-BOX information in the **EXBoxStatus** field.

5.1.9 Automation of R&S DigIConf

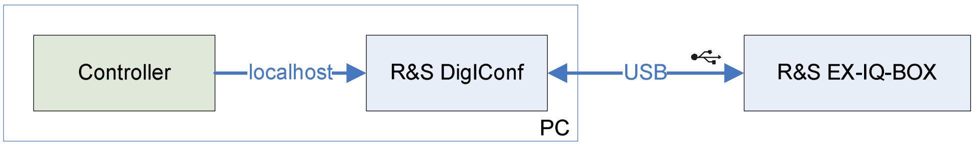
In addition to being able to control the R&S DigIConf in the usual manual way via the user interface, this system can also be controlled remotely.

It is particularly useful for repeating measurement sequences reproducible, when a higher configuration speed is required or when complex test setups are to be performed.

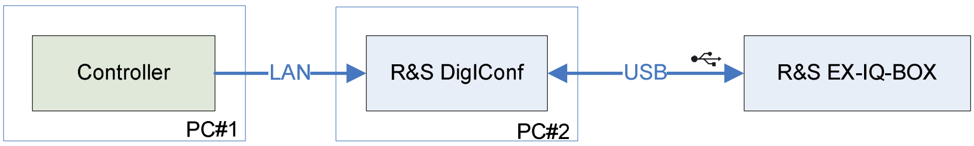
Remote control is an operation by which the software is operated remotely from a so called controller. A controller can be any PC on which some required software is installed and configured. on the controller's PC, a LAN connection between both PCs is required.

The figures below depict the following two possible cases:

- The controller and R&S DigIConf are on the same PC:



- The controller and R&S DigIConf are installed on two separate PCs:



In remote control operation, the R&S DigIConf is operated by means of remote control commands following the **SCPI** (**S**tandard **C**ommands for **P**rogrammable **I**nstruments) standard.

A detailed description of SCPI commands available for R&S DigIConf is provided in "Remote Control Commands" 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 "Remote Control Basics".

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

5.2 Configuration via R&S Instruments

This chapter describes how the R&S EX-IQ-BOX is configured over instruments directly. Connection, indicating and data transmission are treated separately for every instrument family.

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.

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 refer to "R&S DigIConf Configuration Software" on page 56.

Since the configuration parameters of the R&S EX-IQ-BOX only depend on the transmission protocols, these application settings are described in chapter "User Defined - Remote Control Commands" regardless of the connected R&S instrument.

Therefore, this chapter contains only information important for direct control of the box:

- "R&S Signal Generators" on page 97 encloses general information about the connection and operation with the R&S signal generators, the block diagram and the configuration dialogs.
- "R&S Signal Analyzers" on page 105 comprises general information on connection and operation with R&S signal analyzers and shows the display and the analyzers´ configuration dialogs.

5.2.1 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 only be controlled directly by an R&S signal generator in a User Defined application. In case of standardized protocols R&S DigIConf is required.

5.2.1.1 Connection

An R&S instrument has to be equipped with the option for 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.

The appropriate options for each instrument are listed in R&S Instruments Working with the R&S EX-IQ-BOX.

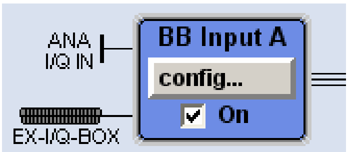
- USB and LVDS cables are connected between the R&S EX-IQ-BOX and the R&S signal generator. For details to the connection refer to Connecting the R&S EX-IQ-BOX.
- The configuration is performed in the signal generator´s configuration dialogs. Accessing the dialogs is described in "Dialogs" and the settings in "User Defined".

Connecting an R&S EX-IQ-BOX during operation

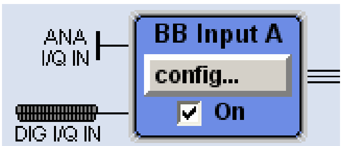
The R&S EX-IQ-BOX can be connected or disconnected while the R&S instrument is in operating mode.

- After establishing the USB and LVDS connection, the R&S instrument identifies the R&S EX-IQ-BOX and establishes the connection. A brief message is indicated in the **Info** line.

The labeled symbol of the R&S EX-IQ-BOX is indicated in the block diagram.



- After cutting the USB or LVDS connection, the active dialogs of the R&S EX-IQ-BOX are closed automatically. In the block diagram label and symbol change to the common symbol DIG I/Q IN or DIG I/Q OUT.



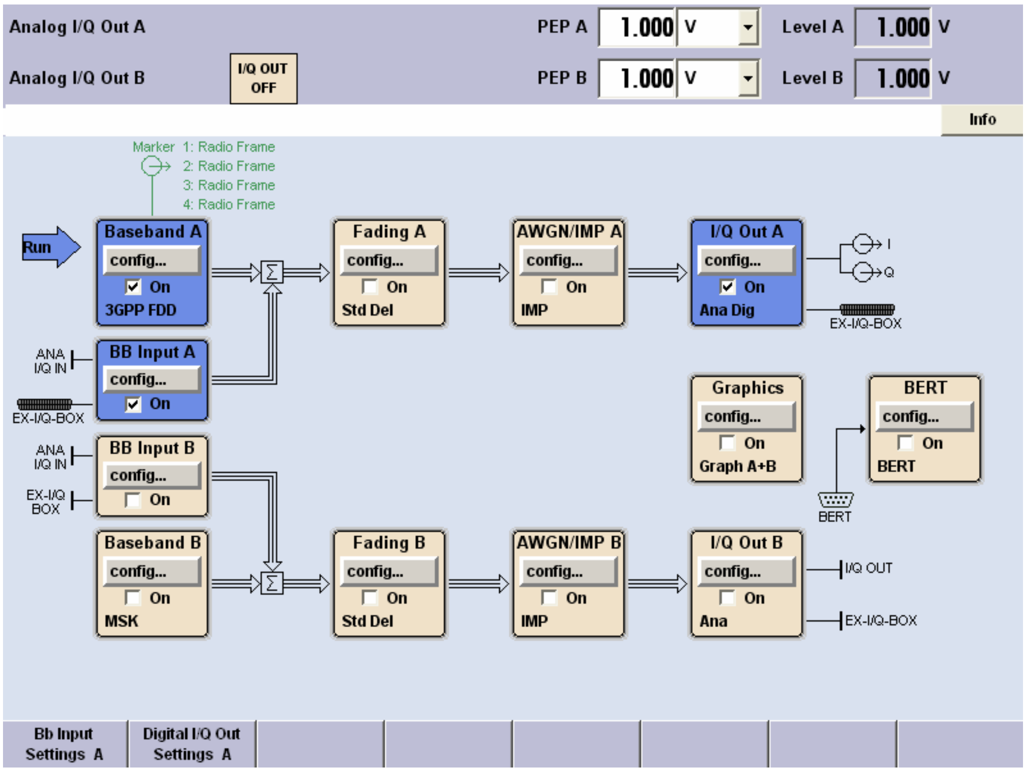
NOTICE

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 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.

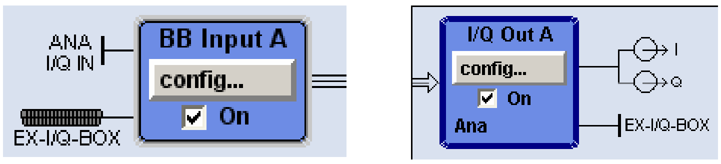
5.2.1.2 Indicating the R&S EX-IQ-BOX in an R&S Signal Generator

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.



Display of the R&S AMU 200A Baseband Signal Generator and Fading Simulator

- The R&S instrument indicates a labeled symbol in of the R&S EX-IQ-BOX at the corresponding function block.

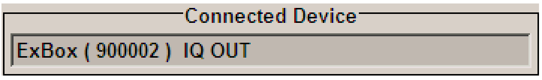


Indication of an R&S EX-IQ-BOX in a generator-block diagram at the example of the R&S AMU 200A

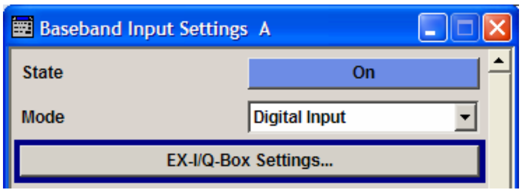
- After cutting the USB or LVDS connection, the active dialogs of the R&S EX-IQ-BOX are closed automatically. In the block diagram label and symbol change to the common symbol DIG I/Q IN or DIG I/Q OUT.

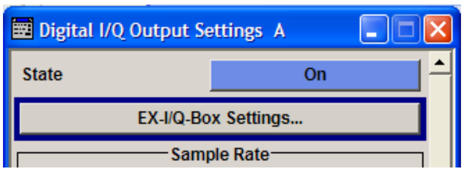
The above mentioned pictures represent the display of an R&S AMU200A. R&S SMx instruments have the same baseband input block, but a baseband signal is output before the RF modulation. Therefore, the digital I/Q signal output is assigned to the AWGN/IMP block.

- The ID (serial number) of the connected R&S EX-IQ-BOX is shown in the "Connected Device" information field of the **Baseband Input Settings...** or **Digital I/Q Output Settings...** dialogs.



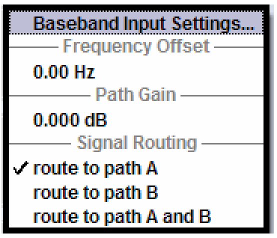
- In adddition, the button "EX-I/Q-BOX Settings..." is shown automatically in these dialogs, providing access to the R&S EX-IQ-BOX settings dialog.

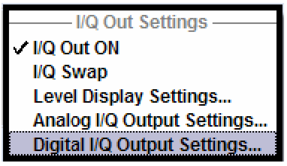




5.2.1.3 Dialogs

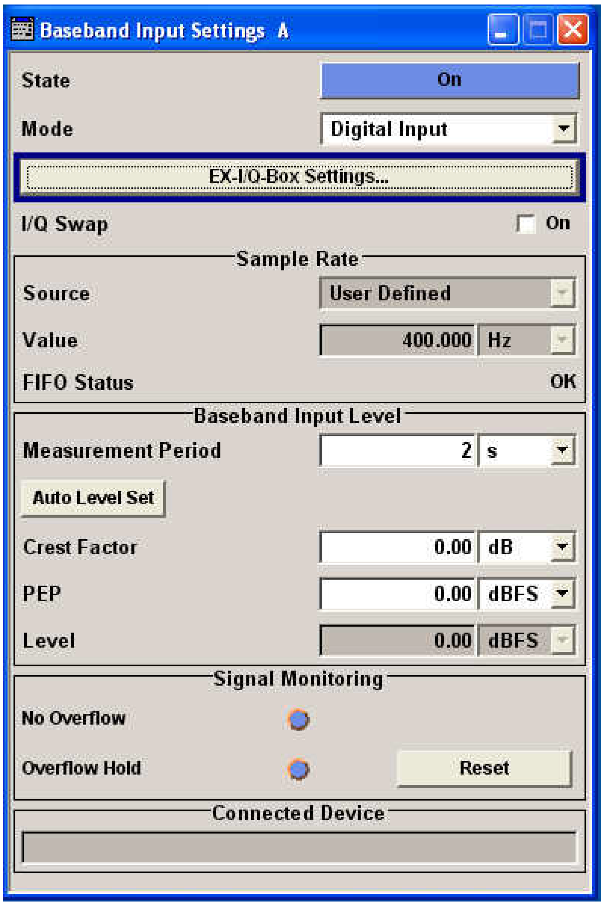
The R&S EX-IQ-BOX settings are accessed via the main settings dialogs **Baseband Input Settings...** or **Digital I/Q Output Settings...** of the associated function block.





► Selecting the respective menu item opens the settings dialog **Baseband Input Settings...** or **Digital I/Q Output Settings...**.

Baseband Input Settings... / Digital I/Q Output Settings ...

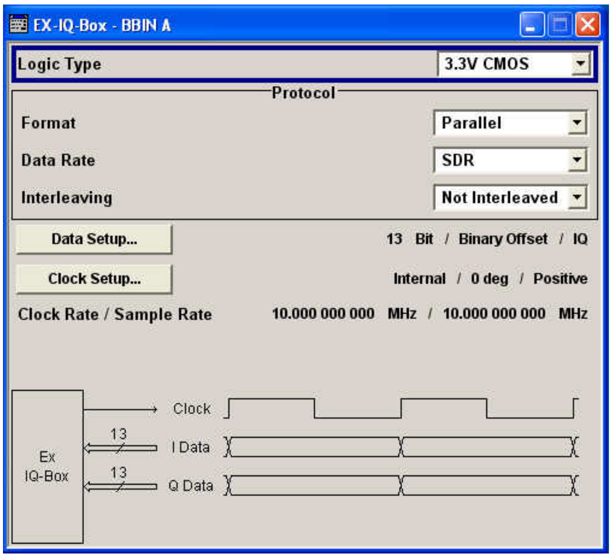


Baseband settings dialog of R&S signal generators, at the example of baseband input settings.

- The parameters of following dialogs are identical for baseband input and output. The heading of each dialog indicates the currently selected R&S EX-IQ-BOX.
- For remote control the appropriate signal direction is addressed with the aid of the command syntax.
- The parameters including the respective control commands are described in chapter "Protocol Settings", section "User Defined".

EX IQ Box: BBIN / BBOUT

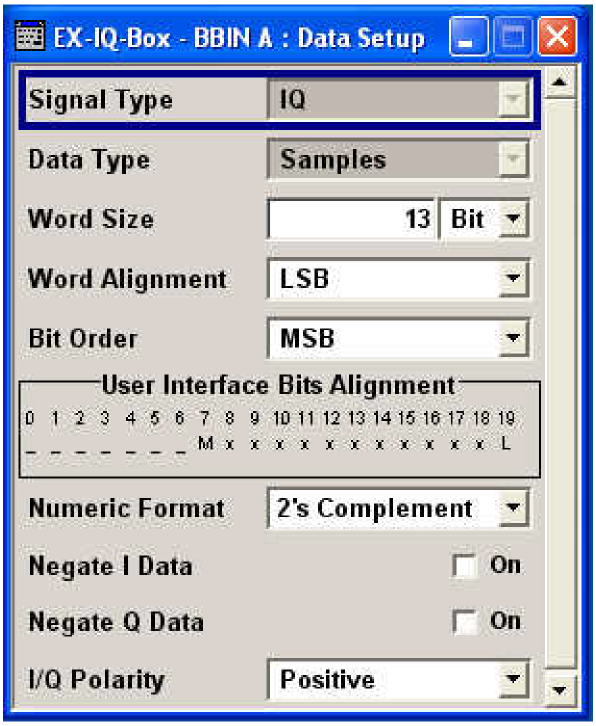
► Clicking on the "EX-I/Q-Box Settings..." button opens the settings dialog of the R&S EX-IQ-BOX.



R&S EX-IQ-BOX main settings dialog of R&S signal generators, at the example of baseband input.

The main configuration dialog provides **Logic Type** and **Protocol** parameters, and two subdialogs enable setting **Data Setup** and **Clock Setup** parameters. Corresponding to the current settings the I/Q data and clock signals are displayed graphically in the lower section of the dialog.

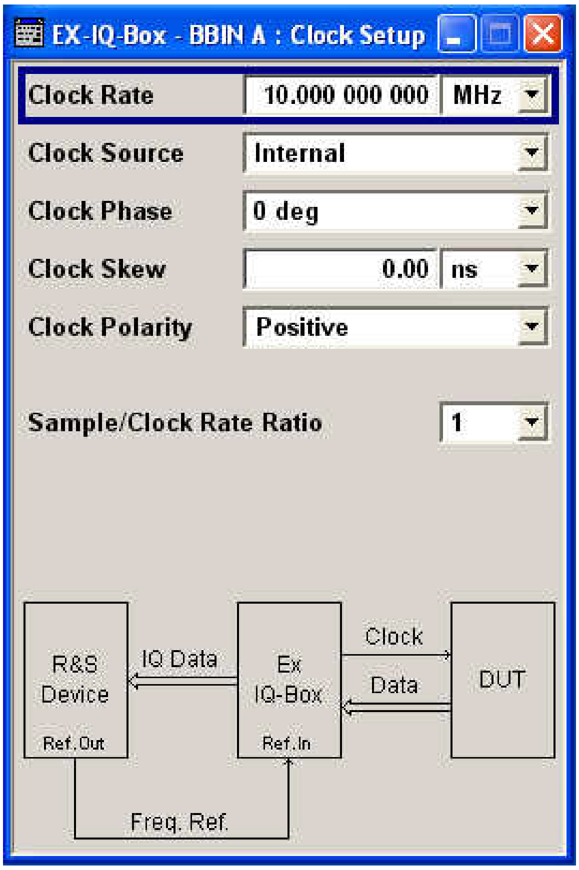
Data Setup



R&S EX-IQ-BOX data setup dialog of R&S signal generators, at the example of baseband input.

The data setup dialog enables to define the mode for data transmission. The currently set bits alignment at the user interface is indicated graphically.

Clock Setup



R&S EX-IQ-BOX clock setup dialog of R&S signal generators, at the example of baseband input.

The clock setup dialog encloses all clock settings required for User Defined protocols. The lower area indicates clock and data signal direction in a block diagram.

5.2.1.4 Data Transmitting I/Q Data

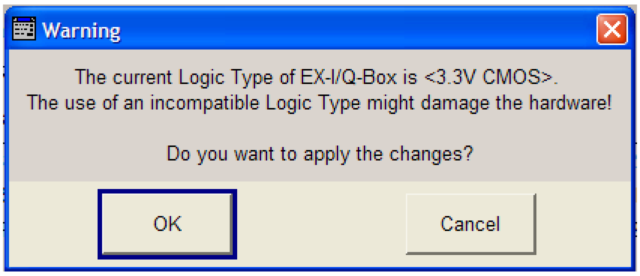
The baseband signal transmission between R&S EX-IQ-BOX and R&S instrument is activated by switching on in the **Baseband Input / Digital I/Q Output**.

NOTICE

Danger of hardware damage!

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.

Therefore, a change of logic type during operation is only enabled after the following warning message has been confirmed.



5. Select "OK" if the correct logic type is selected.
6. Select "Cancel" if an incompatible logic type is selected. In this case, the correct logic type has to be set in the main configuration dialog for User Defined protocols, section "Logic Type".

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

5.2.2 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 only be controlled directly by an R&S signal analyzer in a User Defined application. In case of standardized protocols R&S DigIConf is required.

5.2.2.1 Connection

An R&S signal analyzer has to 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 can be connected either only to an R&S signal analyzer, or be connected with a PC and an R&S signal analyzer.

R&S EX-IQ-BOX and R&S signal analyzer

- USB and LVDS cables are connected with the analyzer. For details to the connection refer to Connecting the R&S EX-IQ-BOX.
- The configuration is performed in the signal analyzer´s configuration dialogs. Accessing the dialogs is described in "Dialogs" on page 108.

Connecting an R&S EX-IQ-BOX during operation

The R&S EX-IQ-BOX can be connected or disconnected while the R&S signal analyzer is in operating mode.

- After establishing the USB and LVDS connection, the R&S signal analyzer identifies the R&S EX-IQ-BOX and establishes the connection. The **ExBox Status** information field is updated with some information, which is read from the box.

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

- After cutting the USB or LVDS connection, the **ExBox Status** is updated with the new state for the box.

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

Note: Unplugging the I/Q Data while the digital interface is activated, may cause unexpected results. Before unplugging the I/Q interface, disable the digital interface.

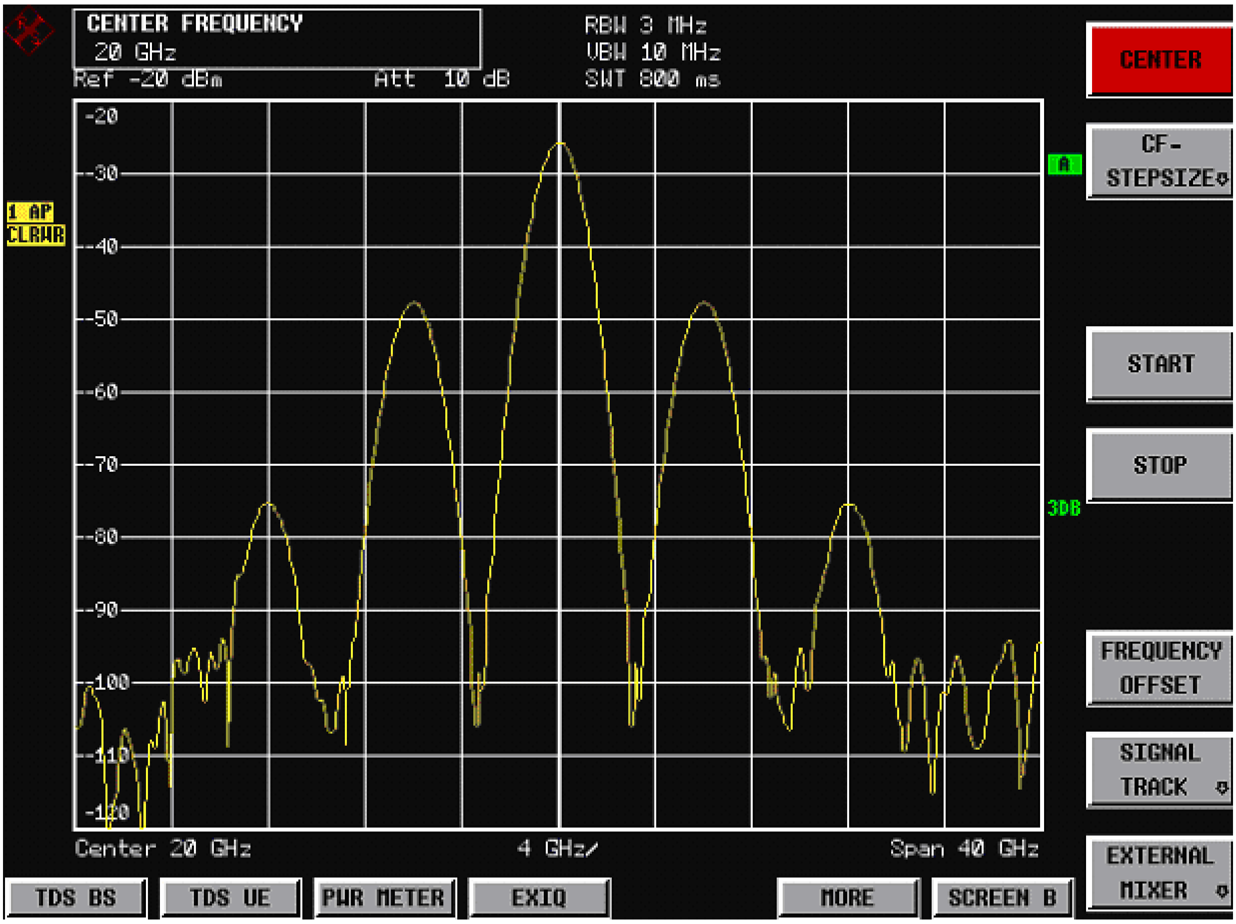
NOTICE

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 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.

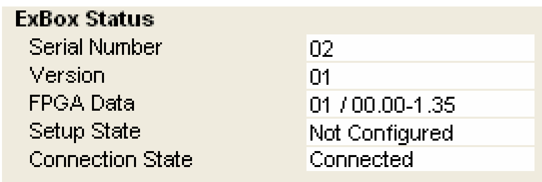
5.2.2.2 Indicating the R&S EX-IQ-BOX in an R&S Analyzer

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.



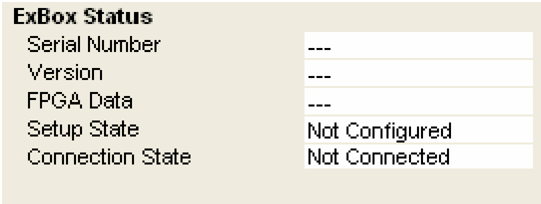
Display of the R&S FSQ Signal Analyzer with R&S FSQ-B17 option

- The R&S signal analyzer indicates a hotkey labeled "EXIQ".
- The R&S signal analyzer updates the EXBoxStatus field with some information, read from the R&S EX-IQ-BOX.



ExBoxStatus field of an R&S signal analyzer

- After cutting the LVDS connection, the **ExBox Status** is updated with the new state for the box.



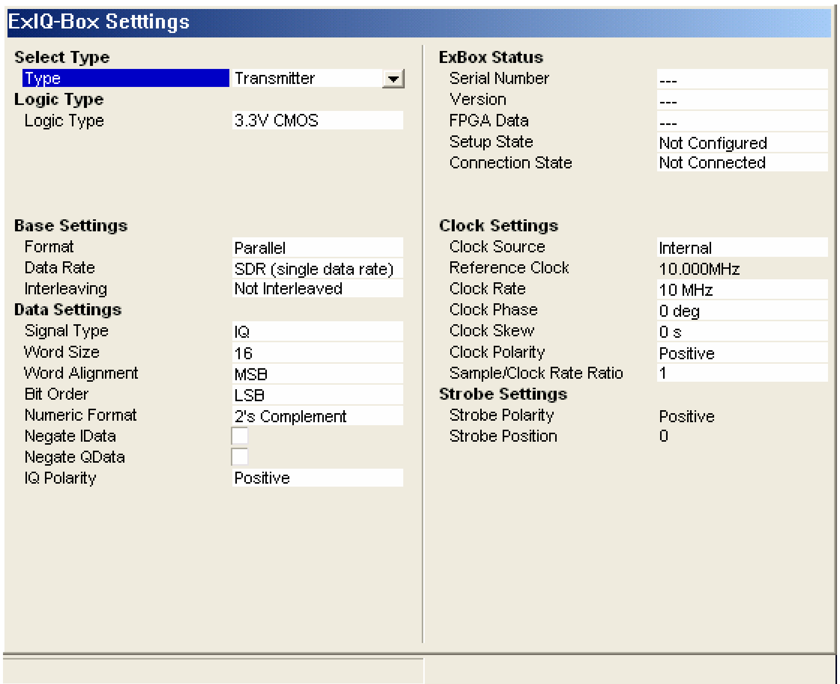
Refer also to the manual of your R&S signal analyzer for description.

5.2.2.3 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 including the respective control commands are described in chapter "Protocol Settings", section "User Defined".



Display of the R&S EX-IQ-BOX configuration dialog for logic type CMOS 3.3V

The ExBoxSettings dialog provides all parameters for User Defined protocols, structured in several sections, as **Select Type** for direction, **Logic Type** and **Base, Data, Clock**a and **Strobe Settings.** Section **ExBoxStatus** indications information on the connected R&S EX-IQ-BOX.

Select Type

Select the input type, i.e. Receiver or Transmitter for the R&S EX-IQ-BOX to define the direction for data transmission.

To toggle between the different types, press the "TX SETTINGS" or "RX SETTINGS" softkey select the type from the combo box.

Note: This parameter corresponds to "Direction" in R&S DigIConf.

Exit

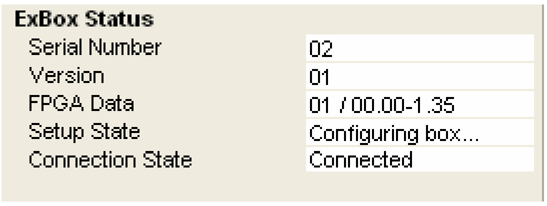
To leave the configuration dialog the user must press the “EXIT” hotkey.

Store

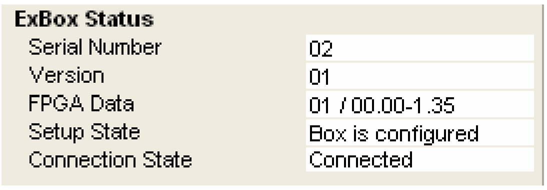
All parameters of the R&S EX-IQ-BOX are stored and available again after switching the Analyzer off and on.

Note: Additionally the settings can be saved with the “Save/Recall” Manager.

The setup of the new data may be taking up to 15 seconds, depending if the logic type has been changed or not. During the configuration in the “Setup State” line a message is displayed that the configuration is in progress. Note that during the configuration no interaction with the GUI is possible.



After the configuration the result of the setup is displayed in the “Setup State” line.



5.2.2.4 Transmitting I/Q Data

Note that data transmission is only possible if the USB and LVDS connections to the analyzer are established.

Setup of the R&S EX-IQ-BOX is executed by pressing the “SEND TO” hotkey and signal transmission starts.

Remote-control command:

`(*):SENDto`

Notes:

- The direction of signal transmission from the DUT to R&S EX-IQ-BOX or vice versa is defined in the Select Type Field in "Dialogs" on page 108.
- The setup of the new data may be taking several seconds. During configuration a message in the "Setup State" field indicates that the configuration is in progress. During this process interaction with the GUI is not possible. After configuration signal transmission starts.

5.2.3 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 "R&S DigIConf Configuration Software" on page 56. The parameters are described in chapter "Protocol Settings".

6 Protocol Settings

Protocol Settings describes the parameters and settings of the respective transmission protocols. It is divided into a functional section, that describes the parameters by means of GUI dialogs, and a section with remote-control commands. Depending on the protocol type, additional information is provided, as for example modifications of the remote-control notation, information on the transmission protocol or on operating elements of the breakout boards.

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.

Protocol Settings comprises the following transmission protocols:

"User Defined" 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.

> **Note:** The previous version of the R&S EX-IQ-BOX, model 1409.5505.02 works with User Defined protocols and can be controlled for this certain mode of operation 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. "Explanation to the SCPI Syntax Used in this Section" explains the used notation of the SCPI commands, that has been adapted with the aid of an abbreviation in order to apply to the R&S EX-IQ-BOX 1409.5505.02 with directly connected R&S instruments and also to R&S DigIConf.

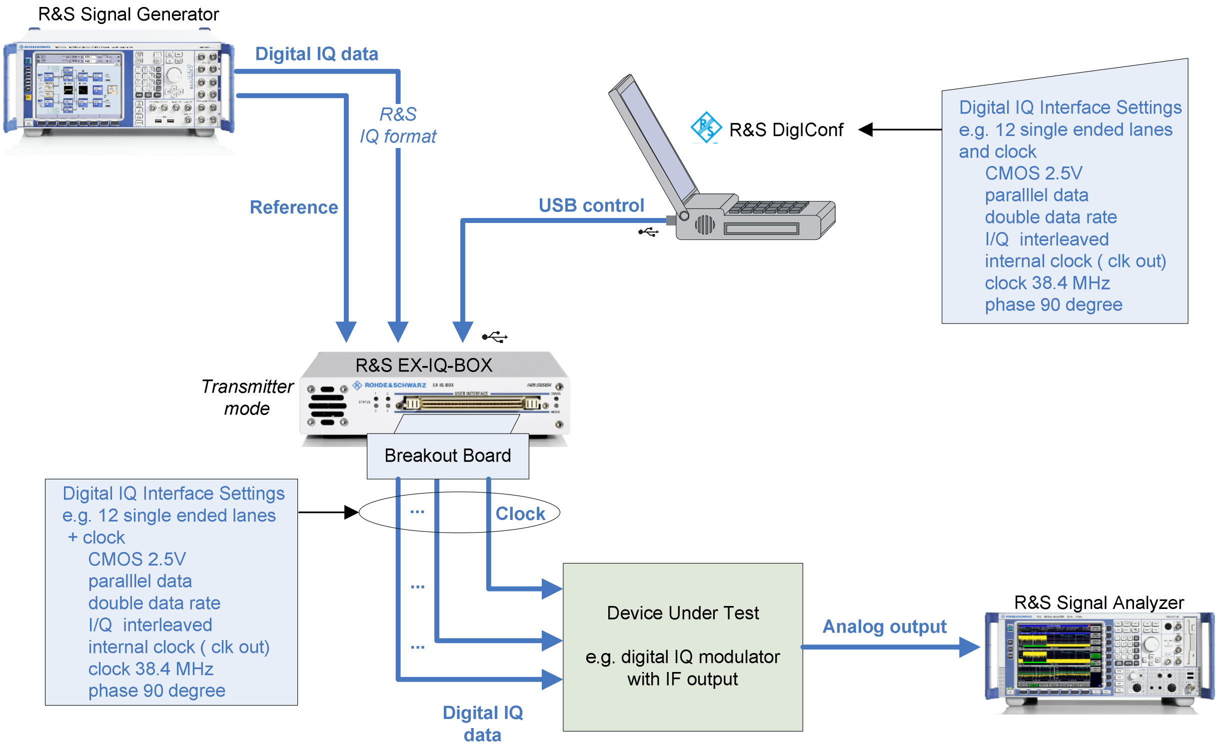
"CPRI" contains a general overview of the standard interface and explains the configuration dialogs and parameters, provided by the configuration software R&S DigIConf. Besides the "Downlink" / "Uplink" settings, R&S DigIConf provides "Control& Management" settings, "Vendor Data" management, "Waveform Playback" and "Recording" memory.

6.1 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, OBSAI or DigRF. 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 can serve a large number of different digital I/Q interfaces. 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.



Typical test scenario of a User Defined application

6.1.1 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
Clock	Interface clock settings	Clock rate, phase shift, skew, frequency reference

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. In the transmit mode 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 in receiver mode. This way, the I/Q interface to or from the DUT can be verified by performing bit error rate tests.

6.1.2 Explanation to the SCPI Syntax Used in this Section

Besides of the functional description, the manual also contains a description of the remote control commands in order to remotely assign the settings of the R&S EX-IQ-BOX. R&S uses therefor SCPI (**S**tandard **C**ommands for **P**rogrammable **I**nstruments) commands and messages for remote control.

Although the graphical user interfaces of the R&S instruments and R&S DigIConf look different, they have the same settings for configuration. I.e. the parameters are almost identical for the BBIN and I/Q Out dialogs of R&S signal generators, or Transmitter/Receiver dialogs of R&S signal analyzers, respectively.

Therefore, the remote-control commands for the parameters are also similar. Depending on the transmission direction and the instrument type, the path of a SCPI command differs, but the command is identical.

Note: This applies only to user defined protocols.

SCPI command structrue and syntax

A SCPI command consists of a so-called **header** and, in most cases, one or more parameters. The header and the parameter are separated by a "white space", e.g. a blank. A command may consist of several levels, represented by combined headers.

The first header of a command represents the highest level, the **root** level. This level has a keyword, which denotes a complete command system.

For commands of lower levels, the complete path has to be specified, starting on the left, with the highest level, the individual keywords being separated by a colon ":".

A question mark after the command denotes a query.

By means of a command for generators, and the corresponding command for analyzers, the example in section "Examples of Similar SCPI Commands with Different Root" on page 114 explains this notation. "Syntax Modification" on page 115 then shows the abbreviations that are used in this documentation, and Root Notation (*) of the Respective R&S Instruments explains the appropriate syntax, which must be used for the respective R&S instrument or R&S DigIConf.

6.1.2.1 Examples of Similar SCPI Commands with Different Root

The following examples illustrate how the SCPI syntax is different in the root, but the command is the same.

R&S DigIConf

Commands used from R&S DigIConf for **input** and **output**

```
[:SOURce<hw>]:EBOX:USER:LOGic[:TYPE]
```

R&S Signal Generators

Command for **digital I/Q In (BBIN)** and **digital I/Q Out**:

```
[SOURce<[1]|2>:]BBIN:EXTernal:LOGic[:TYPE]
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:LOGic[:TYPE]
```

R&S Signal Analyzers

Command for **receiver** and **transmitter**:

```
[SOURce:]RECeiver:LOGic[:TYPE]
[SOURce:]TRANsmitter:LOGic[:TYPE]
```

6.1.2.2 Syntax Modification

As shown in the example, each SCPI command would have to be described separately, although execution and result are the same. In order to describe a command only once, independently from the controlling device, an asterisk (*) is used to substitute the root syntax. This auxiliary notation shortens the description, increases the readability and clarity, but still applies to all "User Defined" test setups.

Note: Chapter "User Defined Remote Control Commands" however covers the SCPI commands fully notated.

Example:

`(*):LOGic[:TYPE]`

Substitute the asterisk with the appropriate root syntax for remote control the respective R&S device; either with:

- the syntax for **R&S DigIConf**:

  `[:SOURce<hw>]:EBOX:USER:...`

- the syntax for **digital I/Q In (BBIN)** or **digital I/Q Out** of R&S signal generators:

  `[SOURce<[1]|2>:]BBIN:EXTernal:...`

  `[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:...`

- or with the syntax for **receiver** or **transmitter** of R&S signal analyzers:

  `[SOURce:]RECeiver:...`

  `[SOURce:]TRANsmitter:...`

Specific properties that relate to a particular instrument, are clearly expressed.

6.1.3 Main Configuration Dialog

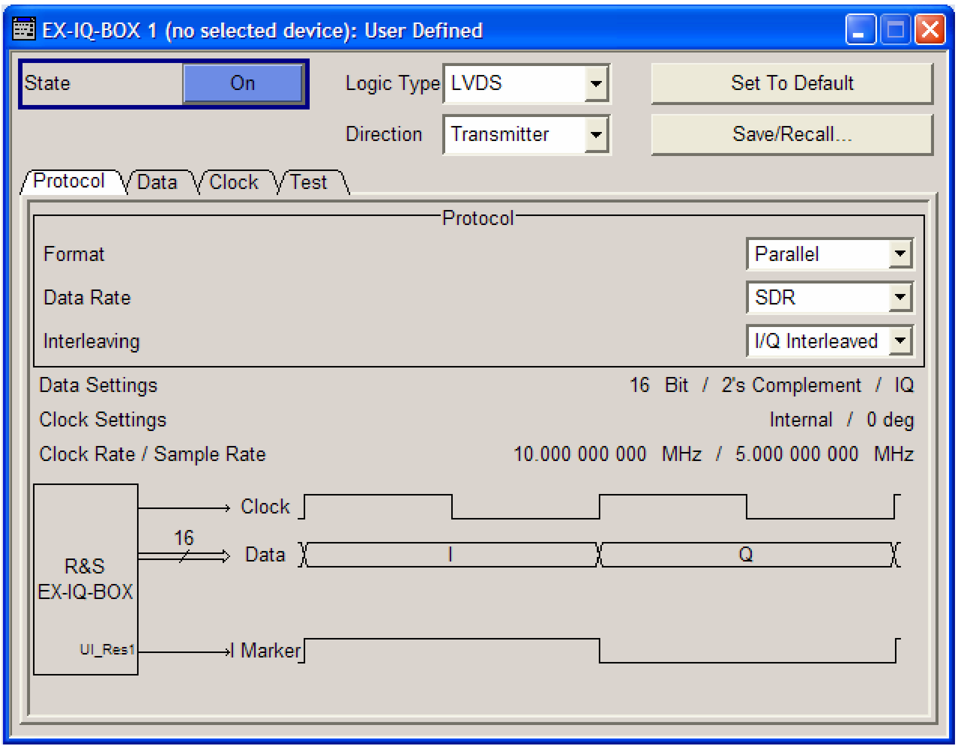
The main configuration dialog comprises the **main controls** as **Logic Type** of the signal, **Direction**, which contains the input types transmitter or receiver, **State** for activating, **Set to Default** for preset and **Save/Recall** for storing or loading previously defined settings. The main controls are always indicated, independently fom the active subdialog.

Grouped by function, the subdialogs **Protocol**, **Clock**, **Data** and **Trigger** cover the respective parameters. The settings are shown in the lower area graphically. I.e. the protocol panel shows the data stream, the data panel indicates the bit alignment, and the clock panel shows the direction of the clock signal in a block diagram. In the middle area of the protocol panel, the clock and data settings are displayed.

Device-specific dialog representation

R&S signal generators have own dialogs for signal input and output providing the protocol parameters. The direction field is not needed and therefore not existing. Clock and data parameters are also set in separate dialogs.

The following figure shows configuration dialog of R&S DigIConf, representative for all applications.



R&S DigIConf User Defined main dialog

6.1.3.1 State

Activate signal transmission.

This parameter applies to R&S DigIConf only.

Data transmission requires that the respective breakout board is connected.

Remote-control command:
`SOUR1:EBOX:USER:STAT ON`

6.1.3.2 Logic Type

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 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.

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

Note: For this setting, the SCPI notation lightly differs between the commands for generators or DigIConf and the commands for the analyzers. This notation is pointed out specially.

LVDS The signal is transmitted by using the signaling system LVDS (**L**ow **V**oltage **D**ifferential **S**ignaling).

Remote-control command:

`(*):LOG LVDS`

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.

Remote-control command:

`(*):LOG LVTTL`

3.3V CMOS The signal is transmitted by using the CMOS Technology (**C**omplementary **M**etal **O**xid **S**emiconductor) with a voltage level of 3.3 V.

Remote-control command:

`(*):LOG CMOS33` (DigIConf, generators)

`(*):LOG CM33` (analyzers)

2.5V CMOS

The signal is transmitted by using the CMOS Technology (**C**omplementary **M**etal **O**xid **S**emiconductor) with a voltage level of 2.5 V.

Remote-control commands:

`(*):LOGic CMOS25` (DigIConf, generators)

`(*):LOG CM25` (analyzers)

1.8V CMOS

The signal is transmitted by using the CMOS Technology (**C**omplementary **M**etal **O**xid **S**emiconductor) with a voltage level of 1.8 V.

Remote-control commands:

`(*):LOGic CMOS18`(DigIConf, generators)

`(*):LOGic CM18` (analyzers)

1.5V CMOS

The signal is transmitted by using the CMOS Technology (**C**omplementary **M**etal **O**xid **S**emiconductor) with a voltage level of 1.5 V.

Remote-control commands:

`(*):LOGic CMOS15` (DigIConf, generators)

`(*):LOGic CM15` (analyzers)

1.2V CMOS

The signal is transmitted by using the CMOS Technology (**C**omplementary **M**etal **O**xid **S**emiconductor) with a voltage level of 1.2 V.

Remote-control commands:

`(*):LOGic CMOS12` (DigIConf, generators)

`(*):LOGic CM12` (analyzers)

1.8 V SSI

The signal is transmitted by using the SSI Technology (**S**erial **S**ynchronuos **I**nterface) with a voltage levelof 1.8 V.

Remote-control commands:

`(*):LOG SSI` (DigIConf, generators)

`(*):LOG SS18` (analyzers)

2.8 V SSI

The signal is transmitted by using the SSI Technology (**S**erial **S**ynchronuos **I**nterface) with a voltage levelof 2.8 V.

Remote-control command:

`(*):LOG SSI28` (DigIConf, generators)

`(*):LOG SS28` (analyzers)

SSI technology

Signaling in the SSI technology is currently only available in R&S signal generators and analyzers. R&S DigIConf will support this logic type in a later release, too.

Different dialogs

The different technologies require different parameters. CMOS LVTTL and LVDS require, e.g. protocol, data and clock settings. SSI types in turn, provide dialogs with general and SPI setup settings.

6.1.3.3 Direction

Selects the direction of signal transmission from the DUT to R&S EX-IQ-BOX or 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 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 "Dialogs".

  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, the **direction** access field is not required for R&S signal generators.

  The transmission is activated by switching On the "State" button.

Transmitter (Output)

The connected R&S EX-IQ-BOX receives data from an R&S instrument and transmits this data to the DUT.

Remote-control command:

`(*):DIRection TRAN` (R&S DigIConf, R&S signal generators)

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:

`(*):SENDto` (R&S analyzers)

Receiver (Input) The connected R&S EX-IQ-BOX receives data from the DUT and transmits this data to an R&S instrument.

Remote-control command:

`(*):DIRection REC` (R&S DigIConf, R&S signal generators)

`(*):SENDto` (R&S analyzers)

6.1.3.4 Set To Default

Executes a default application setup. All parameters and switching states are preset (also those of inactive operating modes). The default application settings provide a reproducible initial basis for all other settings. Refer to table Preset - User defined default settings which contains an overview of the most important default settings.

Note: This parameter applies to R&S DigIConf.

Remote-control command:

`SOUR1:EBOX:USER:PRES`

6.1.3.5 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.

Notes:

- This parameter applies to R&S DigIConf.
- A settings file is always stored, or loaded with the extension *.iqbox. This file type cannot be changed.

Remote-control command:

`SOUR1:EBOX:USER:SETT:STOR "UserSett1.iqbox"`

`SOUR1:EBOX:USER:SETT:LOAD "D:/USER/Settings/UserSett1.iqbox"`

6.1.4 Protocol

The **Protocol** panel contains fundamental interface properties for signal transmission of the DUT to the R&S EX-IQ-BOX and vice versa.

6.1.4.1 Format

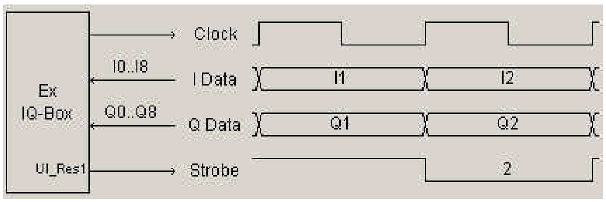
Sets the signal transmission protocol of the R&S EX-IQ-BOX for receiving/sending a baseband signal from/to an external device (DUT) via the user interface of the R&S EX-IQ-BOX.

Serial

Each sample is transmitted serially, i.e. **bitwise** from the DUT to the R&S EX-IQ-BOX or vice versa.

The currently set signal transmission is displayed graphically.

The following graph shows an example for an incoming serial I/Q signal from the DUT:



Using the serial protocol, I data and Q data are sent via the input and output pins IO and QO, respectively.

Remote-control command:

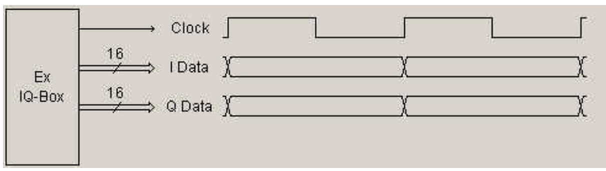
`(*):FORM SER`

Parallel

Each sample is transmitted parallel, i.e. **wordwise** from the DUT to the R&S EX-IQ-BOX or vice versa.

The graphical display shows the currently set signal transmission.

Example: parallel signal output to the DUT



The input and output pin assignment depends on the bits alignment and the bit order settings. The **Data** dialog shows the current assignment.

Remote-control command:

`(*):FORM PAR`

6.1.4.2 Data Rate

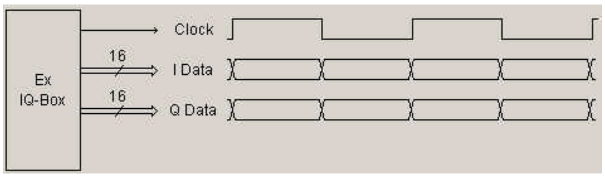
Sets the data rate mode of the R&S EX-IQ-BOX for receiving/sending a baseband signal from/to an external device (DUT).

SDR

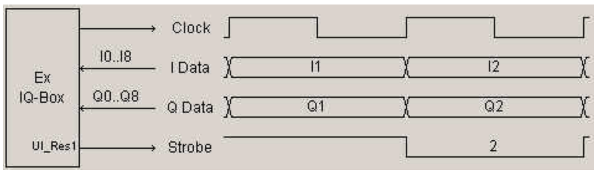
The baseband signal is transmitted in single data rate mode from the DUT to the R&S EX-IQ-BOX or vice versa. The data transmission is triggered by the rising edge of the data clock.

The characteristics of the signal transmission are shown in the graphic.

Example: parallel signal output in single data rate



Example: serial signal input in single data rate:



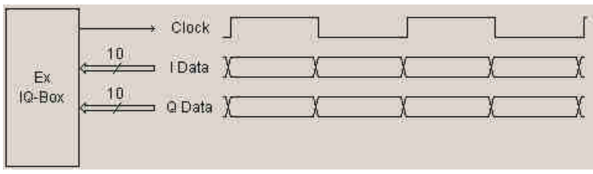
Remote-control command:

`(*):DRAT SDR`

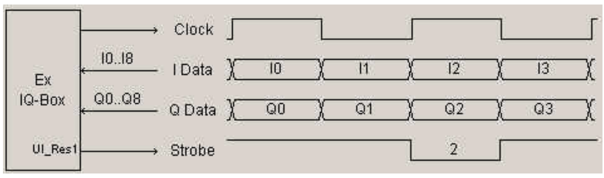
DDR

The baseband signal is transmitted in double data rate mode from the DUT to the R&S EX-IQ-BOX or vice versa. The data transmission is triggered by the rising edge and the falling edge of the data clock (double speed transfer).

The signal transmission is also shown in the graph. Example: parallel signal input in double data rate:



Example: serial signal input in double data rate:



Remote-control command:

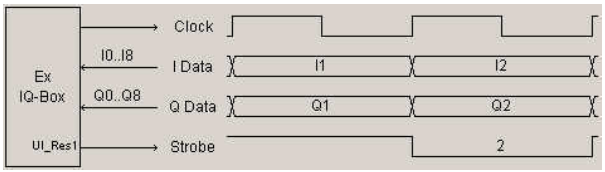
`(*):DRAT DDR`

6.1.4.3 Interleaving

Switches on or off interleaving and selects the interleaving mode.

Depending on the interleaving settings, the baseband signal is transmitted in different orders. The data is either sent simultaneously or in I/Q or Q/I order from the external device to the R&S EX-IQ-BOX or vice versa.

Not Interleaved The baseband signal is transmitted on the I and Q data lines as indicated in the graph below.



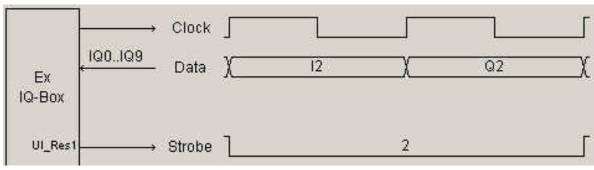
Remote-control command:

(*):ILE OFF

I/Q Interleaved The baseband signal is transmitted on the I data line starting with I data.

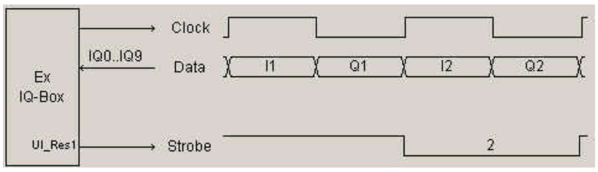
Serial transmission, SDR:

The strobe signal (UI_Res1) lasts for 2 clock cycles. With the first clock cycle the I data is triggered, the second cycle triggers the Q data.



Serial transmission, DDR:

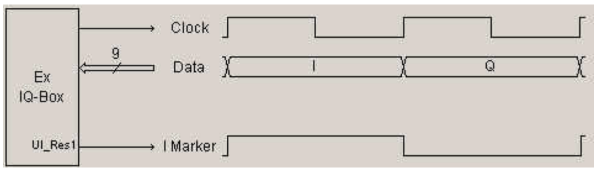
The strobe signal (UI_Res1) lasts for 1 clock cycle. The rising edge triggers the I data, the falling edge triggers the Q data.



I/Q Interleaved

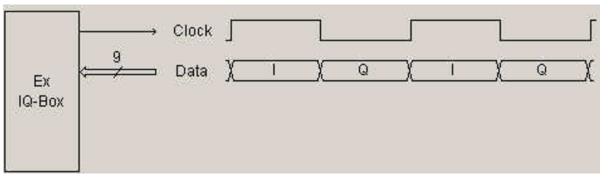
Parallel transmission, SDR:

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 triggers the Q data.



Remote-control command:

`(*):ILE IQ`

Q/I Interleaved

The baseband signal is transmitted 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.

Remote-control command:

`(*):ILE QI`

6.1.4.4 Data Settings

Displays the data parameters Word Size, Numeric Format and Signal Type. For the description of these parameters, see chapter "Data" on page 125, including "Word Size" on page 126, "Numeric Format" on page 128, and "Signal Type" on page 125.

6.1.4.5 Clock Settings

Indicates the current values of the Clock Source and the Clock Phase. For the description of these settings in detail, see chapter "Clock Source" on page 133 and "Clock Phase" on page 134.

6.1.4.6 Clock Rate / Sample Rate

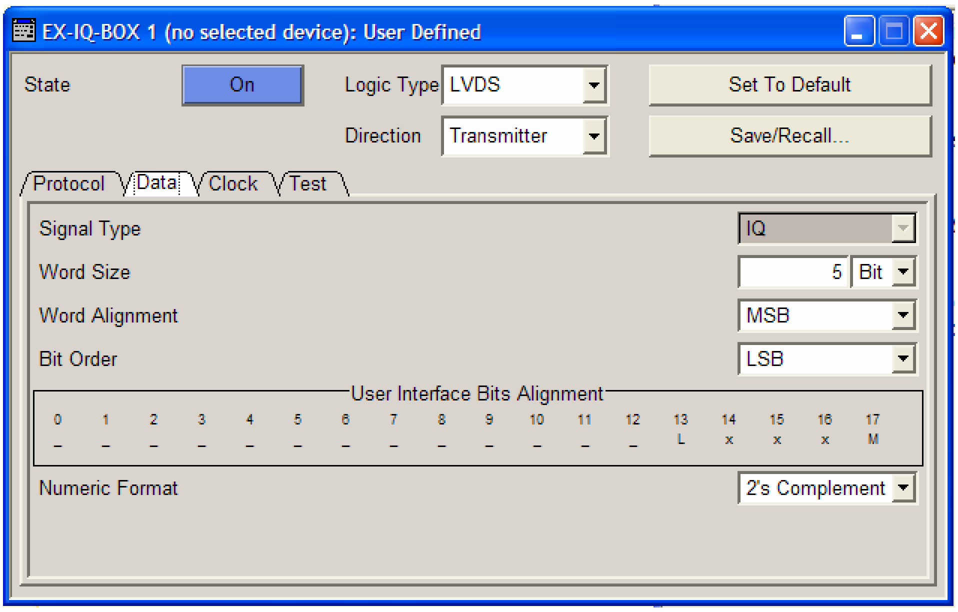
Displays the clock parameters Clock Rate and the calculated Sample Rate. Chapter "Clock Rate" on page 131 explains these parameters in detail.

6.1.5 Data

The **Data** panel contains parameters of data representation.

- **Parallel** signal transmission mode graphically displays the word alignment in the **User Interface Bits Alignment** section.

  Note: Analyzers do not support the graphical indication of data transmission.
- During serial data communication strobe parameters are enabled in the section **Serial Strobe**.



Note: A signal diagram is displayed in the protocol settings dialog, described in "Protocol" on page 121.

6.1.5.1 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).

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.

Remote-control command:

`(*):DATA:STYP IQ`

6.1.5.2 Word 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 16 bits. The R&S EX-IQ-BOX supports word sizes from 4 to 18 bits.

Remote-control command:

`(*):DATA:SIZE 8`

6.1.5.3 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.

Notes:

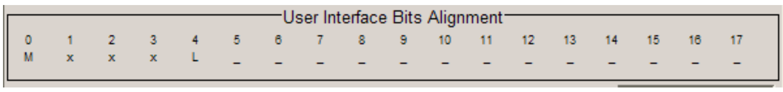
- This parameter is relevant for parallel data transmission.
- Graphics in the dialog of the generators and in R&S DigIConf shows the presently set word alignment in the **User Interface Bits Alignment** section.
-

MSB

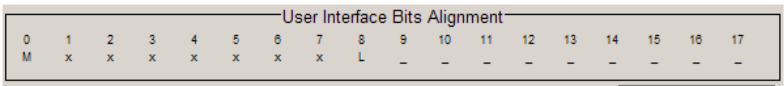
The MSB (**M**ost **S**ignificant **B**it) is mapped firmly to the same data line and the data line of the LSB varies in dependency of the word size.

Examples:

word size = 5, bit order = MSB



word size = 9, bit order = MSB



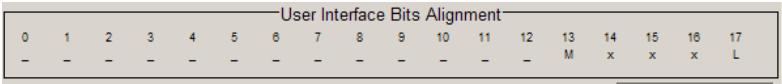
Remote-control command:

`(*):DATA:ALIG MSB`

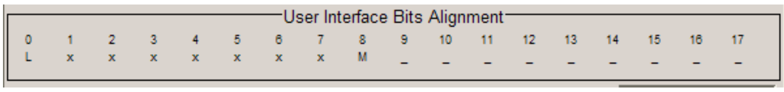
LSB The LSB (**L**ast **S**ignificant **B**it) is mapped firmly to the same data line and the data line of the MSB varies in dependency of the word size.

Examples:

word size = 5, bit order = MSB



word size = 9, bit order = LSB



Remote-control command:

`(*):DATA:ALIG LSB`

6.1.5.4 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.

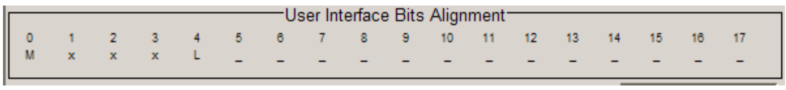
Parallel transmission:

The MSB is transmitted on the first used data line, depending on the word size and alignment.

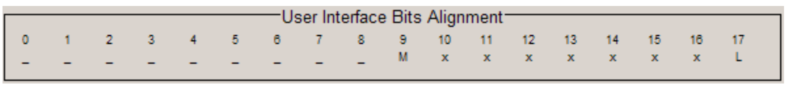
> **Note:** Graphics in the dialog of the generators and in DigIConf shows the presently set bit sequence.

Examples:

word alignment = MSB, word size = 5



word alignment = LSB, word size = 9



Serial transmission:

The MSB is transmitted first.

Remote-control command:

`(*):DATA:BORD MSB`

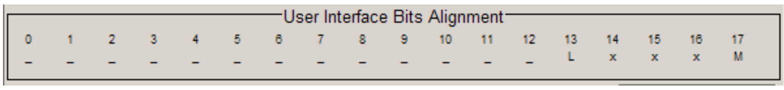
LSB Transmits the LSB (**L**ast **S**ignificant **B**it) first.

Parallel transmission:

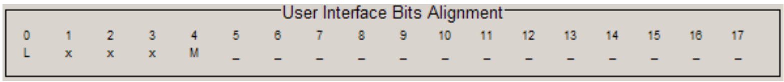
The LSB is transmitted on the first data line.

Examples:

word alignment = MSB, word size = 5



word alignment = LSB, word size = 5



Serial transmission:

The LSB (**L**ast **S**ignificant **B**it) is transmitted first.

Remote-control command:

`(*):DATA:BORD LSB`

6.1.5.5 Numeric Format

Select a numeric representation for data transmission.

Allowed number range for word size n Bit:

$-2^{n-1} \leq n \leq +2^{n+1}$

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:

$+2^{n-2}$ ... $+2^{0}$

Remote-control command:

`(*):DATA:NFOR TCOM`

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.

Remote-control command:

`(*):DATA:NFOR OBIN`

Example:

n = 4 → -8 ≤ z < 8

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

The **Serial Strobe** section covers the strobe parameters that are relevant for serial signal transmission.

6.1.5.6 Strobe Polarity

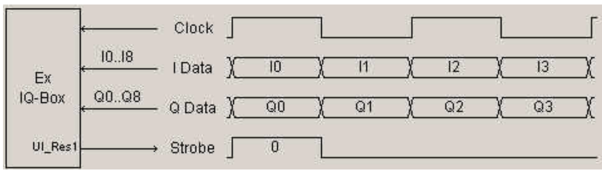
Describes the polarity of the strobe marker signal. During a serial data transmission every data sample is marked by the strobe marker signal.

Note: This parameter is relevant for serial data transmission.

The strobe marker is output at the UI_GP5 of the user interface.

The settings of **Clock Phase** or **Clock Skew do not affect** the strobe marker signal.

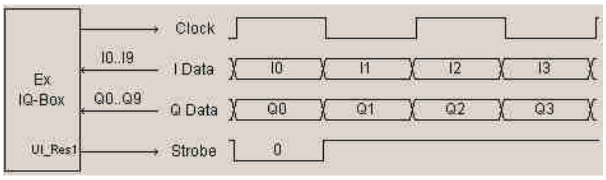
Positive The strobe position is indicated by high level, as displayed in the graph.



Remote-control command:

`(*):DATA:POL:SPOL POS`

Negative The strobe position is indicated by low level, which is also shown in the graph.



Remote-control command:

`(*):DATA:POL:SPOL NEG`

6.1.5.7 Strobe Position

Sets the sample position of the strobe marker output.

The strobe marker is output at the UI_GP5 of the user interface.

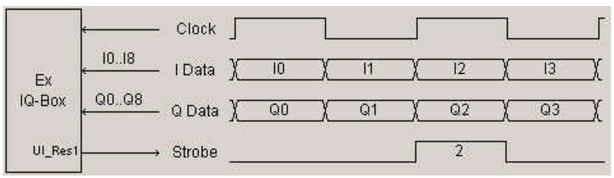
Value range: 0 to word size -1.

Notes:

- This parameter is relevant for serial data transmission.
- The graphic in the clock dialog of the generators and in R&S DigIConf shows the presently set sample position.

Example:

strobe position = 2, strobe polarity = Positive.

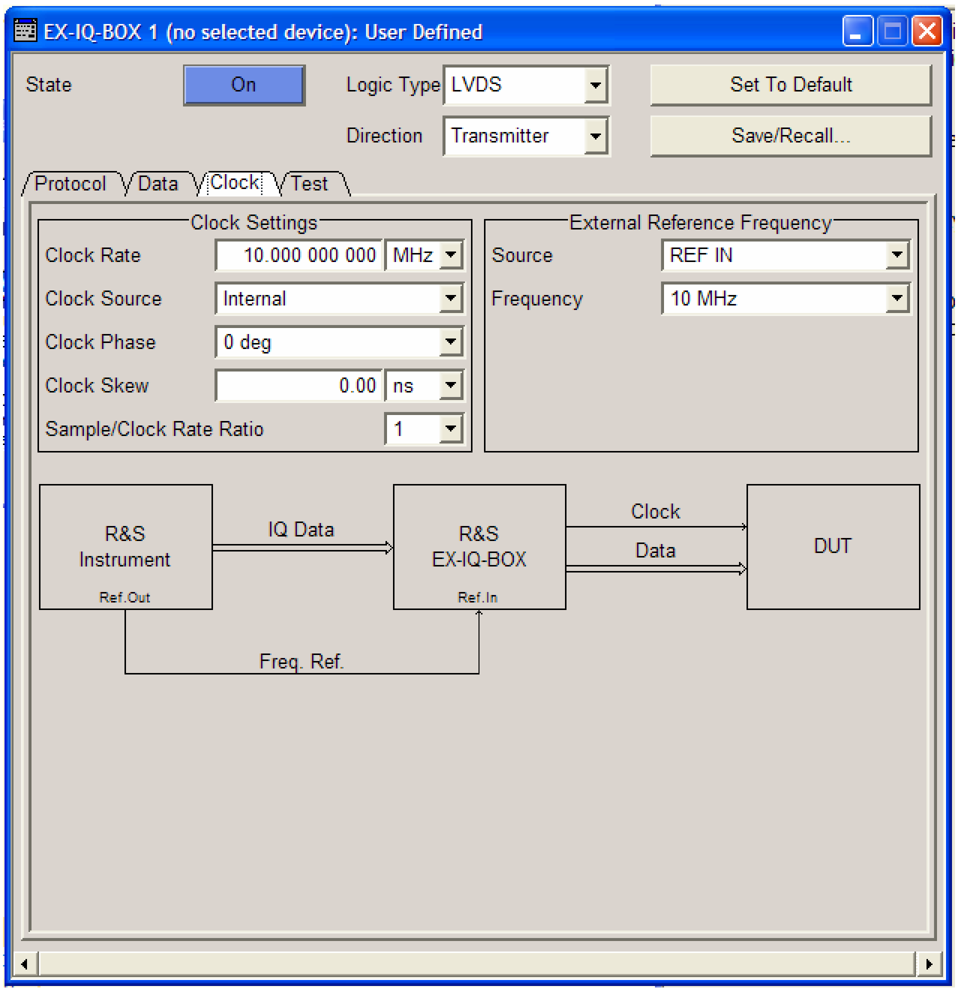


Remote-control command:

`(*):DATA:POL:SPOS 10`

6.1.6 Clock

The **Clock Setup** panel/section contains clock parameters for data transmission.



Note: 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.

6.1.6.1 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.

$f_{CLK} = (f_s \cdot WS \cdot Int) / (DDR \cdot SCR)$

Value range of f_{CLK}

		Value range	
f_s =	Sample rate	1 kHz ... 100 MHz	
f_{CLK} =	Clock rate	**LVTTL:** 1 (25) kHz - 400 MHz*)	**LVDS:** 1 (25) kHz - 100 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 is valid for the internal clock source, fed in from the R&S instrument, 25 kHz is valid for the external reference from the user interface.

Remote-control command:

`(*):CLOC:RATE 100MHZ`

The value range of the clock rate depends on **Protocol**, **Logic Type** and **Signal Type** settings.

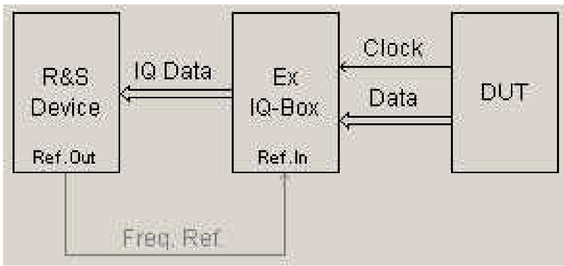
6.1.6.2 Clock Source

Selects the clock source for data transmission. Either the R&S instrument or the external device (DUT) can be set for delivering the reference, irrespective of the direction of transmission.

Currently the following scenarios for data transmission are possible:

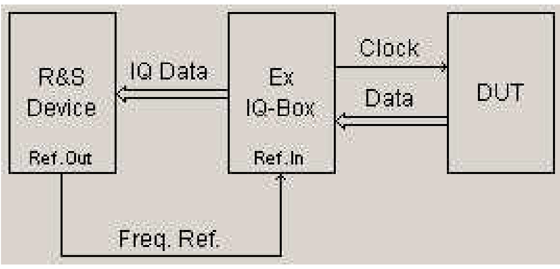
- Signal **input** by using an **external** clock source.

  Data and data clock are transmitted from the external device, as shown in the graph of the Clock Setup dialog.



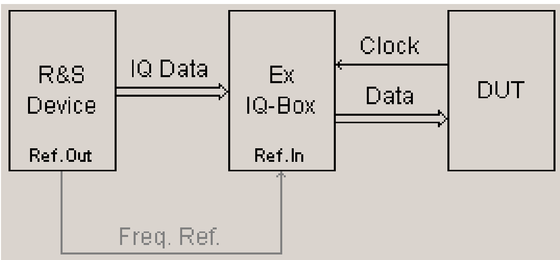
- Signal **input** by using the **internal** clock source.

  The clock source of the R&S instrument is sent to the external device for triggering the data input to the R&S EX-IQ-BOX.



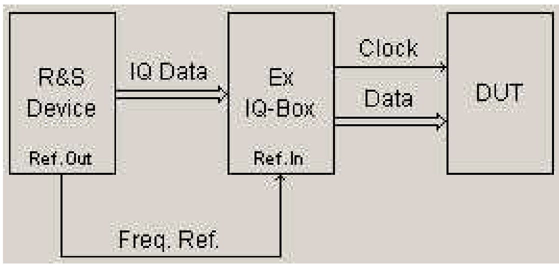
- Signal **output** by using an **external** clock source.

  Synchronized by an external data clock, data are output from the R&S instrument.



- Signal **output** by using the **internal** clock source.

  Data and data clock are delivered from the R&S instrument.



Internal (BNC REF IN)
The BNC reference of the frequency input is used. The R&S EX-IQ-BOX sythesizes 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 (see Rear Panel View). The connection can be kept during the entire operation even if an external clock reference is used.

Remote-control command:
`(*):CLOC:SOUR INT`

External (User Interface)
The clock reference is fed in from the external device (DUT) to the user interface of the R&S EX-IQ-BOX.

Remote-control command:
`(*):CLOC:SOUR EXT`

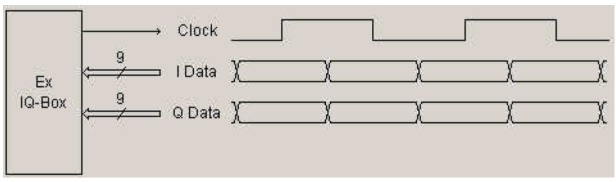
6.1.6.3 Clock Phase

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: clock phase 90°



> **Note:** For this setting, the SCPI notation lightly differs between the command for generators or DigIConf and the command for the analyzers. This notation is pointed out specially.

Remote-control command:
`(*):CLOC:PHAS 90` (DigIConf, generators)
`(*):CLOC:PHAS P90` (analyzers)

6.1.6.4 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.

Value range: -5 ns ... + 5 ns

Remote-control command:

`(*):CLOC:SKEW 2.5NS`

6.1.6.5 Sample / Clock Rate Ratio

Sets the sample to clock rate ratio. This parameter characterizes the ratio of the sample rate to the clock rate.

Note: This parameter is relevant for parallel signal transmission.

For SCR < 1:

- Dummy samples are added.
- The signal SCR_VALID output at the Reserved0 pin (UI_RESERVE_P0) of the user interface marks the validity of the data.

Values: SCR = 1, 4/5, 2/5, 1/5, 1/10, 1/20

Notes:

- The values of the sample/clock rate depend on the parameter settings of **Word Size**, **Interleaving** and **Data Rate**. See also "Clock Rate" on page 131.
- For this setting, the SCPI notation lightly differs between the command for generators or DigIConf and the command for the analyzers. This notation is pointed out specially.

Remote-control command:

`(*):CLOC:SCR SCR4D5` (R&S DigIConf, R&S signal generators)

`(*):CLOC:SCR 0.8` (R&S signal analyzers)

The **External Reference Frequency** section covers the reference frequency parameters that are relevant when the internal clock source is used.

6.1.6.6 Source

Selects the input connector for an external reference frequency.

If the clock source is set to internal, the R&S EX-IQ-BOX synthesizes the clock frequency and outputs this clock to the user interface. In this operating mode, the internal synthesizer requires a reference frequency from the R&S instrument.

> **Note:** This parameter applies to R&S DigIConf and ios relevant for the internal clock source.

Currently the input of the reference frequency is firmly set to EXTernal. The signal is fed into the R&S EX-IQ-BOX at the BNC connector REF IN on the rear panel.

The required reference frequency input is also indicated in the graphic of the clock dialog.

Remote-control command:

`(*):CLOC:REF:SOUR EXT`

6.1.6.7 Frequency

Defines the frequency value of the reference clock.

> **Note:** This parameter applies to R&S DigIConf 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.

Remote-control command:

`(*):CLOC:REF:FREQ 5MHZ`

6.1.7 Trigger

6.1.7.1 Trigger Source

At the moment no help information is available to this functionality, it will be explained in the next release.

6.1.7.2 Trigger Delay

At the moment no help information is available to this functionality, it will be explained in the next release.

6.1.7.3 Arm

At the moment no help information is available to this functionality, it will be explained in the next release.

6.1.8 Test

The Test tabs enable to check the data interface, i.e. the User Interface of the R&S EX-IQ-BOX to the DUT or vice versa.

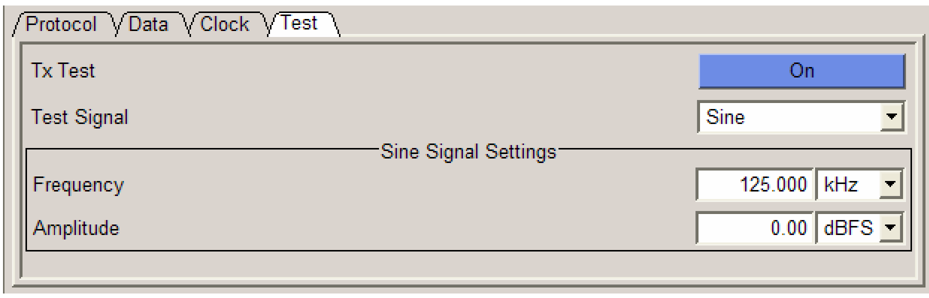
Note: Prior to any measurements regarding the I/Q signal, we recommend that you prove the function of the data interface itself.

The R&S EX-IQ-BOX provides both, a test signal generator and a test receiver with the capability of BER measuring.

The test dialog changes depending on the data direction at the user interface. 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 "TX-Test" on page 137, and to "Rx- Test" on page 140, respectively.

6.1.9 TX-Test

This section comprises the parameters for testing in transmitter mode.



6.1.9.1 Tx Test

Switches the test generator on or off.

While the test generator is switched on, the I/Q data source coming from DIG IQ IN is replaced by the test signal.

Remote-control command:

`SOUR1:EBOX:USER:TEST:TX:STAT ON`

6.1.9.2 Test Signal

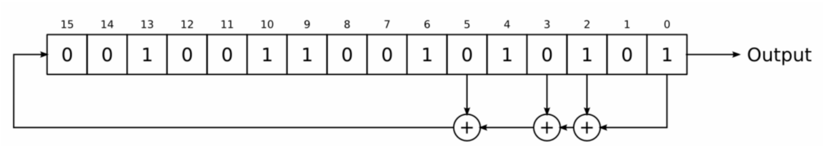
Selects a test signal of the test generator. Three different signals are available.

PRBS A PRBS 16 (**P**seudo **R**andom **B**inary **S**equence) sequence is generated. The output of this sequence is according to the **protocol**, **data** and **clock** settings of the R&S EX-IQ-BOX

E.g. if the I/Q sample is set to a word size of 7 bits, then the PRBS 16 sequence is output in pieces of 7 bits.

The I and Q values always contain the same copy of one test sample.

The PRBS 16 sequence is fully described by the generator polynomial $G(x) = 1 + x^2 + x^3 + x^5 + x^{16}$. The functional implementation of this PRBS generator is also defined by the following linear feedback shift register (LFSR):



Remote-control command:

`SOUR1:EBOX:USER:TEST:TX:SIGN PRBS`

Counter A counter test signal is generated. The counter size is adjusted to the word size of the **data** settings. Each output sample the counter value will be incremented by 1.

Remote-control command:

`SOUR1:EBOX:USER:TEST:TX:SIGN COUN`

Sine A complex sine signal is generated, following the formula below:

$$s(n) = e^{j2\pi \frac{f}{f_s} n} = \cos\left(2\pi \frac{f}{f_s} n\right) + j\sin\left(2\pi \frac{f}{f_s} n\right)$$

The real component is

$$I(n) = \cos\left(2\pi \frac{f}{f_s} n\right)$$

and the imaginary component is

$$Q(n) = \sin\left(2\pi \frac{f}{f_s} n\right)$$

Here, **n** is the discrete time index, **f** is the frequency of the test sine signal, and $\mathbf{f_s}$ is the sampling frequency that results from the settings in the sections **protocol**, **data** and **clock**.

Remote-control command:

`SOUR1:EBOX:USER:TEST:TX:SIGN SINE`

6.1.9.3 Frequency

Sets the frequency of the sine test signal. The frequency is limited to **0.4** $\mathbf{f_s}$, and the sampling frequency $\mathbf{f_s}$ depends on the clock settings, the double data rate setting and the interleaving mode.

Note: This parameter applies to the sine test signal.

Remote-control command:

`SOUR1:EBOX:USER:TEST:TX:SINE:FREQ 100KHZ`

6.1.9.4 Amplitude

Sets the amplitude of the sine test signal in terms of dBFS. The maximum amplitude is full scale (0 dBFS).

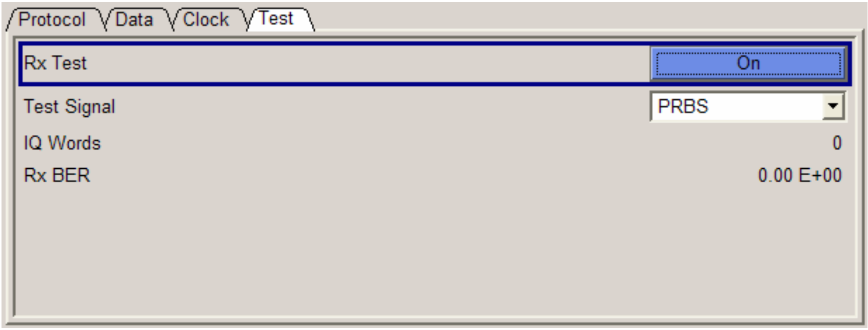
Note: This parameter applies to the sine test signal.

Remote-control command:

`SOUR1:EBOX:USER:TEST:TX:SINE:AMPL -50DBFS`

6.1.10 Rx- Test

This section comprises the parameters for testing in receiver mode.



6.1.10.1 Rx Test

Switches the test receiver on or off.
The R&S EX-IQ-BOX expects a test signal to be input at the user interface. After switching on, the test receiver synchronizes to the last received data word. From that time onward, the test receiver generates its own test sequence and compares each generated sample with the corresponding received sample.

Remote-control command:
`SOUR1:EBOX:USER:TEST:RX:STAT ON`

6.1.10.2 Test Signal

Selects the expected test signal to be analyzed.

The test receiver can analyze PRBS 16 or counter test signals.

Remote-control command:
`SOUR1:EBOX:USER:TEST:RX:SIGN COUN`

6.1.10.3 IQ Words

Indicates the total number of received words. This functions consecutively counts the number of received words in order to compare them with the sent data and to determine the error rate.

Remote-control command:
`SOUR1:EBOX:USER:TEST:RX:WORD?`

6.1.10.4 Rx BER

Displays the bit error rate. 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.

Remote-control command:
`SOUR1:EBOX:USER:TEST:RX:BER?`

6.2 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 chapters "Main Configuration Dialog" on page 160, "Hardware" on page 163, "Downlink and Uplink" on page 172, "Control & Management" on page 195, "Vendor Data" on page 200, and "Test & Diagnostics" on page 202.

Note: You also find a panel "ARB Settings" on page 208 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 "Start with CPRI - Setup Example" on page 152 for information on this application example.

CPRI parameter settings are set by means of the configurator software R&S DigIConf. Chapter R&S DigIConf Configuration Software comprises the description of R&S DigIConf in detail.

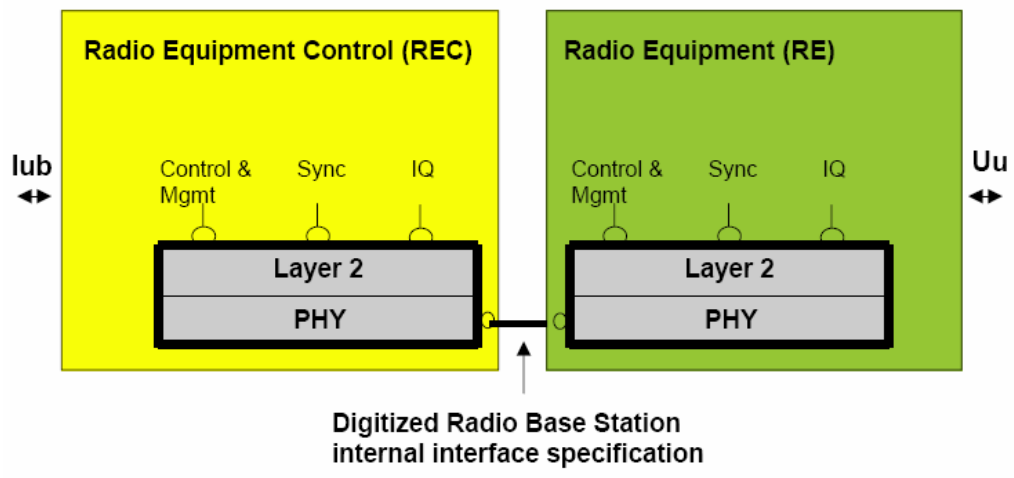
The CPRI transmission protocol option, as well as the options for Waveform Memory, Multi Waveform Playback and Recording Memory require the R&S EX-IQ-BOX **1409.5505K04** and the configuration software R&S DigIConf.

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

6.2.1 Introduction

CPRI™ (**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.



R&S provides this standardized protocol by a special purpose option for the R&S EX-IQ-BOX, i.e. option R&S EXBOX-B85.

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 "Installing R&S EX-IQ-BOX Options".

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.

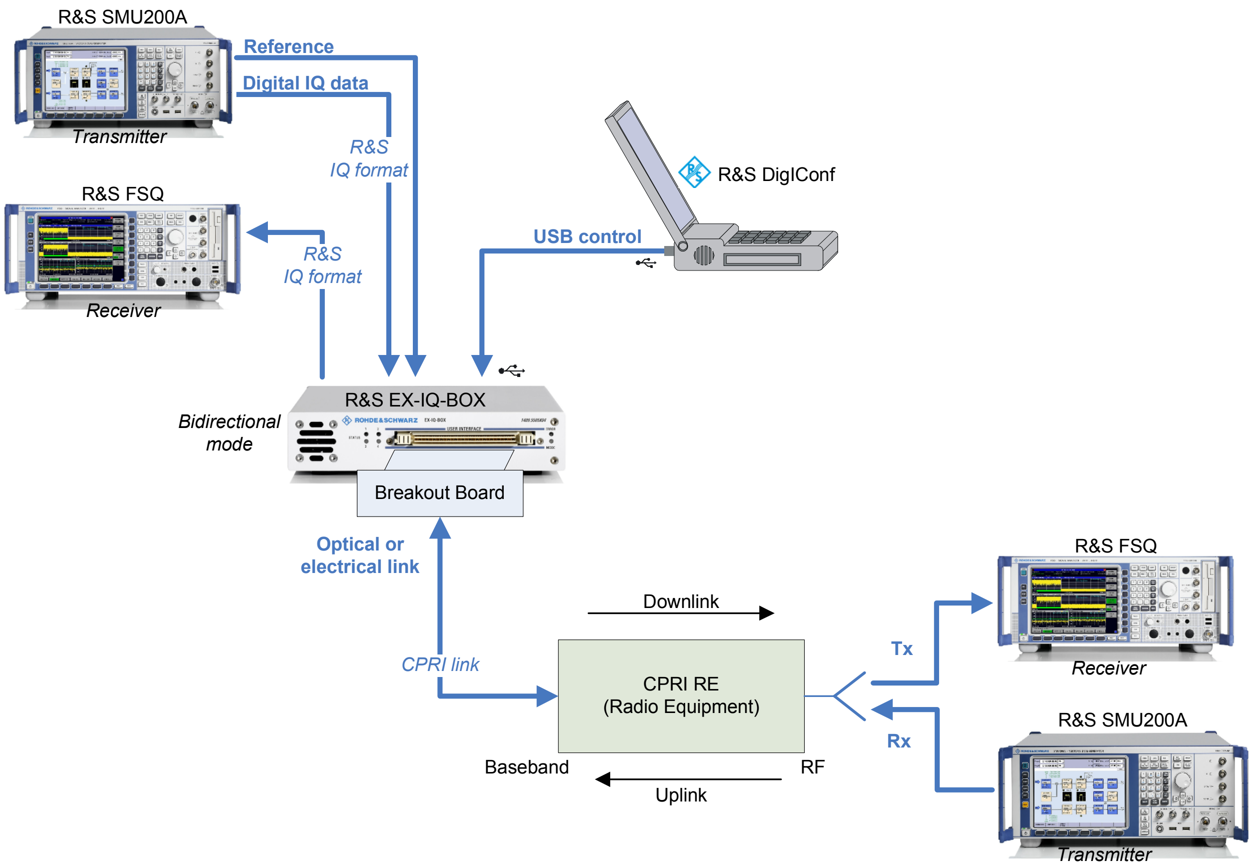
For information on connection of a test setup example, refer to "Start with CPRI - Setup Example" on page 152.

The option R&S EXBOX-B85 enables performing 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.

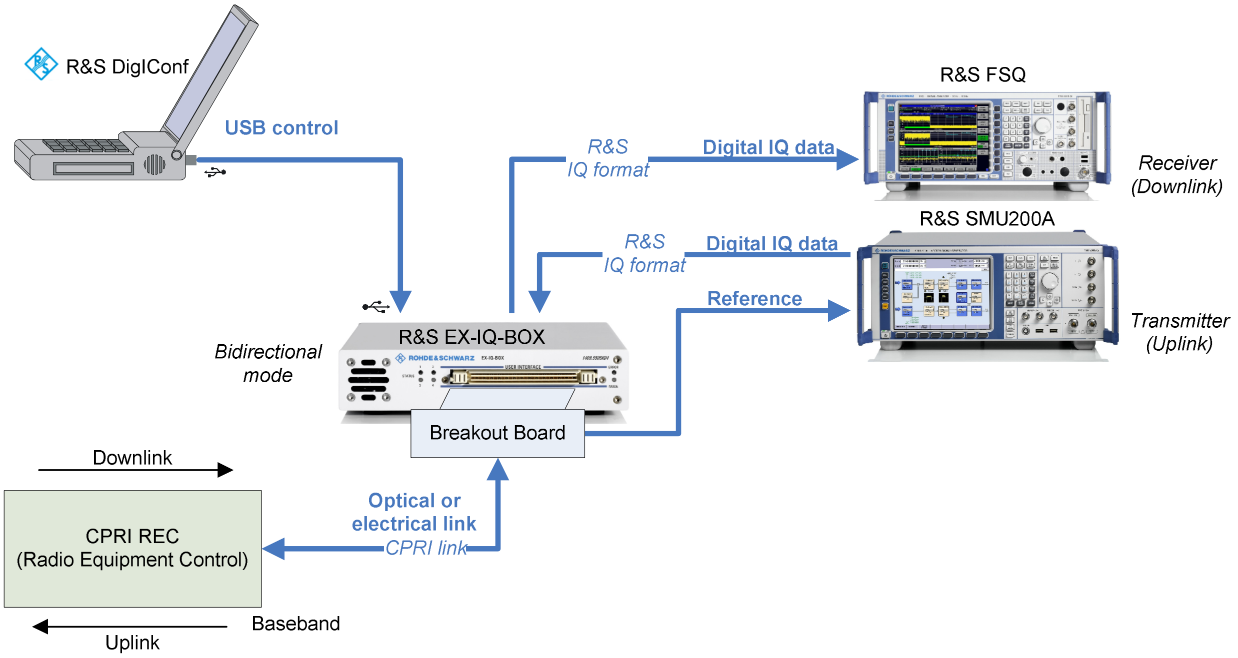
In combination with R&S signal generators and R&S spectrum analyzers, the R&S EX-IQ-BOX utilizes the enhanced functions of the signal generators, like e.g. generation of digital communication signals, fading and AWGN simulation, and the signal analysis features of the spectrum analyzers, like e.g. EVM 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.



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.

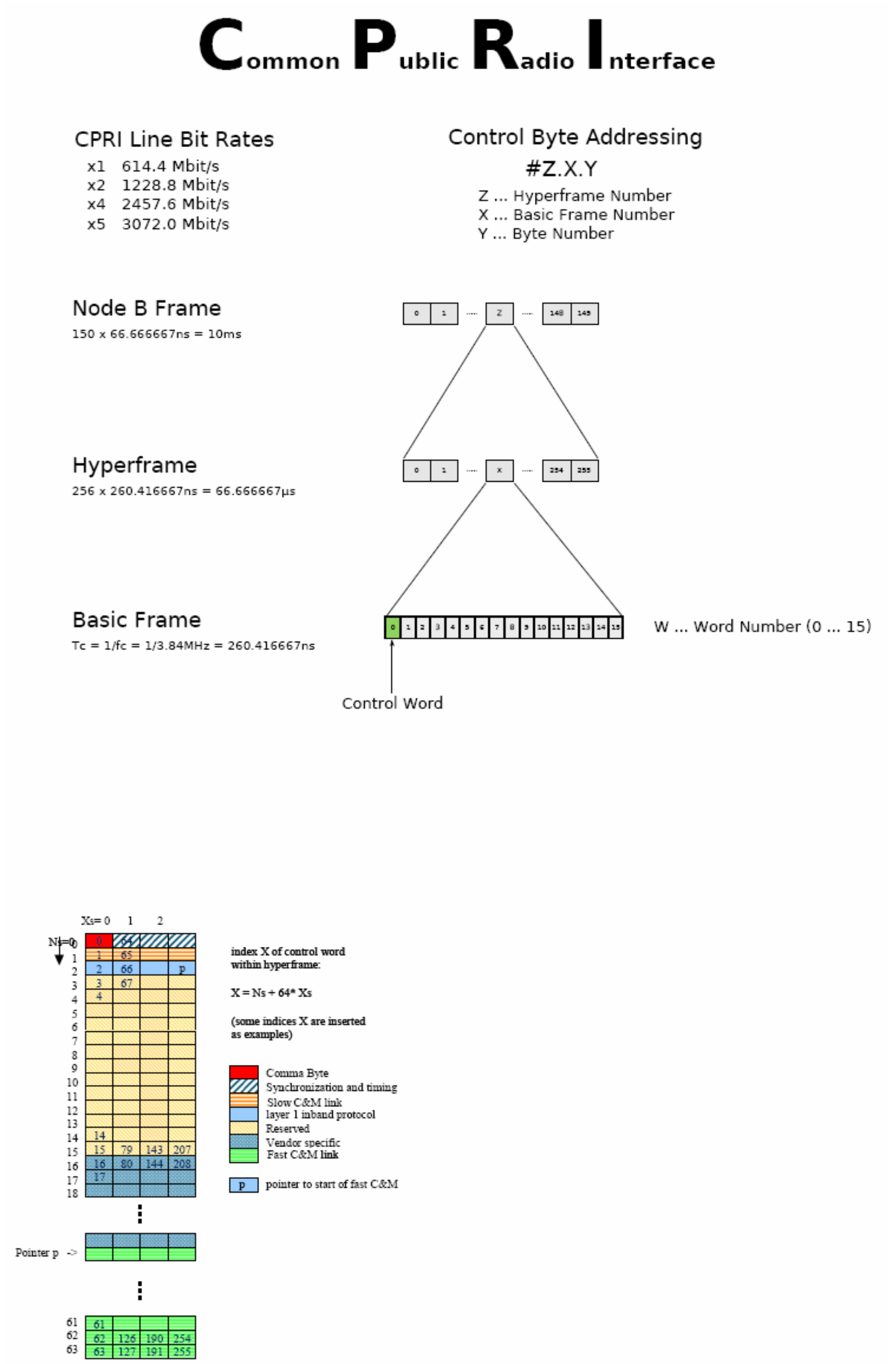
The following application example shows a CPRI **REC** test scenario, with the R&S EX-IQ-BOX emulating the RF module **RE**.



Also in this test setup, DL and UL either can be tested at simultaneously, i.e. full duplex, or Uplink/Downlink individually.

6.2.2 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.



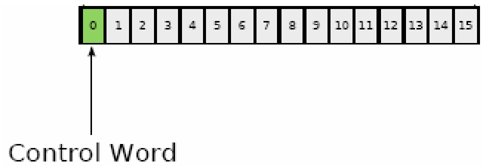
Frame structure of the CPRI transmission protocol

6.2.2.1 Short Description of the CPRI Frame Structure

This segment briefly describes some basic features and the structure of CPRI, as shown in "Frame structure of the CPRI transmission protocol" on page 145.

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.

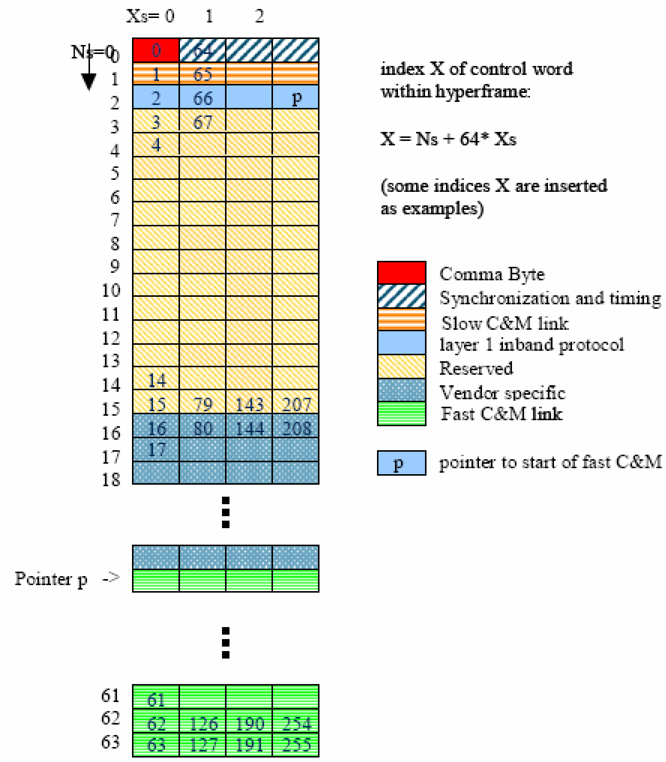
256 basic frames form the **CPRI hyper frame**. Each hyper frame contains 256 control words, which in turn form one **control block**.

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:



Organization of the control words in subchannels

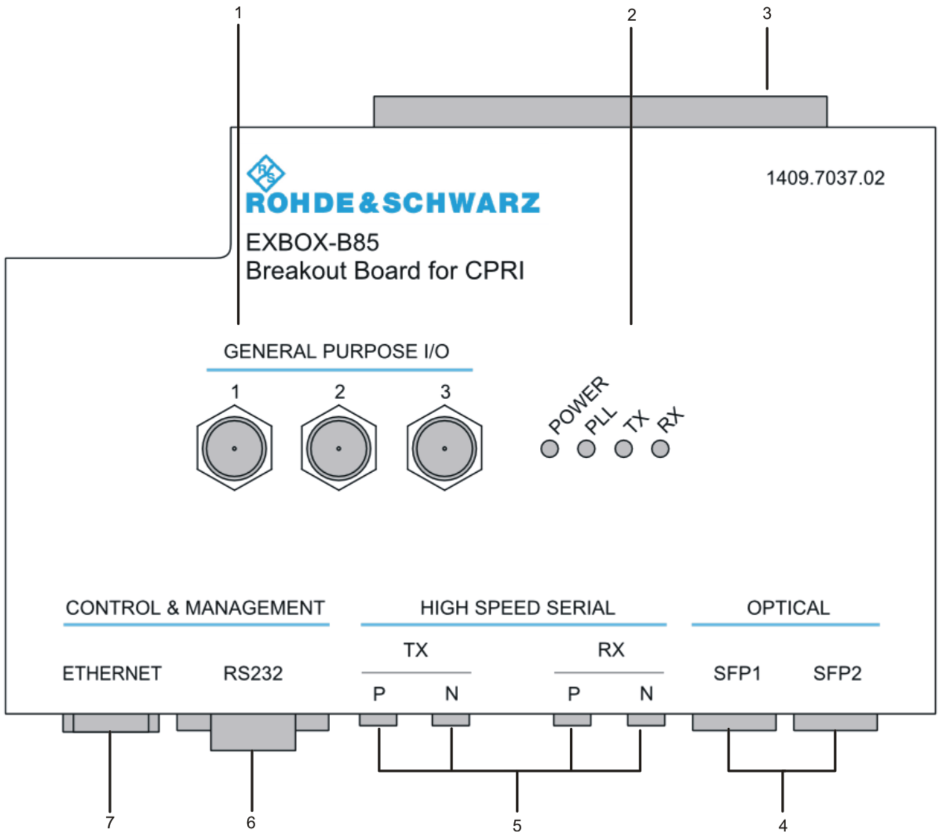
6.2.3 Parameter Overview

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.
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

6.2.4 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.

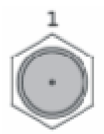


Schematic view of the CPRI breakout board, option R&S EXBOX-B85

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.

1 "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 (**R**emote **R**adio **H**ead) 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.

2 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.	-	-

Notes: 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.

Rear Panel

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.

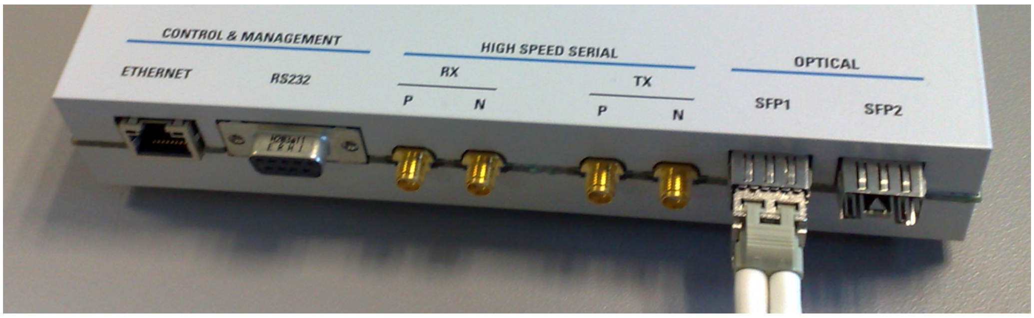
3 User Interface

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 Z-Dok Adapter Board connector

Front Panel

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.



Front panel view

4 "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.

5 "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 "SMA Settings" on page 168 to activate the interface and to set the corresponding parameters.

6 "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.

Notes:

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 "Slow C&M (HDLC)" on page 195.

7 "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 "Fast C&M (Ethernet)" on page 198.

6.2.5 Start with CPRI - Setup Example

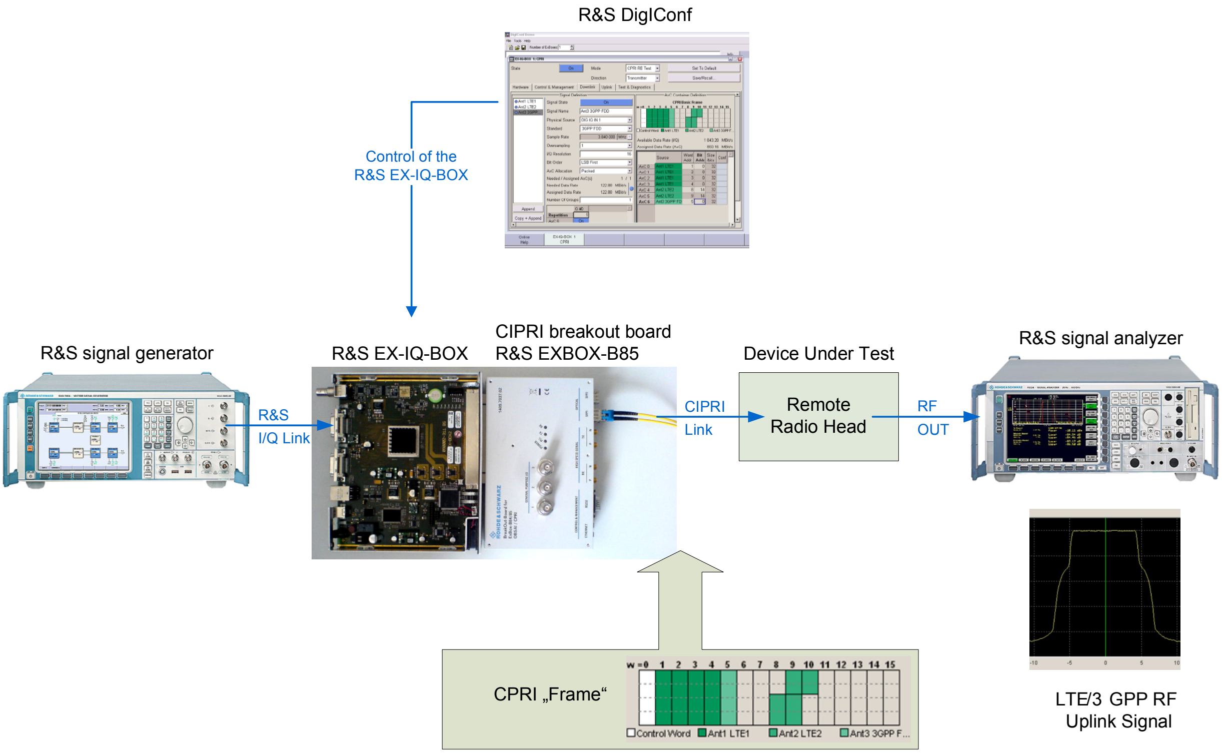
This section describes a **RE** (**R**adio **E**quipment) test setup for testing **RRH** (**R**emote **R**adio **H**ead) with the CPRI transmission protocol in downlink mode.

Note: 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 "Connecting the R&S EX-IQ-BOX" in the Quick Start Guide.

Note: You find a detailed explanation of the CPRI parameter settings under "Main Configuration Dialog" on page 160, and the following chapters.

6.2.5.1 Overview



Setup 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.

6.2.5.2 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

6.2.5.3 Setup of the Devices

Cabling

- 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.
- Connect the CPRI breakout board to the R&S EX-IQ-BOX, i.e. at the Z-Dok user interface connector.

  Note: The R&S EX-IQ-BOX powers the CPRI breakout board via the user interface.
- 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.

  Note: Currently, the interface DIG IQ IN/OUT 1 is firmly set to input.
- 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.
- Connect the USB cable plug A to the PC, and plug B to the R&S EX-IQ-BOX (USB IN)
- Plug the SFP module into the SFP cage on the breakout board
- Connect the power supply to the RRH.
- Establish the optical connection between the breakout board and the RX/TX input of the RRH.
- Connect the RF output of the RRH, i.e. the RRH antenna with the analyzer's RF input.

  Note: Ensure 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.

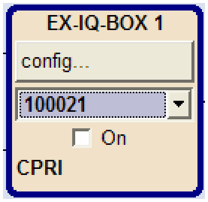
Setting the R&S Signal Generator

- Preset the R&S signal generator.
- Set reference frequency on externally, as the reference frequency is fed in from the signal analyzer.
- Activate the test signal, e.g. 3GPP FDD in the respective baseband block.
- Set the sample rate of the digital signal output according to the settings in R&S DigIConf, i.e. 7.68 MHz.
- Set the sample rate of the digital signal output to 7.68 MHz in User Defined mode.

Setting the CPRI Protocol

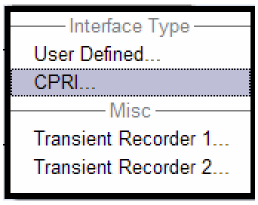
- Start the R&S DigIConf software on the PC.

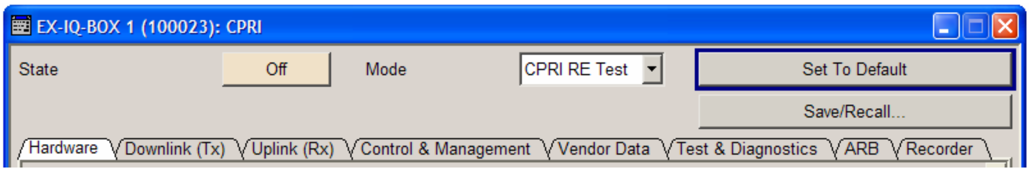
  R&S DigIConf recognizes connected R&S EX-IQ-BOX devices and indicates their IDs in the selection list below the config button in the block diagram.



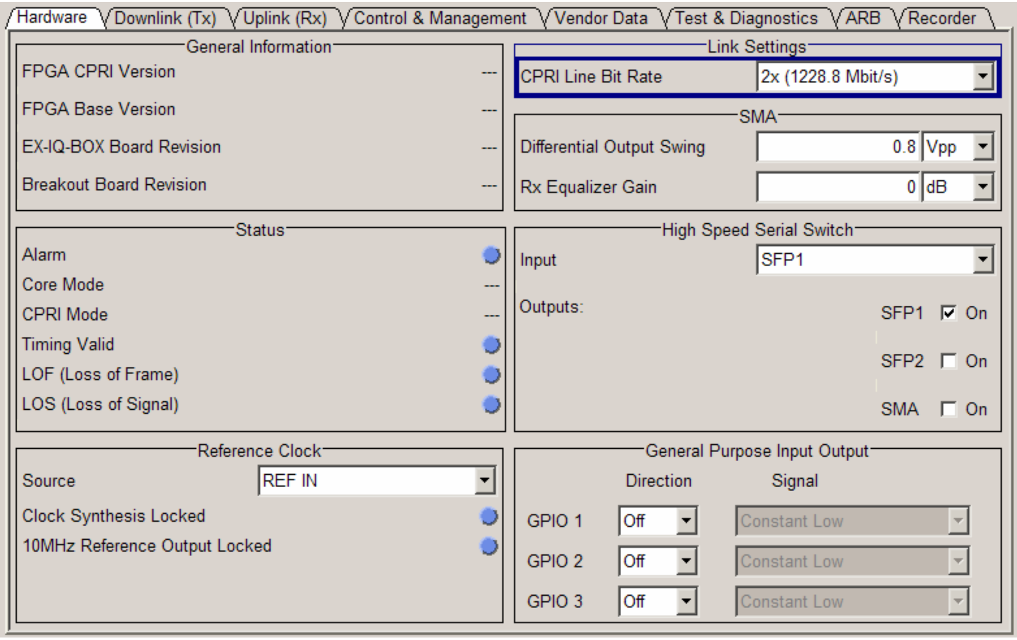
- Select the respective R&S EX-IQ-BOX.

- Press the "config..." button and open the CPRI settings dialog.

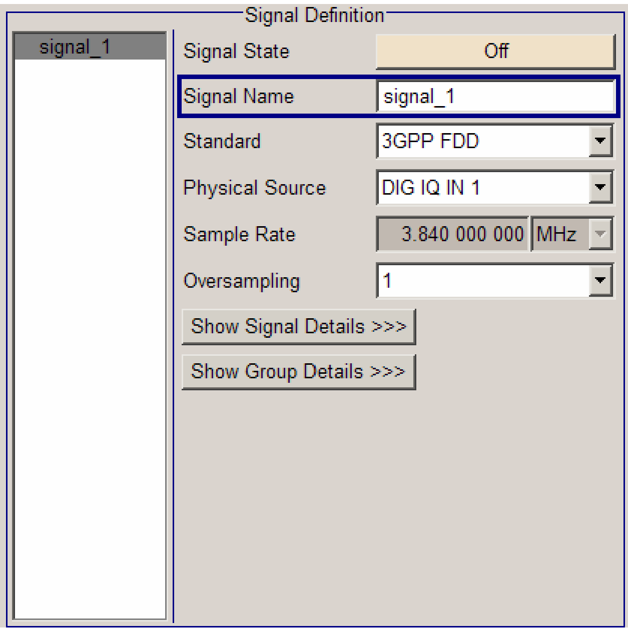




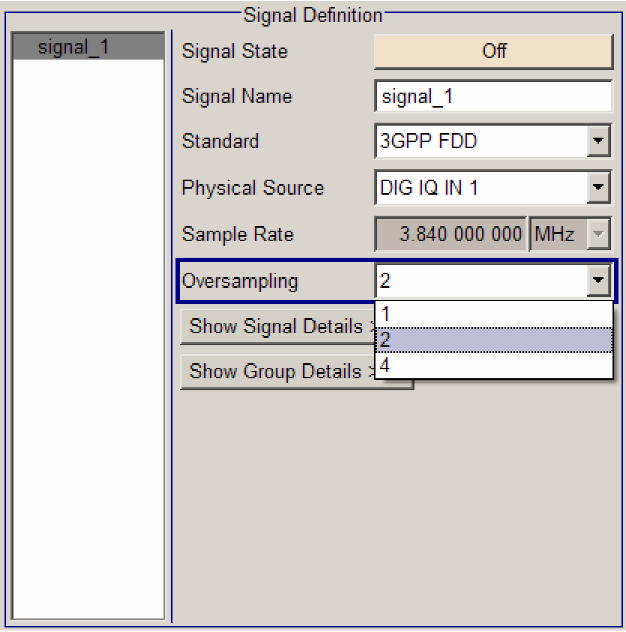
- Execute "Set to Default" for starting in a defined state.



- Select the appropriate outpt port in the "Hardware" panel, and set the CPRI Line Bit Rate, the SFP connection supports.
- Switch to the "Downlink" panel, and select the 3GPP FDD signal.



- Set Oversampling to 2



Note: The sampling rate and oversampling correspond to the incoming 3GPP FDD signal:

$\text{SampleRate}_{\text{EXIQBOX}} * \text{Oversampling} = \text{Sample Rate}_{\text{Generator}}$

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.

- Switch on "Signal State", and "State".
- 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 devices and the respective tools and utilities.

Setting the R&S Signal Analyzer

- Preset the R&S signal analyzer.
- Set it to center frequency 2.5 GHz, corresponding to the carrier frequency of the DUT.
- Set Span 20 MHz, and set Level +10 dBm.

6.2.5.4 Measuring process

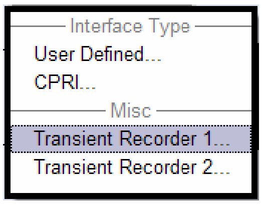
If the CPRI link is active, and the RRH transmits the signal correctly, all LEDs on the breakout board are green.

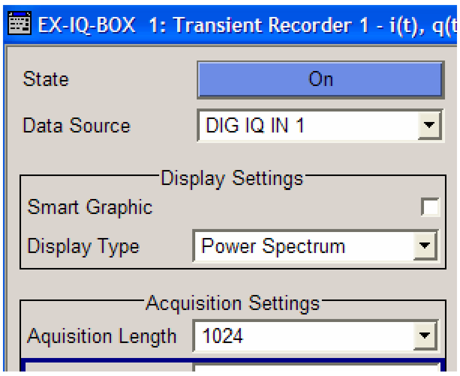
Measuring the I/Q Signal

Check signal output

To see if the signal is properly transmitted, the transient recorder function records the signal and displays it graphically.

- Switch on the Transient Recorder of the active R&S EX-IQ-BOX.

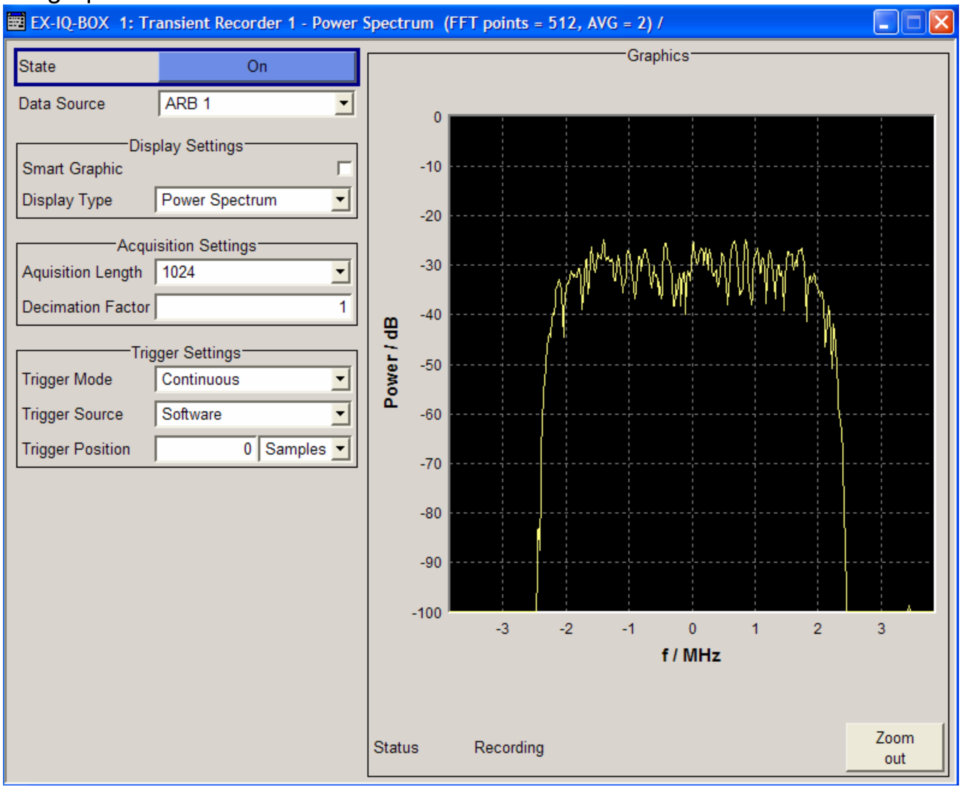




To capture the digital I/Q signal, set:

- Data Source: Dig IQ IN 1
- Display Type: Power Spectrum
- Aquisition Length: 1024

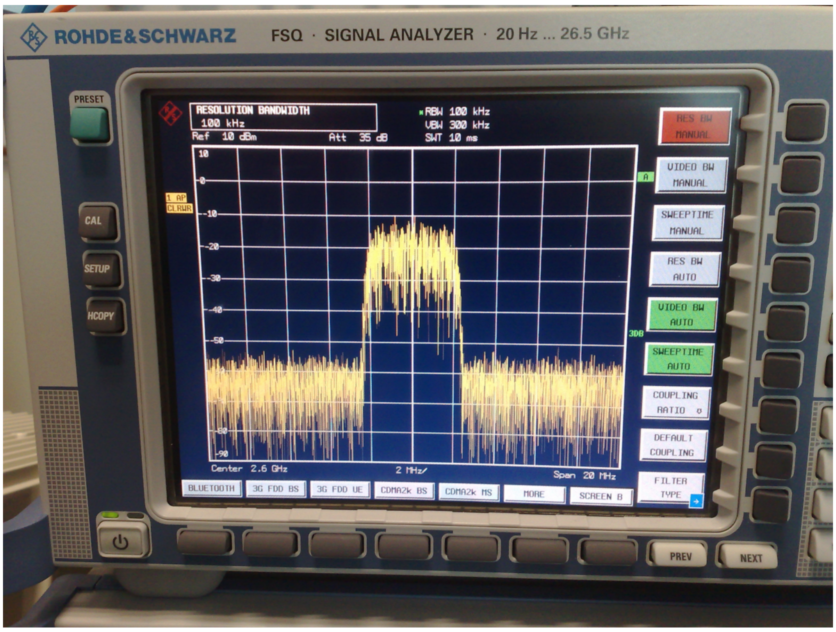
The Recording Memory records the signal data and displays the 3GPP FDD signal in the graphics window.



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.

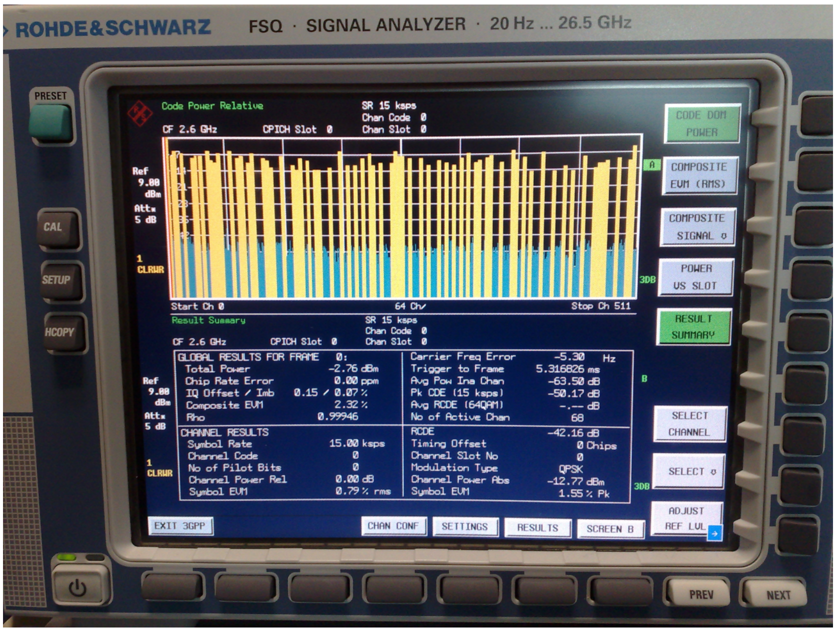


The analyzer displays power spectrum of the 3GPP FDD signal.

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:

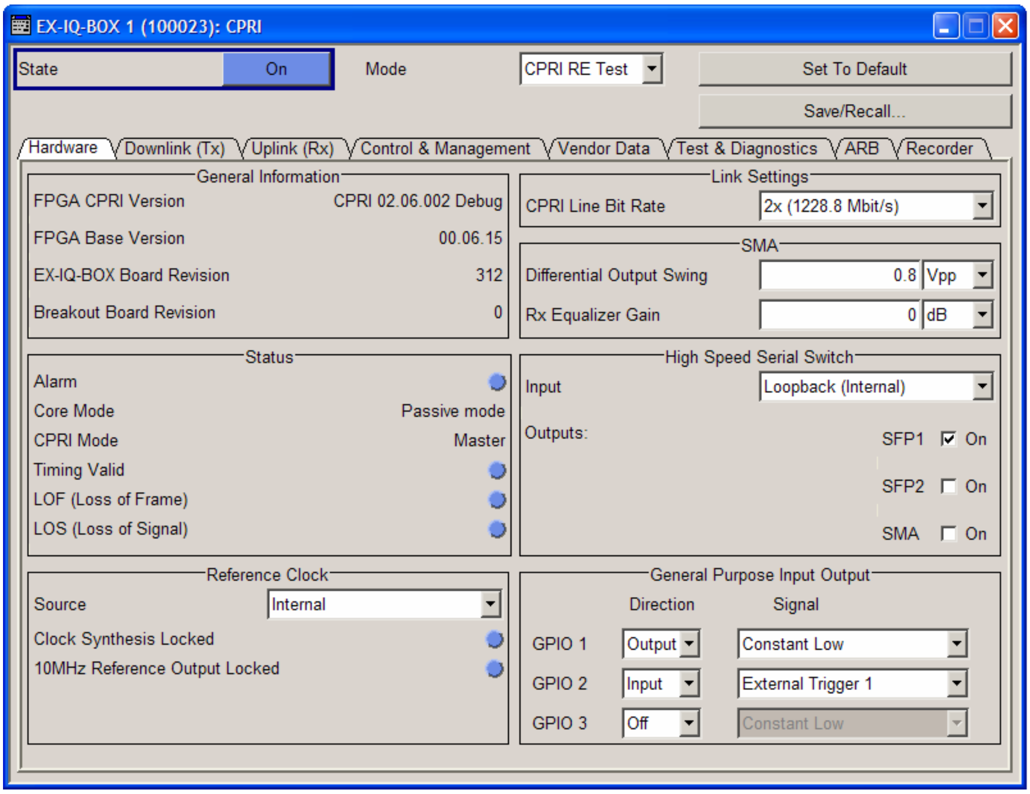
- Switch to 3GPP FDD BS demodulation.



The analyzer displays the demodulation result of the incoming signal.

6.2.6 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 "Main Controls" on page 161.



R&S DiglConf 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 the chapters "Hardware" on page 163, "Control & Management" on page 195, "Downlink and Uplink" on page 172, and "Test & Diagnostics" on page 202.

Additionally, you find a panel 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 "ARB Settings" on page 208.

Finally, you find the "Recorder" panel for I/Q recorder settings in the dialog that, if the R&S EX-IQ-BOX is equipped with an option for waveform recording, provides recording of an I/Q signal. Find the respective information on I/Q recorder functions in chapter "Recorder Settings" on page 210.

6.2.6.1 Main Controls

The upper part of the CPRI configuration dialog contains the controls for activating, for setting to default, or for loading and saving predefined settings. These controls are always indicated, independently from the active subdialog.

State

Activate or deactivate the CPRI standard. The corresponding FPGA (**F**ield **P**rogrammable **A**rray) is loaded automatically into the R&S EX-IQ-BOX.

Remote-control command:

SOUR1:EBOX:CPRI:STAT ON

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 .

Remote-control command:

SOUR1:EBOX:CPRI:MODE RET

CPRI REC Test Select REC (**R**adio **E**quipment **C**ontrol) test mode .

Remote-control command:

SOUR1:EBOX:CPRI:MODE RECT

Set To Default

Set all parameters to default values. Refer to table Preset - CPRI default settings which contains an overview of the most important default settings.

Remote-control command:

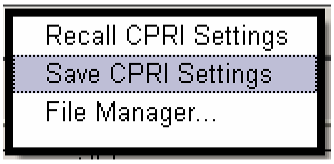
SOUR1:EBOX:CPRI:PRES

Save /Recall

Call the Save/Recall menu. A menu list opens to store or to load CPRI configurations, or to call the file manager.

CPRI configurations 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.

Remote-control command:

SOUR1:EBOX:CPRI:SETT:LOAD "D:/USER/CPRISettings/RETtest.cpri"

Save CPRI Settings

Open the file select window for saving the current CPRI signal configuration. Specify the name of the file in the "File Name" entry field. Save the file by pressing the "Save" button.

Remote-control command:

`SOUR1:EBOX:CPRI:SETT:STOR "D:/USER/CPRISettings/RETtest.cpri"`

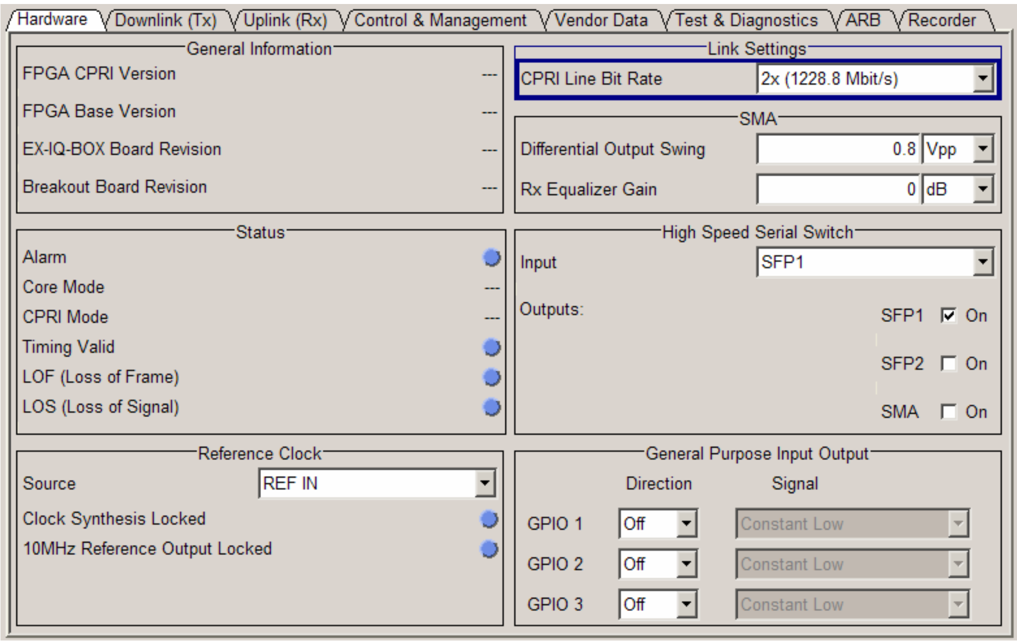
File Manager

Call the File Manager. "CPRI Setting (*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.

6.2.7 Hardware

The **Hardware** panel encloses all settings with regard to the hardware, including the assignment to the connected interfaces, special settings of the link, status information, reference clock settings, as well as general information on the R&S EXBOX-B85 CPRI option.



R&S DiglConf CPRI hardware dialog

6.2.7.1 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

The version of FPGA (**F**ield **P**rogrammable **G**ate **A**rray) CPRI design.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:FCV?`

Response: `CPRI 01.01.001`

FPGA Base Version

The version of the FPGA (**F**ield **P**rogrammable **G**ate **A**rray) basic design.

Remote-control command:

SOUR1:EBOX:CPRI:HW:FBV?

Response: `02.01.123`

R&S EX-IQ-BOX Board Revision

Indicates the revision number of the R&S EX-IQ-BOX´s internal board.

Remote-control command:

SOUR1:EBOX:CPRI:HW:EBR?

Response: `123`

Breakout Board Revision

The revision number of the connected breakout board.

Remote-control command:

SOUR1:EBOX:CPRI:HW:BBR?

Response: `4`

6.2.7.2 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 as a summary warning indicator.

Remote-control command:

SOUR1:EBOX:CPRI:HW:ALAR?

Response: `1` (red), `(0` = blue, no error)

Core Mode

Indicates the current state of the CPRI core.

CPRI core states

The CPRI core can operate in the following different states:

- Reset, i.e. at the starting point of establishing the link
- Attempting of L1 synchronization
- Protocol version setup
- C&M parameter setup
- Passive mode, i.e. only I/Q data are active, C&M is not used
- Link-up (normal operating mode)

Remote-control command:
`SOUR1:EBOX:CPRI:HW:CORE?`
Response: `'Link is up'`

CPRI Mode

Displays the role of the R&S EX-IQ-BOX, i.e. either master (CPRI RE test) or slave (CPRI REC test).

Remote-control command:
`SOUR1:EBOX:CPRI:HW:CMOD?`
Response: `Slave`

Timing valid

Indicates red, if the R21 timing calculation is invalid (CPRI requirement 21).

Remote-control command:
`SOUR1:EBOX:CPRI:HW:TIM`
Response: `1` (red), `(0` = blue, no error)

LOF (Loss of Frame)

Indicates red, if the CPRI frame delimiter K28.5 is not found.

Remote-control command:
`SOUR1:EBOX:CPRI:HW:LOF?`
Response: `1` (red), `(0` = blue, no error)

LOS (Loss of Signal)

Indicates red, if the data lost their synchronization.

Remote-control command:
`SOUR1:EBOX:CPRI:HW:LOS?`
Response: `1` (red), `(0` = blue, no error)

6.2.7.3 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

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.

Applies to a CPRI RE test setup with an external connected R&S instrument.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:RCL:SOUR RIN`

Internal

The R&S EX-IQ-BOX uses its internal reference oscillator for synchronization.

Applies to a CPRI RE test setup if the R&S EX-IQ-BOX is working stand-alone.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:RCL:SOUR INT`

Clock Recovery

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.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:RCL:SOUR REC`

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.

Remote-control command:

`SOUR:EBOX:CPRI:HW:RCL:CSL?`

Response: `0`

Clock Recovery Locked

Indicates red, if clock recovery is unlocked. Clock recovery must be locked in CPRI REC test mode.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:RCL:CRL?`

Response: `1` (red), `(0` = blue, no error)

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.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:RCL:ROL?`

Response: `1` (red), `(0` = blue, no error)

6.2.7.4 Link Settings

Section **Link Settings** contains 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.

2x 1228.8
4x 2457.6
5x 3072.0 Mbit/s

Available line bit rates.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:LBR LR2X`

6.2.7.5 SMA Settings

Define the electrical parameters of the SMA interface in this section.

Differential Output Swing

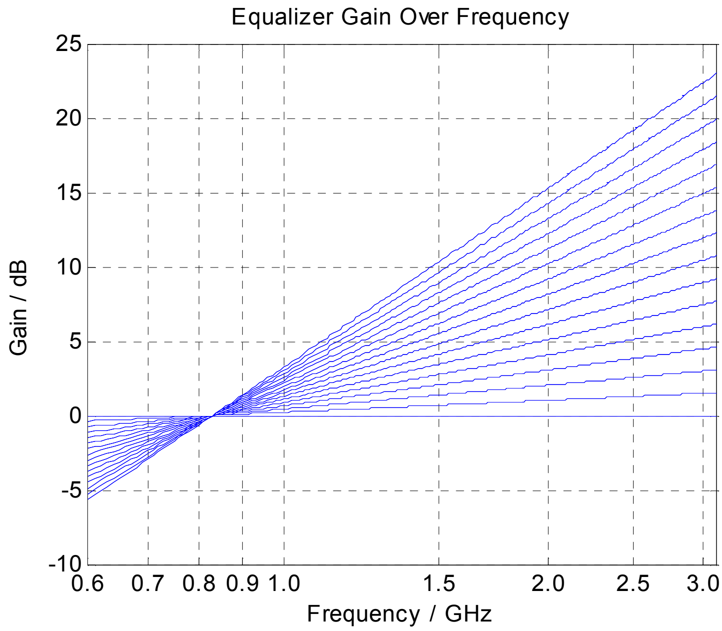
Determine the differential output voltage swing of the CML (**C**urrent **M**ode **L**ogic) transmitter.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:SMA:DOSW 1.0`

Rx Equalizer Gain

Set 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.



CPRI - equalizer gain over frequency

Remote-control command:

`SOUR1:EBOX:CPRI:HW:SMA:RXEG 10`

6.2.7.6 High Speed Serial Switch

Assign input and output to the connected interfaces in this section.

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 one of the optical interfaces SFP1, or SFP2. SMA is used, primarily, to the diagnosis.

For test purposes, the signal can be led back internally. This enables that all signal processing processes, as well as the CPRI transmitters and receivers work normal without having connected an external device.

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 one of the optical interfaces SFP1, or SFP2.

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 to receive the signal.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:HSSS:INP SFP2`

SMA
Select the SMA (**S**ub**M**iniatur version **A**) interface, if the R&S EX-IQ-BOX is receiving the signal from the DUT via this transmission line.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:HSSS:INP SMA`

Loopback internal
Assign the internal loopback, if the signal is routed back internally.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:HSSS:INP LOOP`

None
Deactivate the input, if no connection is established.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:HSSS:INP SFP2 NONE`

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.

Remote-control command:
`SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SFP1 ON`

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 via this transmission line.

Remote-control command:
`SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SMA ON`

6.2.7.7 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 direction of transmission of your connected GPIO interfaces. You can individually activate each of the three interfaces separately. Find additional information on the connectors see chapters "Top View" on page 148, and "Connector Locations - CPRI Breakout Board".

OFF
Deactivate the GPIO interface.

Remote-control command:
`SOUR1:EBOX:CPRI:HW:GPIO1:DIR OFF`

Output
Select the respective GPIO interface as output, i.e. send a control signal to the external device.

Remote-control command:
`SOUR1:EBOX:CPRI:HW:GPIO1:DIR OUTP`

Input
Select the appropriate GPIO interface as input, which means you receive a signal from the external device, e.g. for trigger purpose.
Remote-control command:
`SOUR1:EBOX:CPRI:HW:GPIO1:DIR INP`

Signal GPIO 1-3

Determine the type of the control signal. You can define separate signals for each of the three interfaces.

GPIO configured as output

Constant Low/High
Set the control signal to constant level high or low.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG CLOW`

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG CHIG`

DL/UL Basic Frame
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.

Remote-control command:

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG DLBF`

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG ULBF`

DL/UL Hyper Frame
Use the CPRI hyper frame clock for control. The hyper frame clock rate amounts 15 kHz.
Remote-control command:

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG DLHF`

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG ULHF`

DL/UL Node B Frame
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.
Remote-control command:

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG DLNBF`

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG ULNBF`

Timing Measurement Clock
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..
Remote-control command:

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG TMC`

10MHz Reference Clock
Use this signal as clock reference output in order to feed the clock reference to connected instruments and/or the DUT.
Remote-control command:

`SOUR1:EBOX:CPRI:HW:GPIO1:SIG RCL`

GPIO configured as input

External Trigger 1/2/3
In input mode, each of the three GPIO ports provide also an external trigger signal.

6.2.8 Downlink and Uplink

The **Downlink** and the **Uplink** panels comprise the settings related to the CPRI basic frame. 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 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, which are used in the description and familiar synonyms.

UL (Uplink):

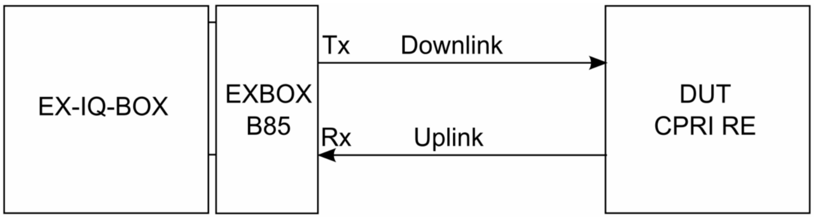
The UL defines the direction from a mobile device to a base station. A synonym to UL is RL (Reverse Link).

DL (Downlink):

DL defines the direction from the base station to the mobile device. A synonym to DL is FL (Forward Link).

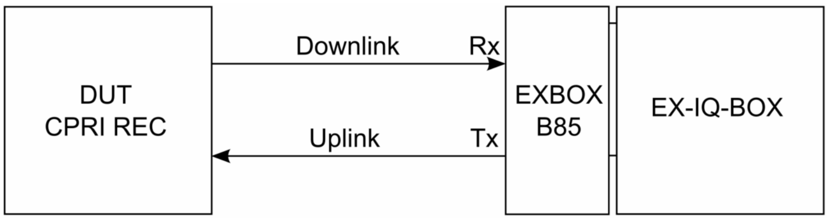
Depending on the CPRI test mode, the R&S EX-IQ-BOX works either as a transmitter (Tx) or receiver (Rx), as illustrated in the following diagrams.

- 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).



CPRI RE test - schematic representation

- In **CPRI REC** test mode, the EX-IQ-BOX works in the DL as a receiver (Rx) and in the UL as a transmitter (Tx).

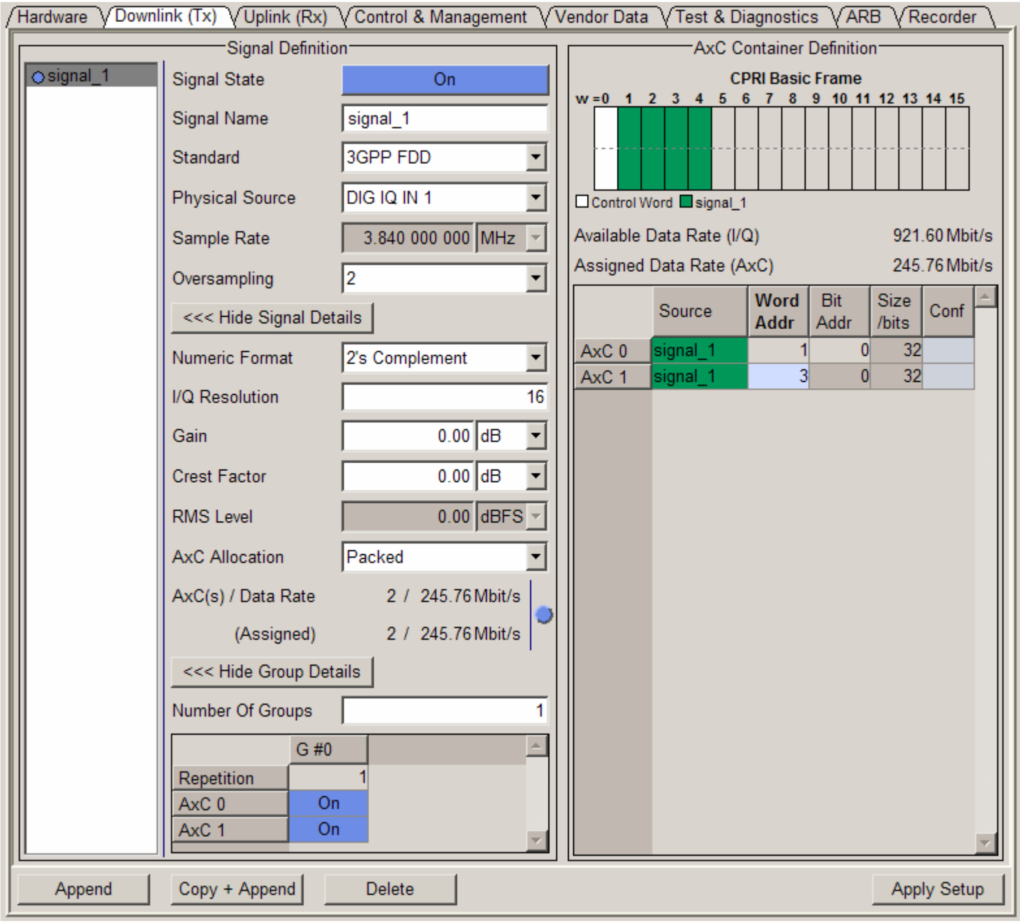


CPRI REC test - schematic representation

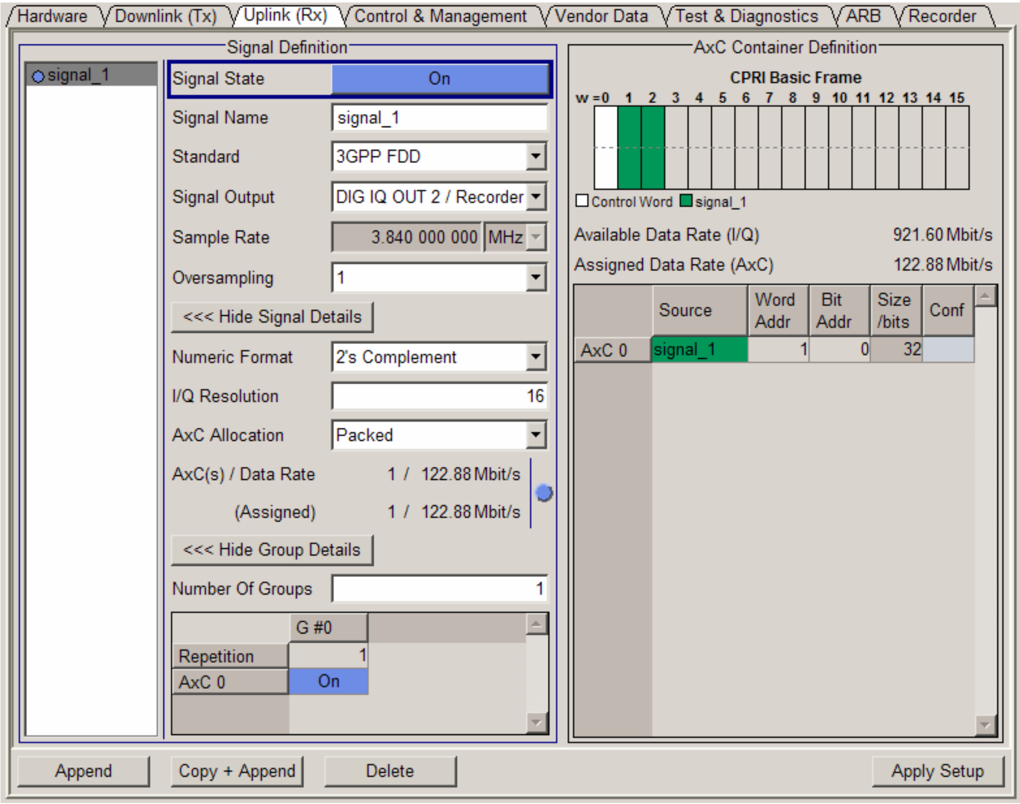
The settings dialogs for the transmitter (Tx) and the receiver (Rx) are identical for both CPRI test modes (RE / REC).

That means, the DL (downlink) dialog of CPRI RE and the UL (uplink) of CPRI REC are the same, and accordingly reversed, the UL dialog of CPRI RE test is identical to the DL dialog of CPRI REC.

Note: 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 clearly expressed.



R&S DiglConf CPRI downlink dialog



R&S DigIConf CPRI uplink dialog

6.2.8.1 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.

Note: The active AxCs are shown on the top right of this panel graphically. You find the description to this graphic under "AxC Container Definition" on page 189.

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN2:APP`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN3:COPY`

Delete

Remove the currently selected signal from the list. The function removes the corresponding AxCs from the list of used AxCs.

Remote-control command:

`SOUR:EBOX:CPRI:TX:SIGN2:DEL`

Signal State

Activate a selected signal.

Remote-control command:

`SOUR1:EBOX:CPRI:RX:SIGN:STAT ON`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN4:NAME "sig_3gpp"`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:STAN GSM`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:STAN W3GPP`

CDMA 2000

Select a signal that follows te CDMA standard.

CDMA2000 (**C**ode **D**ivision **M**ultiple **A**ccess) uses a multiple access scheme for digital radio, to send voice, data, and signalling data (such as a dialed telephone number) between mobile phones and cell sites.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:STAN CDMA2K`

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 bandwiths: 1.4 | 3.0 | 5.0 | 10.0 | 15.0 | 20.0 MHz

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:STAN LTE_20M`

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 transmmission modes, as e.g. point-to-multipoint links or mobile internet access.

WiMAX bandwiths: 3.5 | 5.0 | 7.0 | 8.75 | 10.0 | 20 MHz

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:STAN WIMAX_3M5`

Sync Pattern Sync Pattern uses an internal pattern generator as signal source.

Note: As this feature uses the internal signal source, the parameter is only provided in downlink mode.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:STAN PATT`

User defined Specify a user defined signal for transmission, define a signal with arbitrary parameters.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:STAN USER`

Physical Source

Assign the signal source for the transmitted signal to the DUT. This parameter applies to downlink in CPRI RE test mode, uplink in REC test mode. The signal comes either from an R&S instrument via one of the digital interfaces of the R&S EX-IQ-BOX, or the signal is generated by means of a waveform memory in the R&S EX-IQ-BOX.

Notes:

- In **RE** test mode,this parameter refers to downlink, when the R&S EX-IQ-BOX sends a signal. In uplink mode, the R&S EX-IQ-BOX receives the signal from the DUT, and forwards it to an R&S instrument. Select, therefore, in the uplink panel instead of the signal source the interface for signal output. See also "Signal Output" on page 179.
- In **REC** test mode, the parameter refers to uplink, when the R&S EX-IQ-BOX sends a signal. In downlink mode, the R&S EX-IQ-BOX receives the signal from the DUT, and forwards it to an R&S instrument. Select, therefore, in the downlink panel instead of the signal source the interface for signal output. See also "Signal Output" on page 179.
- Currently, the interface DIG IQ IN 1 is firmly set to input. The IN / OUT LED of this interface indicates in green, that the port operates in input mode.

DIG IQ IN 1...2

Select the digital interface for signal input from an R&S instrument to the R&S EX-IQ-BOX.

The R&S EX-IQ-BOX receives a digital I/Q baseband signal at one of its interfaces DIQ IQ IN, 1 or 2 from an R&S instrument. The R&S EX-IQ-BOX converts the R&S I/Q format into the CPRI protocol, which additionally contains control data. The CPRI link then transmits the data to the DUT.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:SOUR IQIN`

ARB 1...4

Select one of the waveform memories, which contains an I/Q signal.

> **Note:** This feature requires, that the R&S EX-IQ-BOX is equipped with the appropriate 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 R&S EX-IQ-BOX then embeds the ARB signal in the CPRI frame.

> **Tip:** The Multi Waveform options support simultaneous playback of up to four signals. For information on the available options refer to "Waveform Memory, Multi Waveform Playback and Recording Memory".

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:SOUR ARB1`

Signal Output

Assign a signal destination to the received signal in order to transmit it to an instrument and/or to the built-in I/Q recorder.

Notes:

- In **RE** test mode, Signal Output refers to the uplink signal. The R&S EX-IQ-BOX receives a signal from the DUT and forwards it to an R&S instrument via the digital interface. In downlink, the equivalent parameter is "Physical Source" on page 178.
- In REC test mode, Signal Output refers to the downlink signal. The R&S EX-IQ-BOX receives a signal from the DUT and forwards it to an R&S instrument via the digital interface. In uplink, the equivalent parameter is "Physical Source" on page 178.
- Currently, the output interface is firmly set to DIG IQ OUT 2, indicated by the yellow LED of this port.

DIG IQ OUT <n> / Recorder

Select the digital output interface for signal transmission from the R&S EX-IQ-BOX to an R&S instrument.

The R&S EX-IQ-BOX receives a baseband signal from the CPRI link. The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, and sends the signal to an R&S instrument via one of the digital interfaces DIG IQ OUT, 1 or 2.

In addition, the same signal can also be recorded via the I/Q recorder, see "Recorder Settings" on page 210.

Remote-control command:

`SOUR1:EBOX:CPRI:RX:SIGN:OUTP IQO`

Recorder

Select the built-in I/Q recorder as the destination for the received signal.

The R&S EX-IQ-BOX receives a baseband signal from the CPRI link. The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, and routes it to the R&S EX-IQ-BOX I/Q recorder.

Remote-control command:

`SOUR1:EBOX:CPRI:RX:SIGN:OUTP REC`

Wave file

Indicates the loaded waveform file, if the physical signal source is one of the waveform memories.

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:ARB:FILE?`

Response: `"p4DQPSK7_68M_OV4_2016Samples.wv"`

Sample Rate

Indicates the sample rate. But with user defined signals, you can assign a sample rate 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.

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

Standard	Frequency variant	Sample Rate
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

Remote-control command:

SOUR1:EBOX:CPRI:TX:SIGN:SRATe?

Pattern Length

Define the length of the pattern used by the internal pattern generator.

> **Note:** The parameter applies to the physical source "Sync Pattern" in downlink mode.

Remote-control command:

SOUR1:EBOX:CPRI:TX:SIGN:PLEN 4

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.

Remote-control command:

SOUR1:EBOX:CPRI:TX:SIGN:OSAM 2

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^{n-1}, the bits of lesser significance follow as:

$+2^{n-2} \ldots +2^{0}$

Remote-control command:

SOUR1:EBOX:CPRI:TX:SIGN2:NFOR COMP

Binary Offset

Format the data in binary offset.

A binary offset of -2^{n-1} is added such that the final values are always positive.

Remote-control command:

SOUR1:EBOX:CPRI:TX:SIGN2:NFOR BOFF

Example:

$n = 4 \rightarrow -8 \le z < 8$

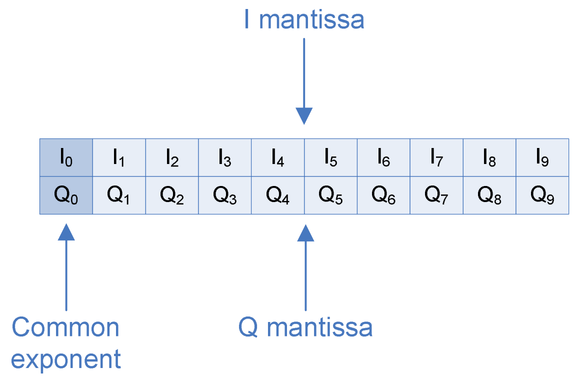
z	2´s Complement				Binary Offset			
-8	1	0	0	0	0	0	0	0
-7	1	0	0	1	0	0	0	1
-6	1	0	1	0	0	0	1	0
-5	1	0	1	1	0	0	1	1
-4	1	1	0	0	0	1	0	0
-3	1	1	0	1	0	1	0	1
-2	1	1	1	0	0	1	1	0
-1	1	1	1	1	0	1	1	1
0	0	0	0	0	1	0	0	0
1	0	0	0	1	1	0	0	1
2	0	0	1	0	1	0	1	0
3	0	0	1	1	1	0	1	1
4	0	1	0	0	1	1	0	0
5	0	1	0	1	1	1	0	1
6	0	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 illustrated in the figure:



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 samples of 2's complement 9E2

$$I = \left(\left(\sum_{i=0}^{7} 2^{i} \cdot I_{i+1}\right) - 2^{8} \cdot I_{9}\right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

► Q sample 10 bits: 9 bits Q mantissa + 1 bit, i.e. bit_1 exponent

Q samples of 2's complement 9E2

$$Q = \left(\left(\sum_{i=0}^{7} 2^{i} \cdot Q_{i+1}\right) - 2^{8} \cdot Q_{9}\right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN2:NFOR C9E2`

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.

Remote-control command:
`SOUR1:EBOX:CPRI:TX:SIGN:IQR 16`

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.

Remote-control command:
`SOUR1:EBOX:CPRI:TX:SIGN:GAIN -20`

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.

Remote-control command:
`SOUR1:EBOX:CPRI:TX:SIGN:CRES 10dB`

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(I^2+Q^2)).

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.

Remote-control command:
`SOUR1:EBOX:CPRI:TX:SIGN:RMS?`
Response: `"-10 dbFS"`

AxC Allocation

Define how to allocate the AxCs to the signal. R&S DigIConf automatically assigns the AxCs to a signal, but 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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:AXC:ALL PACK`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:AXC:ALL FLEX`

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:

AxC / Data Rate

$AxCs_{needed}$ = ceil (Sample Rate · Oversampling / 3.84 [MHz])

The data rate is calculated with the formula:

AxC / Data Rate needed

Data $Rate_{needed}$ [Mbit/s] = Sample Rate · Oversampling · 2 · I/Q Resolution

> **Note:** For signal source "Pattern" the needed number of AxCs is 1.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN2:AXC:COUN:NEED?`

Response: "`3 / 358.40 Mbit/s`"

(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:

AxC / Data Rate (Assigned)

Data $Rate_{assigned}$ [Mbit/s] =

3.84 [MHz] · 2 · I/Q Resolution (∑(AxC_on_$count_{grp}$ · $Repetition_{grp}$) / ∑$Repetition_{grp}$)

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 $Rate_{assigned}$ = Sample Rate * Pattern Length

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN2:AXC:COUN:ASS?`

Response: `"3 / 368.40 Mbit/s"`

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.

Deviations in data rates!

Refer to the example under "Example to CPRI Groups Concept" on page 193, on what to do if the status LED turns red.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:AXC:DRAT:STAT?`

Response: `"0"` if OK, `"1"` if not OK

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:GRO:COUN 2`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:GRO1:REP 3`

AxC<index> State Indicates the status of the respective AxCs. By default, all states are set to On. Click into the desired field or press the enter key to switch between On and Off.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN2:GRO1:AXC1:STAT ON`

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 182.

Note: AxC n (bin) refers to Sync Pattern signals.

Remote-control command:

`SOUR1:EBOX:CPRI:TX:SIGN:GRO1:AXC0:PATT "0101"`

Example

The following example explains the need of the CPRI group definition:

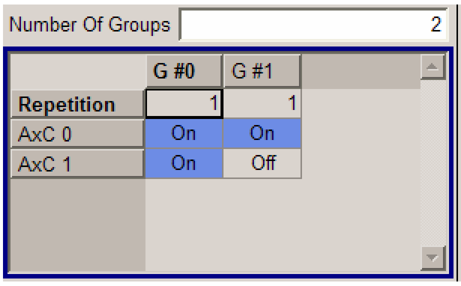
Let us assume we want to transmit an I/Q signal over the CPRI link with a sampling rate of 5.76 MS/s. The CPRI basic frame rate amounts the defined 3.84 MHz.

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?



7. We allocate 2 AxCs in the AxC container definition which corresponds to: ceiling = 1.5. For example, we use AxC0 and AxC1.
8. In the "Number of Groups" entry field, we define two groups.
9. Then, in the groups table, we define:
   - G#0: Reptition = 1, AxC0= On, AxC1 = On.
   - G#1: Repitition = 1, AxC0 = On, AxC1= Off.

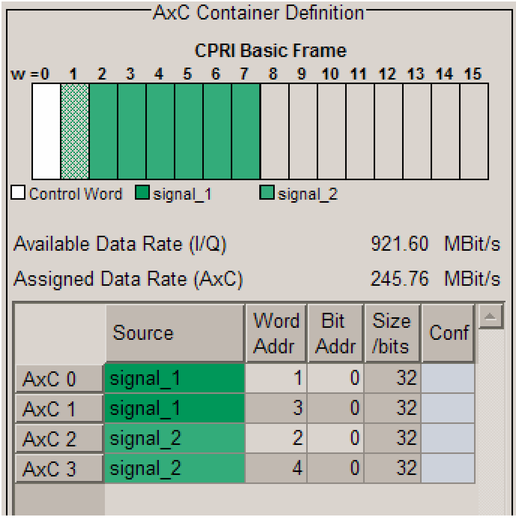
With these settings, we transmit 2 samples (G#0) for one basic frame, and only 1 sample (G#1) for the following.

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.

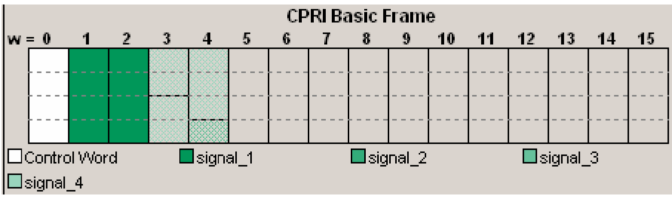
6.2.8.2 AxC Container Definition

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.



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 stuctured in AxCs (antenna carriers). A signal needs one or more AxCs for carrying the I/Qdata, 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.

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:

Available Data Rate (I/Q)

Data $\text{Rate}_{\text{available}}$ [Mbit/s] = Data Word Count · Word Length [bit]   3.84 [MHz]

= 15 · Word Length [bit]   3.84 [MHz]

Note: The word length depends on the line bit rate, as listed in "CPRI Basic Frame Graph" on page 190.

Remote-control command:

SOUR1:EBOX:CPRI:TX:DRAT:AVA?

Response: 921.60 Mbit/s

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:

Assigned (AxC)

Data $\text{Rate}_{\text{assigned}}$ [Mbit/s] = $\sum$AxC_size_{axc} · 3.84 [MHz]

Remote-control command:

SOUR1:EBOX:CPRI:TX:DRAT:ASS?

Response: 491.52 Mbit/s

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.

Remote-control command:
`SOUR1:EBOX:CPRI:TX:AXC0:SOUR?`
Response: `"signal_1"`

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.

Remote-control command:
`SOUR1:EBOX:CPRI:TX:AXC0:WADD 15`

Bit Address
Specifies the starting bit inside the word.

Remote-control command:
`SOUR1:EBOX:CPRI:TX:AXC0:BADD 0`

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_size_{axc} [bit] = I/Q $Resolution_{signal} \cdot 2$

For Sync Pattern signals, calculate the source with the formula:

AxC_size_{axc} [bit] = Pattern $Length_{signal}$

Remote-control command:
`SOUR1:EBOX:CPRI:TX:AXC1:SIZE?`

Conflict
A conflicht arises, when AxCs overlap. A red LED indicates the overlapping with a previous AxC.

Remote-control command:
`SOUR1:EBOX:CPRI:TX:AXC0:CONF?`

Apply

Assign the settings in order to become effective.

Remote-control command:

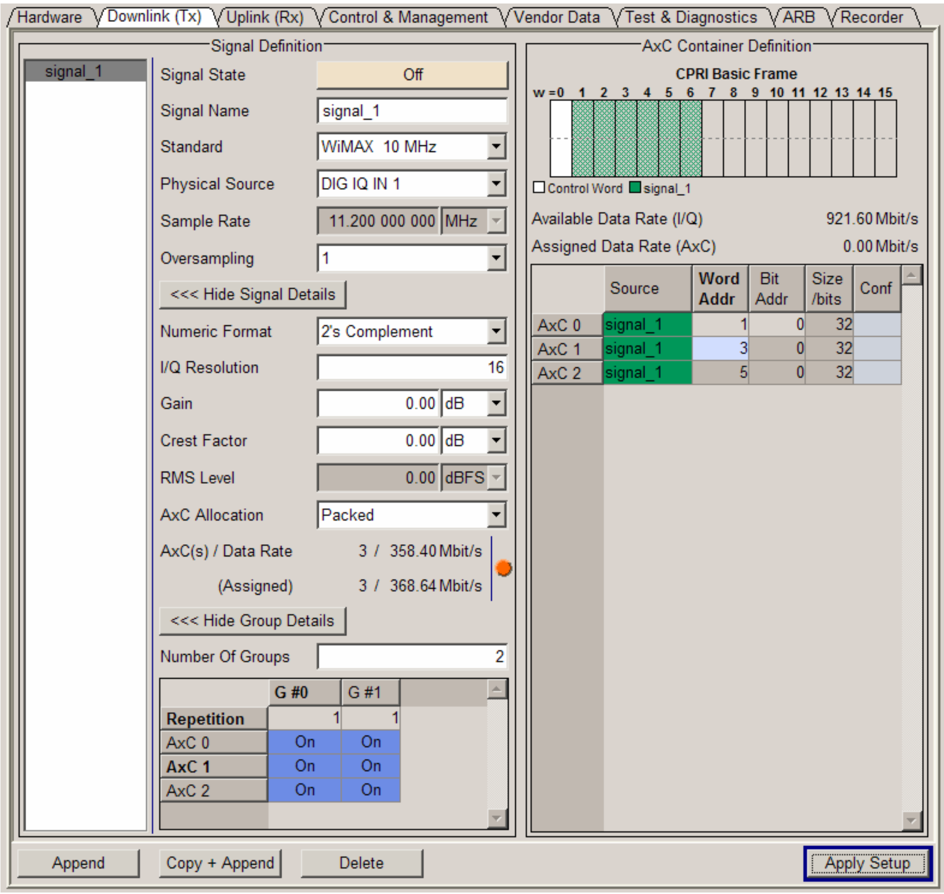
`SOUR1:EBOX:CPRI:TX:APPL`

Example to CPRI Groups Concept

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.

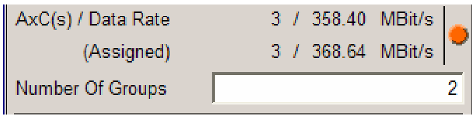
Example:
By means of a 10 MHz WiMAX signal, with an oversampling factor of 1 and an I/Q resolution of 16 Bit, the following settings present a possible solution.



How to customize?

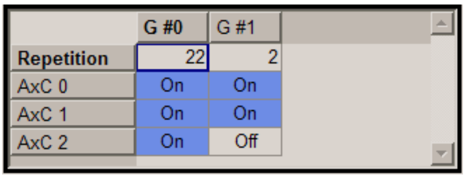
In this example, the WiMAX data rate amounts 11.2 MHz and requires 3 AxCs for its data. Since 3.84 MHz does not fit into 11.2 MHz, change the following parameters:

1. Increase the number of groups to 2.

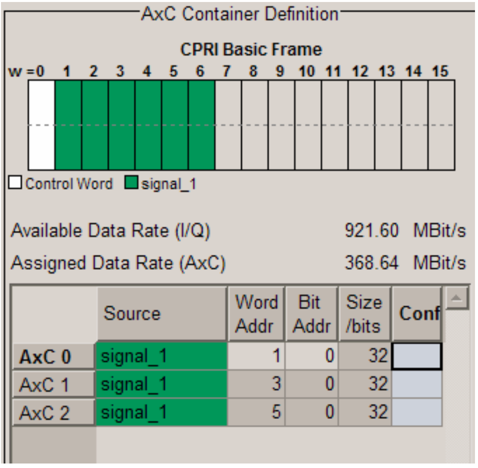


2. Enter 22 repetitions for Group #0, and 2 for Group #1.
3. Allocate all the AxCs of the first group consecutively, and from the second group only AxC0 and AxC1.

The combination of repetition and the variable allocation of the AxCs provides a correct distribution of the signal in the CPRI frame.



The graph in the AxC Container Definition shows the distribution of the data in the CPRI frame slots.



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
2x		AXC_2 0		AXC_2 1	

Argument

Let us prove that using the formula:

AxC / Data Rate assigned

Data $Rate_{assigned}$ [Mbit/s] =

3.84 [MHz] · 2 · I/Q Resolution (∑($AxC\_on\_count_{grp}$ · $Repetition_{grp}$) / ∑$Repetition_{grp}$)

Data $Rate_{assigned}$ [Mbit/s] =
3.84 [MHz] · 2 · 16 [bit] ((3 · 22 + 2 · 2) / 22 + 2) = 358.4 [Mbit/s]

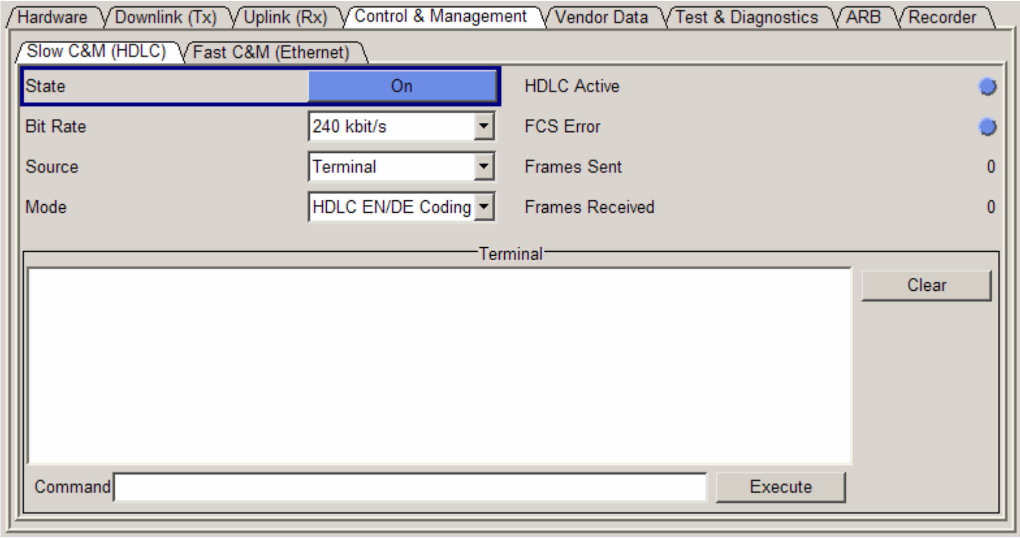
6.2.9 Control & Management

The **Control & Management** (C&M) panel 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-**L**evel **D**ata **L**ink **C**ontrol) and the fast Ethernet.

6.2.9.1 Slow C&M (HDLC)

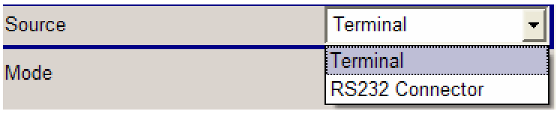
The **HDLC Settings** section comprises the necessary parameters for activating HDLC control and management data protocol.

Note: In chapter "Connecting the R&S EX-IQ-BOX", you find information on how to connect the interface. For more information on the hardware, see the data sheet of the option R&S EXBOX-B85.



R&S DigIConf CPRI Control & Management dialog - Slow C&M (HDLC)

R&S DigIConf provides two methods for transmitting or receiving Slow C&M Data:



1. Using the internal **Terminal**, you can enter text commands. With "Execute", the R&S EXBOX-B85 encodes the plain text commands in HDLC format. Then, the R&S EXBOX-B85 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 R&S EXBOX-B85 expects already HDLC encoded data on the RS-232-C input. Then, the EXBOX-B85 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.

   Note: This method is applicable to both, the CPRI RE and the CPRI REC test mode.

State

Activate the C&M data exchange by means of HDLC protocol.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:HDLC:STAT ON`

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

Remote-control command:

`SOUR1:EBOX:CPRI:CM:HDLC:BRAT 480`

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

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.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:HDLC:SOUR TERM`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:HDLC:SOUR RS232`

Mode

Select the mode for HDLC C&M data transmission.

Direct

The R&S EXBOX-B85 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".

Remote-control command:

`SOUR1:EBOX:CPRI:CM:HDLC:MODE DIR`

HDLC EN/DE Coding

The R&S EXBOX-B85 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".

Remote-control command:

`SOUR1:EBOX:CPRI:CM:HDLC:MODE DIR`

HDLC Active

The LED indicates red, if the interface is inactive. Blue indicates that the interface is active.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:HDLC:ACT?`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:HDLC:FCS?`

Frames sent

Indicates the number of sent HDLC frames.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:HDLC:SFR?`

Frames received

Indicates the number of received HDLC frames.

Remote-control command:

SOUR1:EBOX:CPRI:CM:HDLC:RFR?

Input Window, Command line, Clear, Execute

The lower part of the slow C&M panel provides an entry field to enter control commands manually. The commands are displayed in the input window above. "Clear" erases the entries and the input window.

> **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.

Remote-control commands:

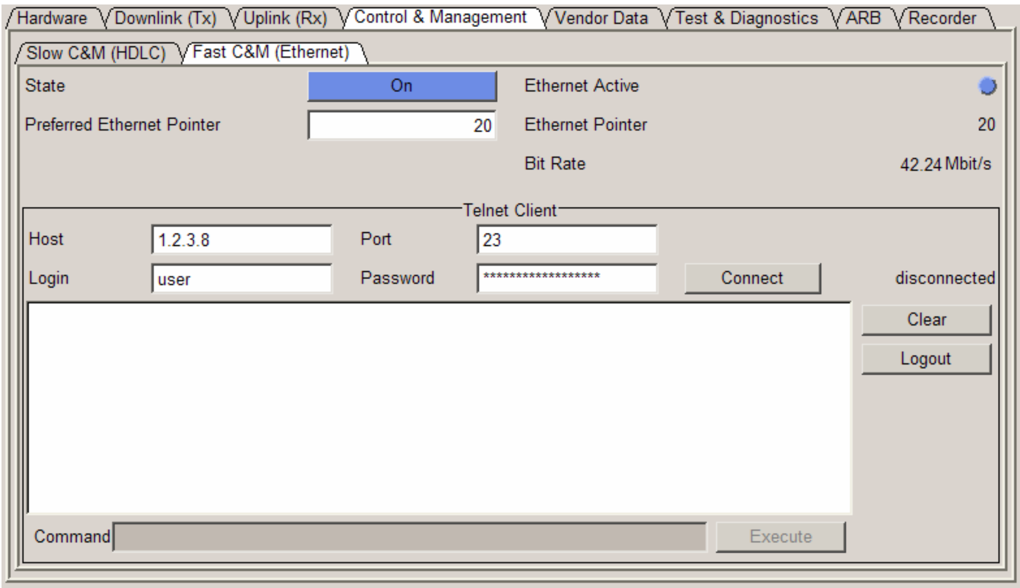
SOUR1:EBOX:CPRI:CM:HDLC:COMM "test cmd"

SOUR1:EBOX:CPRI:CM:HDLC:EXEC

6.2.9.2 Fast C&M (Ethernet)

The **Ethernet Settings** section comprises the necessary parameters for activating fast control and management data exchange via the Ethernet interface.

> **Note:** In chapter "Connecting the R&S EX-IQ-BOX", you find information on how to connect the interface. For more information on the hardware, see the data sheet of the option R&S EXBOX-B85.



R&S DiglConf 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 EXBOX-B85 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 (Internet Protocol), 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.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:ETH:STAT ON`

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 "Transmission Protocol - Overview" on page 144.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:ETH:PPTR 25`

Ethernet Pointer

Indicates the resulting Ethernet pointer after the link setup, i.e. the position after the handshake between the EXBOX-B85 and the DUT.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:ETH:PTR?`

Ethernet Active

The LED indicates red, if the interface is inactive. Blue indicates that the Ethernet data transfer is active.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:ETH:ACT?`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:CM:ETH:BRAT?`

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 / Logout

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, Clear, Execute, Logout

The lower part of the fast C&M panel provides an entry field to enter control commands manually. The commands are displayed in the input window above. "Clear" erases the entries and the input window. "Execute" executes the command, or the conmmand sequence.

Note: This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

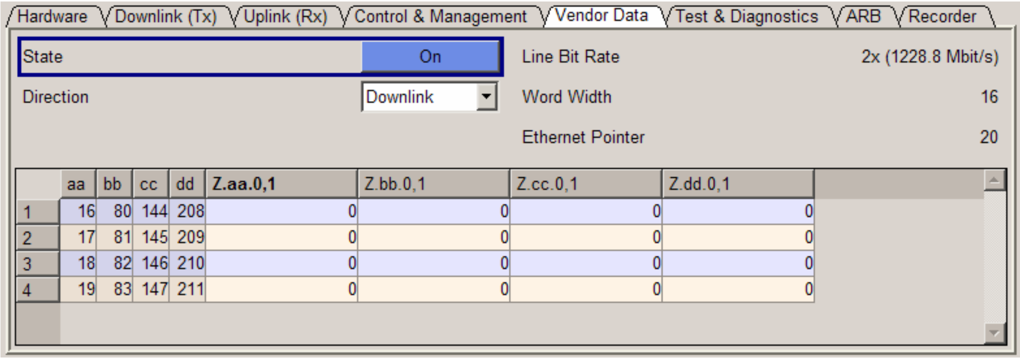
Remote-control command:

`SOUR1:EBOX:CPRI:CM:ETH:COMM "test cmd"`

`SOUR1:EBOX:CPRI:CM:ETH:EXEC`

6.2.10 Vendor Data

The **Vendor Data** panel 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.



R&S DiglConf CPRI Vendor Data dialog

State

Activate the vendor data exchange.

Remote-control command:

`SOUR1:EBOX:CPRI:VEND:STAT ON`

Direction

Select the data direction shown in the vendor data table, see "Vendor Data Table" on page 202.

Remote control command:

`SOUR1:EBOX:CPRI:VEND:DIR DLIN`

`SOUR1:EBOX:CPRI:VEND:DIR ULIN`

CPRI RE test mode

Uplink (Rx) Vendor data is extracted from the CPRI link and displayed in the table.

Downlink (Tx) User data entered in the table is embedded in the CPRI link for transmission to the DUT.

CPRI REC test mode

Uplink (Tx) User data entered in the table is embedded in the CPRI link for transmission to the DUT.

Downlink (Rx) Vendor data is extracted from the CPRI link and displayed in the table.

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 panel, under "CPRI Line Bit Rate" on page 168. The bit rate and thus the word length is determined by the DUT.

Remote-control command:

SOUR1:EBOX:CPRI:HW:LBR LR2X?

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.

Line bit rate [Mbit/s]	Word width [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 168.

Remote-control command:

SOUR1:EBOX:CPRI:VEND:WWID?

Ethernet Pointer

Indicates the Ethernet pointer position resulting from the fast C&M settings. Refer to "Ethernet Pointer" on page 199.

Remote-control command:

SOUR1:EBOX:CPRI:CM:ETH:PTR?

Vendor Data Table

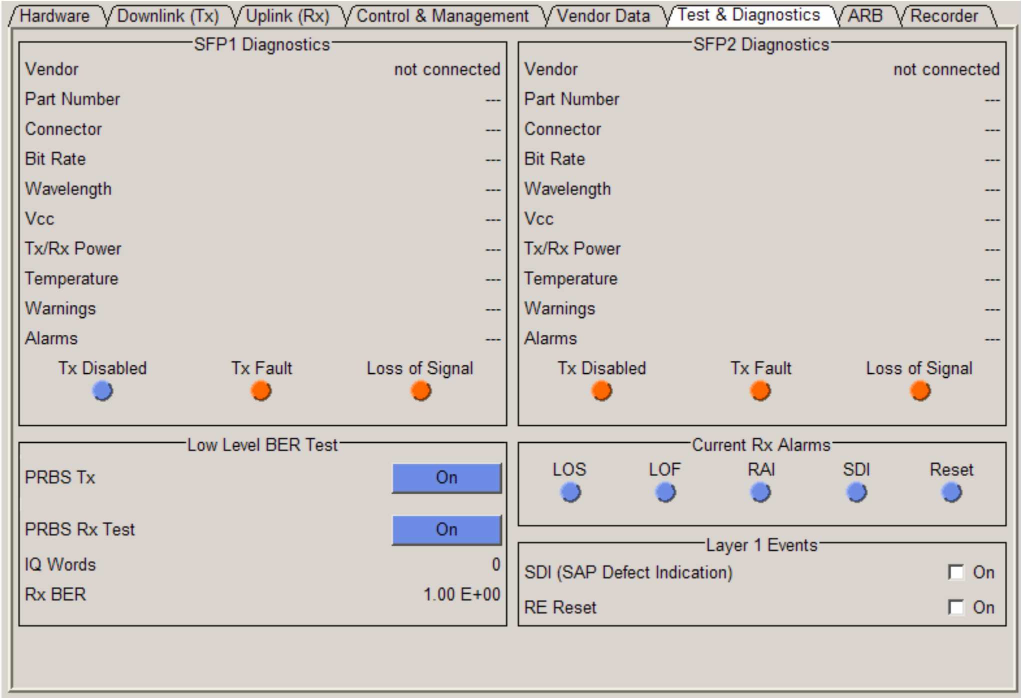
For CPRI RE downlink or CPRI REC uplink, the table can be used to determine vendor-specific data for transmission. In receive direction, i.e. in uplink for CPRI RE and downlink for CPRI REC test modes, the table shows the received vendor specific data, and switches into read-only mode.

Remote-control command:

SOURce1:EBOX:CPRI:VEND:DATA 16,#H2A

6.2.11 Test & Diagnostics

The **Test & Diagnostics** panel 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 (PRBS = pseudo random binary sequence). 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.



R&S DiglConf CPRI Test & Diagnostics dialog

6.2.11.1 SFP Diagnostics

Sections **SFP1/SFP2 Diagnostics** indicate the most important parameters of the SFP transceiver modules. The fields in the left section inform about the SFP1 connection, and on the rigth about SFP2 respectively.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:SFP:INFO?`

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.

6.2.11.2 SFP LEDs

Tx Disabled

Indicates, if the interface of the breakout board and the SFP transmission line is disabled.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:SFP:TX:DIS?`

Tx Fault

Indicates when a transmission error occurs. If the SFP is disconnected, R&S DigIConf displays "Not Available".

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:SFP:TX:FAUL?`

Loss of Signal

Indicates that data communication failed and the signal is lost.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:SFP:LOS?`

6.2.11.3 Low Level BER Test

Section **Low Level BER Test** provides the possibility, to check the function of the CPRI transmission line. Evaluate the bit error ratio of the link with the aid of a defined data sequence.

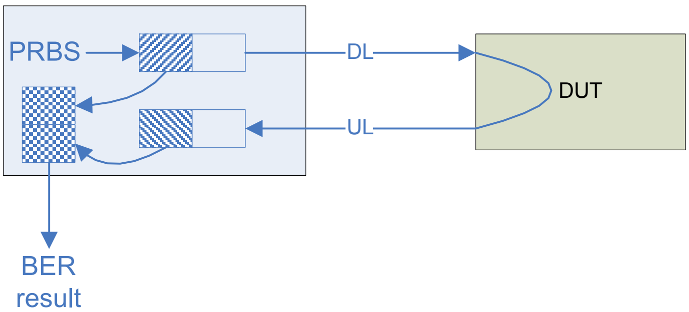
The Bit-Error-Rate function provides testing the signal via the selected interface in the hardware settings dialog.

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 panels.

For this test the downlink and uplink signals must be identical and the CPRI line must be looped back, e.g. at the DUT.

For this test the downlink and the uplink signals must be identical, and the CPRI line must be led back, e.g., in the DUT.

Example to Low Level BER Test using CPRI RE test mode



Low Level BER Test

For testing a signal execute the following steps.

1. Select a signal in the downlink panel, and define its parameters.
2. Enter the same settings in the uplink panel.

   Note: For testing the function itself, the signals in the downlink and uplink panel must be identical.
3. Set the connected DUT to CPRI loopback mode.
4. Activate the signals and switch to the Test & Diagnostics Panel.
5. Switch on Low Level BER PRBS Tx. The PRBS test data are generated and assigned to the downlink signal.
6. Switch on PRBS Rx Test. The received data are extracted from the uplink signal and are compared 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.

The bit error rate test function 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.

This feature allows you to test whether the link is working properly.

The result of the test can be continuously observed in the test panel.

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 panel, e.g. set the value 4 in the AxC table.
2. Return to the Test & Diagnostics panel, 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 Test

Switch on the transmission of the test data.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:BER:TX:STAT ON`

PRBS Rx Test

Switch on the test receiver.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:BER:RX:STAT ON`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:BER:RX:WORD?`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:BER:RX:RATE?`

6.2.11.4 Current Rx Alarms

The alarm LEDs within this range refer to errors, which are received from the DUT. Red LEDs denote DUT alarms, blue LEDs indicate that no errors have been detected.

LOS

The LOF (**L**oss **o**f **S**ignal) LED indicates a loss of signal.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:RX:LOS?`

Response: `1` (red), `(0` = blue, no error)

LOF

LOF (**L**oss **o**f **F**rame) indicates, when the received data lost the synchronization, i.e. loss of frame.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:RX:LOF?`

RAI

RAI (**R**emote **A**rm **I**ndication) indicates, if any remote part of the end-to-end link has failed.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:RX:RAI?`

SDI

SDI (**S**ervice Access Point **D**efect **I**ndication) indicates, if the data communication failed.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:RX:SDI?`

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.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:RX:RES?`

6.2.11.5 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 is reacting to this 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 is defective or is 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 is reacting to this events.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:TX:SDI ON`

RE Reset

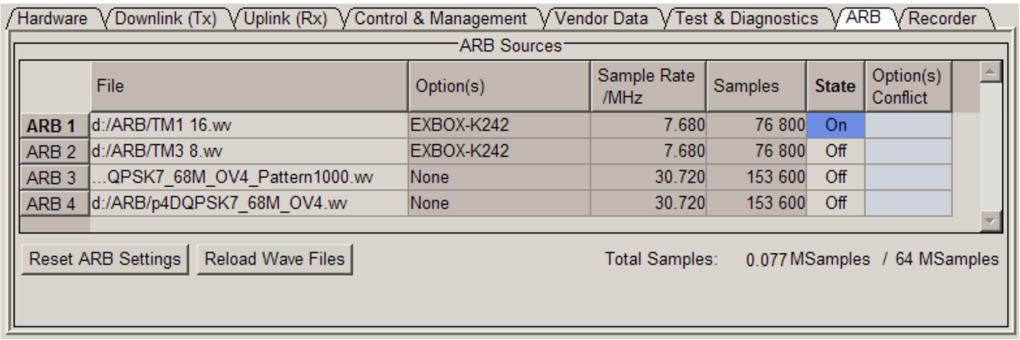
Set or clear the bit on the downlink connection which requests the RE to reset.

Remote-control command:

`SOUR1:EBOX:CPRI:TEST:TX:RER ON`

6.2.12 ARB Settings

The **ARB** settings panel displays all fields that are relevant for loading a waveform file in the waveform memory of the R&S EX-IQ-BOX.



R&S DiglConf ARB settings dialog

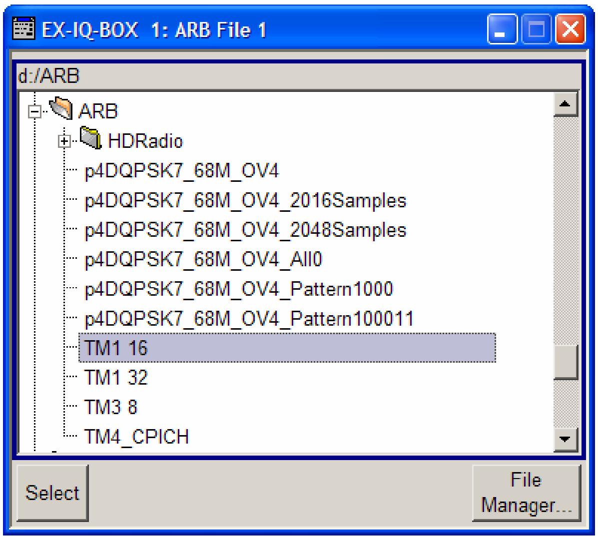
Note: Instead of a signal generator as signal source, the R&S EX-IQ-BOX creates the signal from a waveform file and embeds it in the CPRI protocol. The ARB functionality applies to the transmission mode, when the R&S EX-IQ-BOX is sending to the DUT, i.e. in CPRI RE test mode, the R&S EX-IQ-BOX sends 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 "Recorder Settings" on page 210.

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 Options, section "Waveform Memory, Multi Waveform Playback and Recording Memory".

File

Opens 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 settings dialog. The ARB table indicates the file name and its path, the directory respectively 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.

Remote-control command:
`SOUR1:EBOX:CPRI:ARB2:FILE "..//DigIConf/Waveforms/p4DQPSK7.wv"`

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 "Digital standards with R&S WinIQSIM2".

Remote-control commands:
`SOUR:EBOX:OPT?`

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.

Remote-control command:

SOUR1:EBOX:CPRI:ARB1:SRAT?

Samples

Indicates the number of samples the loaded signal is composed of.

Remote-control command:
SOUR1:EBOX:CPRI:ARB1:SAMPl?

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 178. The R&S EX-IQ-BOX then embeds the signal into the CPRI protocol.

Remote-control command:
SOUR1:EBOX:CPRI:ARB1:STAT ON

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.

Remote-control command:
SOUR1:EBOX:CPRI:ARB:CONF?

Reset

Erases the ARB table, i.e. all loaded waveform files and their settings.

Remote-control command:
SOUR1:EBOX:CPRI:ARB:PRES

Reload

Update the waveform file in R&S DigIConf, in case waveform data have changed. Reload updates all currently assigned files.

Remote-control command:
SOUR1:EBOX:CPRI:ARB:REL

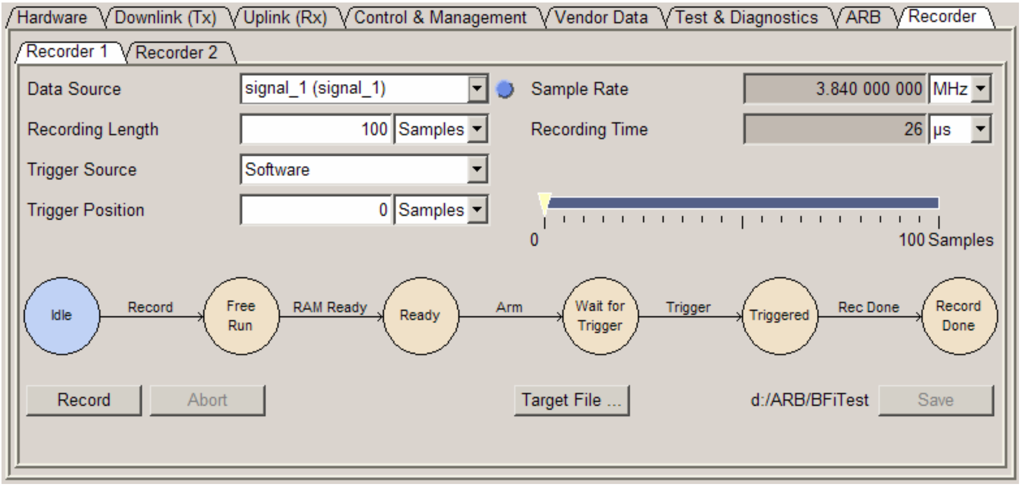
Total Samples

Indicates the total number of samples, added up from all active ARB files.

Remote-control command:
SOUR1:EBOX:CPRI:ARB:SAMP:TOT?

6.2.13 Recorder Settings

The **Recorder** dialog covers the parameters relevant for recording an I/Q signal and storing the data in a waveform file.



R&S DiglConf Recorder settings dialog

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.

> **Note:** 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 "ARB Settings" on page 208. 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 Options, section "Waveform Memory, Multi Waveform Playback and Recording Memory".

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 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". Switch on "Signal State" on page 176.

Remote-control command:

`SOUR1:EBOX:CPRI:REC:DATA:SOUR:CAT?`

`SOUR1:EBOX:CPRI:REC:DATA:SOUR "signal 1"`

Recording Length

Set the length of data trace in samples.

Remote-control command:

`SOUR1:EBOX:CPRI:REC:RLEN 1024`

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.

Remote-control command:
`SOUR1:EBOX:CPRI:REC:TRIG:SOUR EXT`

External Trigger 1/2/3

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 "Short Description of the CPRI Frame Structure" on page 145 and "Top View" on page 148.

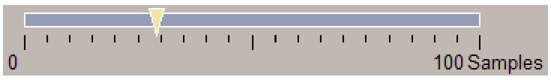
Remote-control command:
`SOUR1:EBOX:CPRI:REC:TRIG:SOUR EXT`

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 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.

The trigger position is graphically displayed on the right.



Remote-control command:
`SOUR1:EBOX:CPRI:REC:TRIG:POS 2`

Sample Rate

Indicates the sample rate of the signal to be recorded.

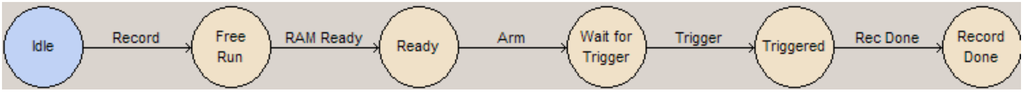
Remote-control command:
`SOUR1:EBOX:CPRI:REC:DATA:SRAT?`

Recording Time

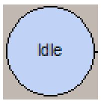
Indicates the duration of recording. The recording time results from the recording length and the sample rate.

Remote-control command:
`SOUR1:EBOX:CPRI:REC:RTIM?`

Recorder Status Diagram



Displays graphically the current process step of the recording.

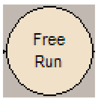


Idle

The recording process is inactive. Configure the recorder in that state.

The recorder remains in Idle state until you start with the "Record" button.

► Record



Free Run

The recorder records the signal continuously in a ring memory. These data are required for pre-trigger analyzes.

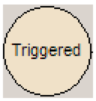
Ready

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.

Remote-control command:
`SOUR1:EBOX:CPRI:REC:STAT WTR`

Record

Starts the recording.

Remote-control command:

`SOUR1:EBOX:CPRI:REC:EXEC`

Abort / Discard

Stops and cancels the 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.

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.

Remote-control command:

`SOUR1:EBOX:CPRI:REC:ABOR`

Target File

Open a file dialog to select directory and file name for storing the recorded data.

Remote-control command:

`SOUR1:EBOX:CPRI:REC:FILE:SEL "D:\3GPP_CPRIRE.rec"`

Save

Save the data in a file.

> **Note:** R&S DigIConf 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.

Remote-control command:

`SOUR1:EBOX:CPRI:REC:FILE:CRE "D:\3GPP_CPRIRE.wv"`

7 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.

7.1 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

Note: No VISA installation is necessary to remote control while using socket communication.

For a description of the protocol refer to "LAN interface" on page 219.

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.

7.1.1 Messages

There are different types of instrument messages, depending on the direction they are sent:

- Commands
- Responses

  Note: Structure and syntax of messages are described in "SCPI Command Structure" on page 227. A detailed description of all messages available for R&S DigIConf is provided in "Remote Control Commands" on page 241.

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.

7.1.2 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 RJ45 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.

> **Note:** 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.

7.1.3 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 "Examples" on page 220 for practical examples on setting up of a remote control link and starting of a remote control session.

7.1.4 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.

7.1.5 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.

7.1.5.1 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.

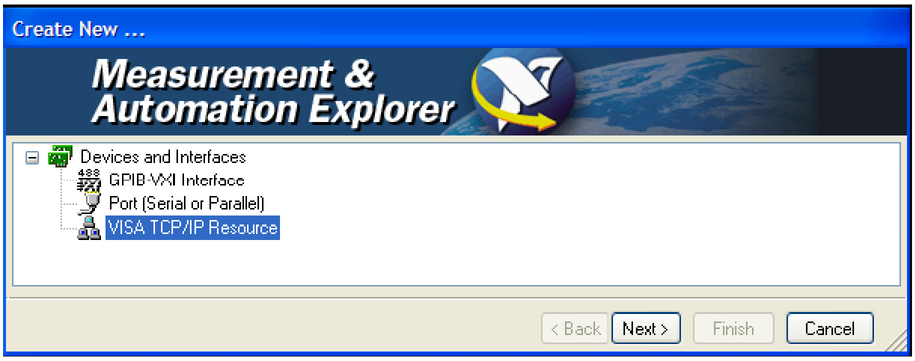
Configuring the controller

To enable the external controller to communicate with the software via TCP/IP protocol, set up a remote control link as follow:

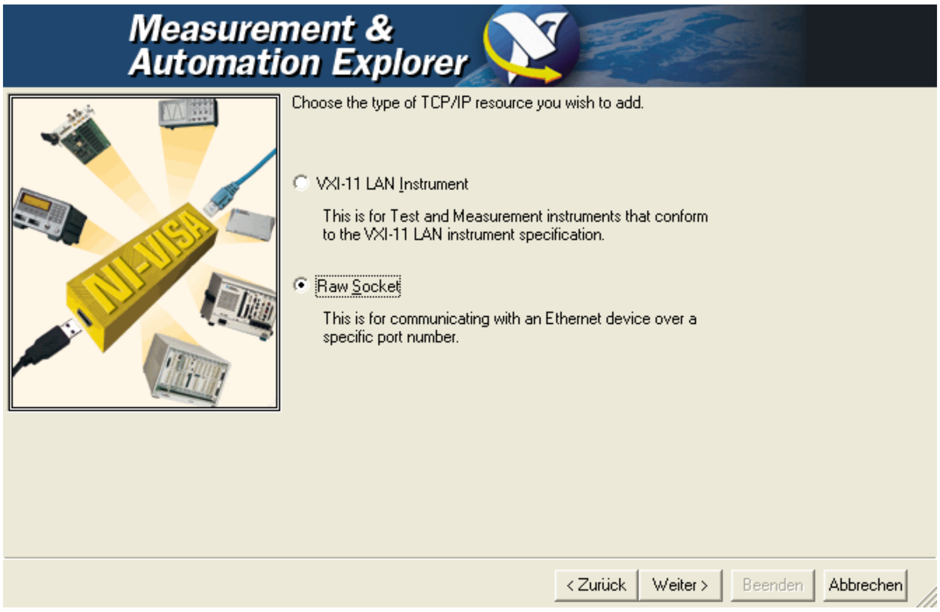
1. Connect the controller and the instrument to the network (network cable) and switch them on.
2. Start the 'Measurement & Automation Control' program on the controller.

3. Select "Devices and Interfaces > Create New".

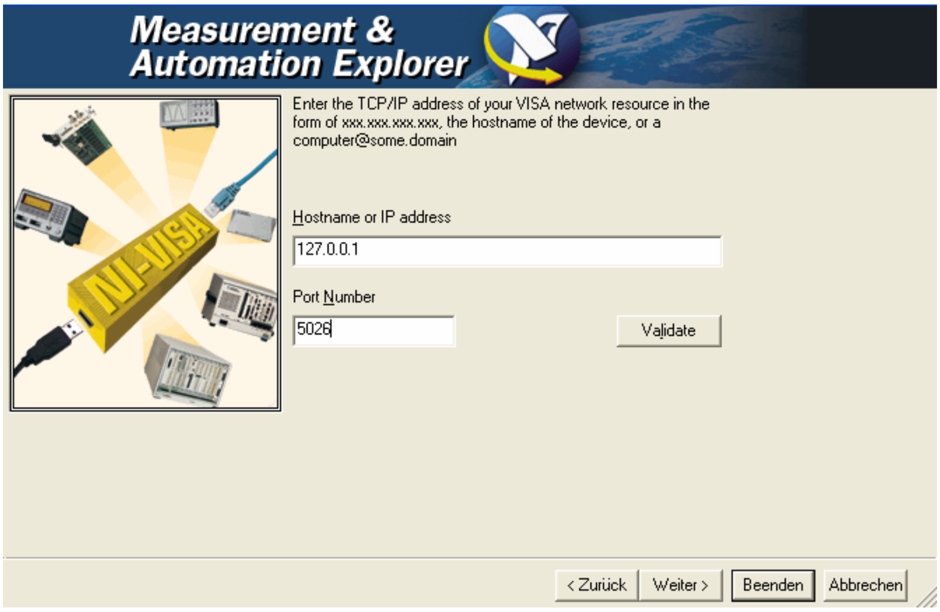
4. Select "VISA TCP/IP Resource" and confirm with "Next".



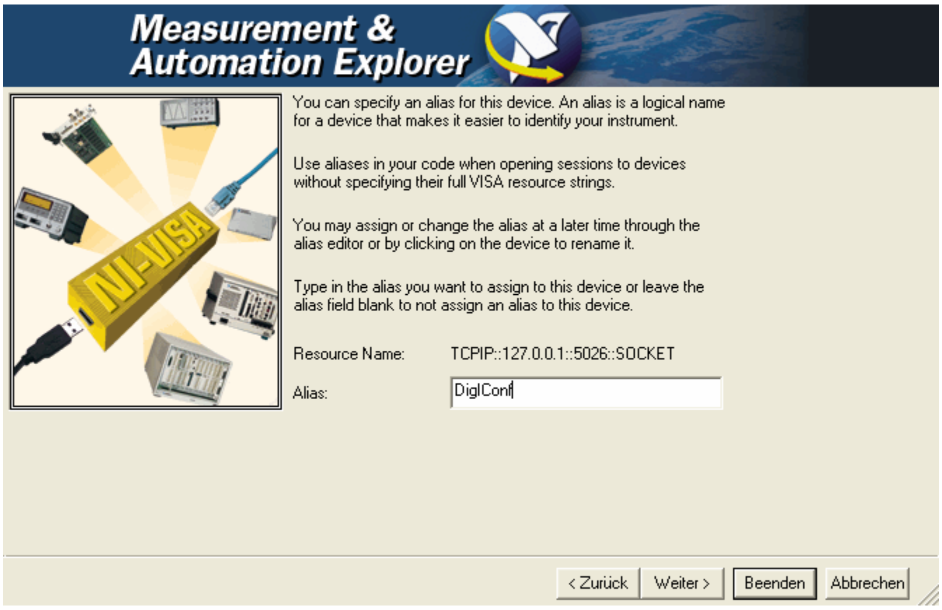
5. Choose the type of TCP/IP resource you wish to add and select "Next".



6. Enter the IP address or the host name of R&S DigIConf and select "Next".

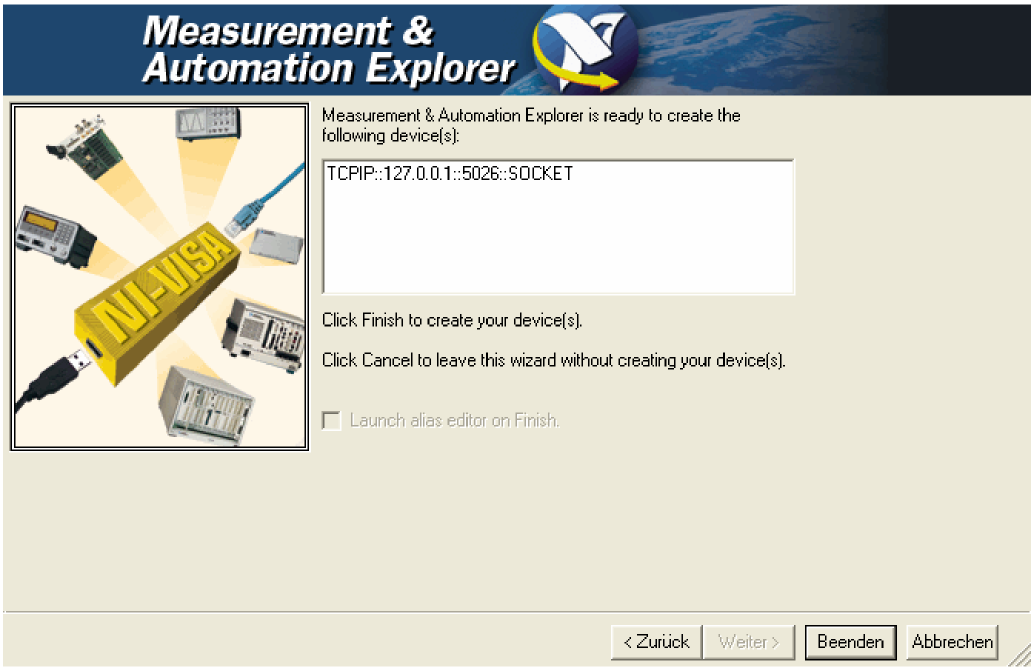


7. Enter the alias name if required.

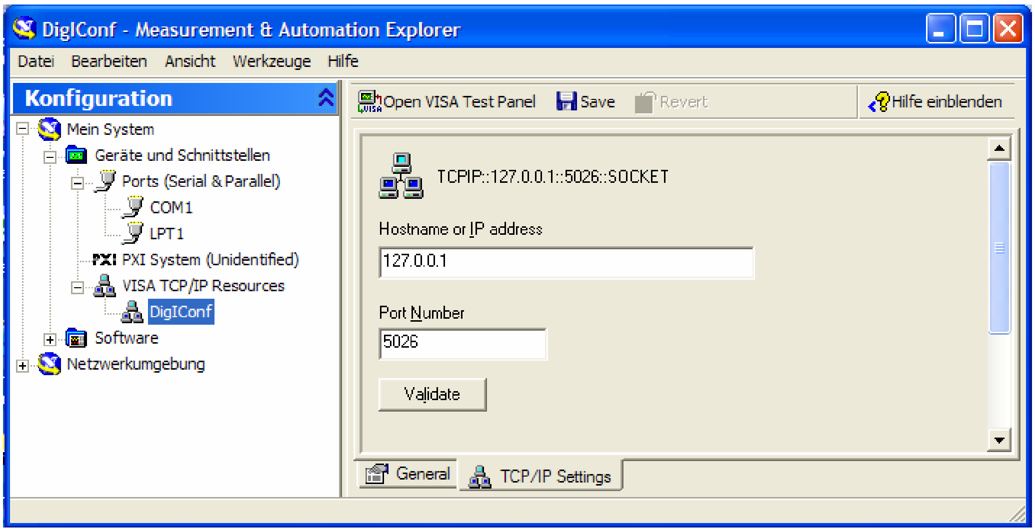


The alias name must not be mistaken for the computer name. It is only used for instrument identification within the program and displayed in the menu as an option in case of an Ethernet link.

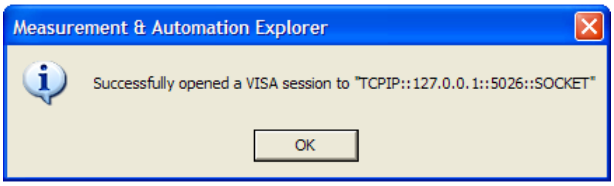
8. Confirm the settings with "Finish".



The instrument is configured and the settings are displayed in the "TCP/IP Settings" tab.



9. To test the connection, select "Validate".



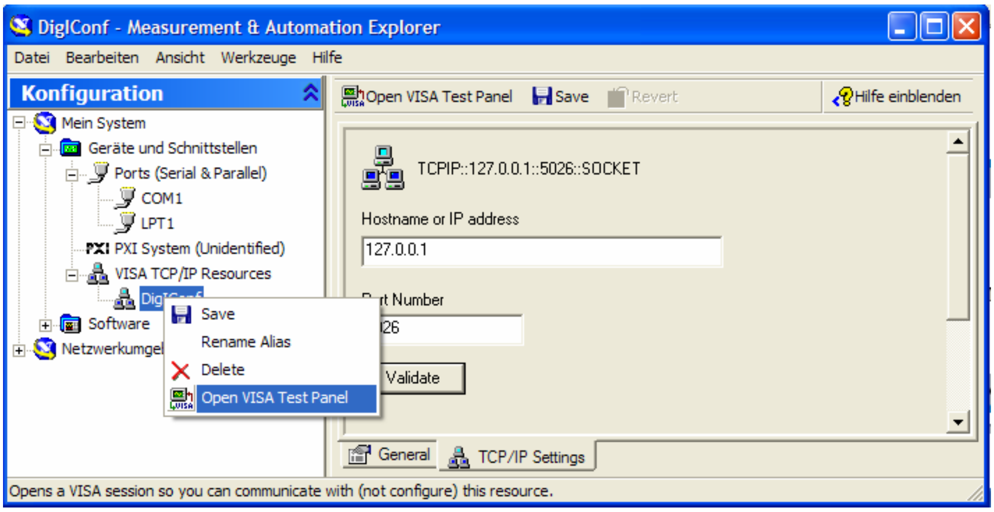
A message indicates whether the link to the instrument can be set up or not.

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.

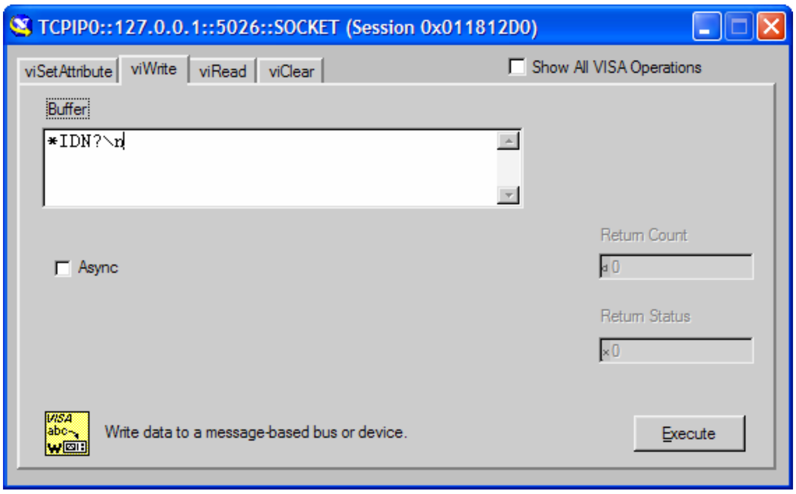
R&S DigIConf is now registered in the program and can be addressed via the resource string or alias name.

Starting a remote control over LAN

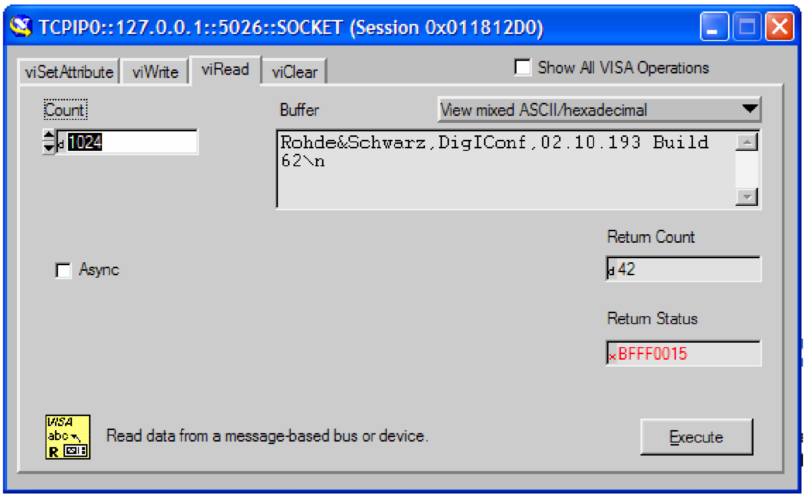
1. Start the 'Measurement & Automation Explorer' on the controller.
2. In the "Configuration" window, select "Device and Interfaces > VISA TCP/IP Resources", select the required instrument and select "Open VISA Test Panel".



3. In the "viWrite" tab, write the command to be send to the instrument and select "Execute".



Instrument responses are displayed on the "viRead" tab.



Tip: For further program operation refer to the online help of the program.

Setting up a Telnet Connection

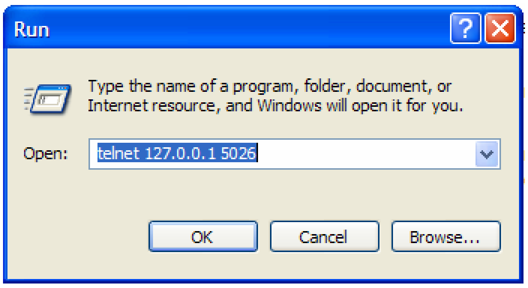
This chapter provides an example on how to establish a remote control connection over telnet protocol and a simple sockets-based program example that can be further developed.

To control the software, only a telnet program is required. The telnet program is part of every operating system.

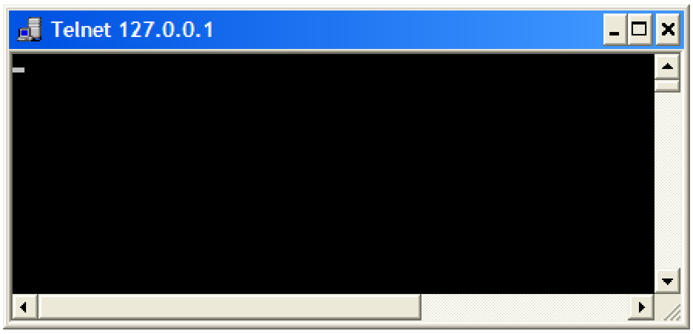
1. To establish a Telnet connection with R&S DigIConf, start the telnet program and enter the socket address.

   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.

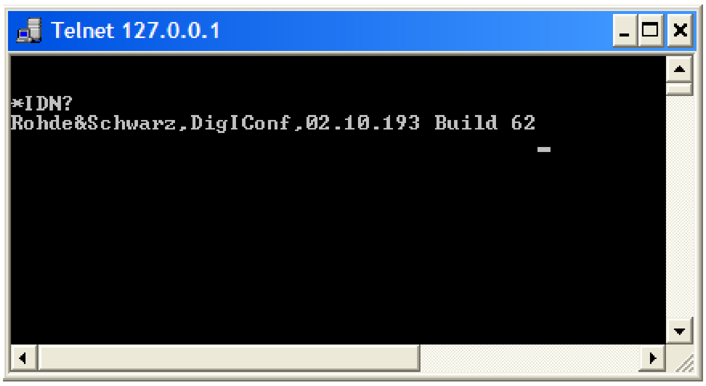
   Tip: R&S DigIConf uses the port number 5026 for remote connection via Telnet.

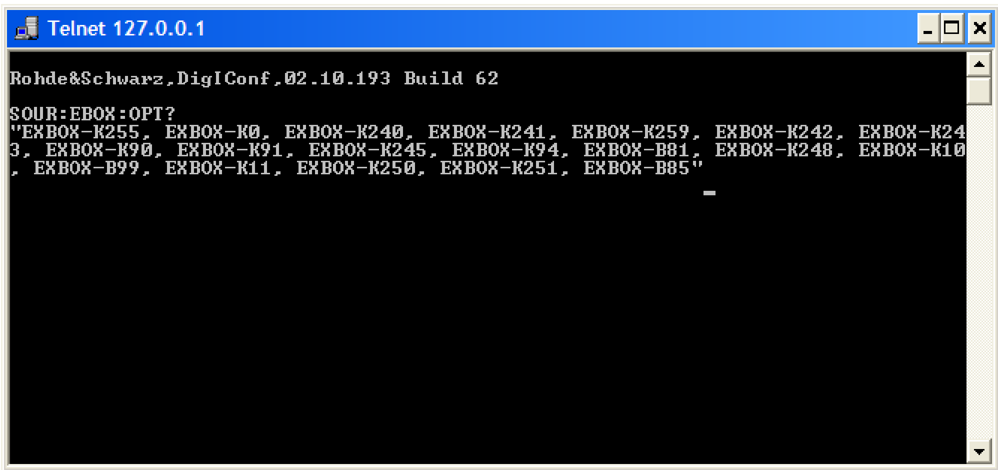
   The connection to the instrument is set up and remote-control commands can be sent.



2. Even if the cursor is not visible on the screen, enter blind a remote-control command and confirm with Enter.



After the first remote-control command had been send, R&S DigIConf is in remote-controlled state.



Instrument response is displayed after the command has been sent.

7.2 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

7.2.1 Syntax for Common Commands

Common (=device-independent) commands consist of a header preceded by an asterisk (*) and possibly one or more parameters.

Examples:

*RST	RESET	Resets the instrument.
*IDN?	IDENTIFICATION QUERY	Queries the instrument identification string.
*OPT?	OPTION IDENTIFICATION QUERY	Queries the options included in the instrument.

7.2.2 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 "SCPI Parameters" on page 231.

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`

7.2.3 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.

7.2.3.1 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.

7.2.3.2 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
```

7.2.3.3 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`

7.3 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`

7.3.1.1 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.

7.4 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.

8 Remote Control Commands

This chapter describes in detail all the remote control commands, which apply generally to R&S DigIConf. It includes common SCPI commands, general commands valid for DigIConf, general memory commands, and commands for controlling the Waveform Memory and Recorder.

Commands related to the specific applications, such as User Defined or Standardized Transmission Protocols are described in the relevant sections of their functional units, see:

- User Defined - Remote Control Commands
- CPRI - Remote Control Commands

8.1 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.

8.1.1 Table of Commands

8.1.2 Command Description

CLear Status

***CLS**

Sets the status byte (STB), the standard event register (ESR) and the `EVENt` part of the `QUEStionable` and the `OPERation` registers to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

Usage Setting only

Identification

***IDN?**

This command returns the instrument identification.

Return Values

<ID> "Rohde&Schwarz,<device type>,<serial number>,<firmwareversion>"

Example `Rohde&Schwarz,ZVA8-4Port,12345,0.10.1.23`

Usage Query only

Operation Complete

***OPC**

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.

Usage Setting only

Option Identification

***OPT?**

Queries the options included in the instrument. For a list of all available options and their description refer to the CD-ROM.

Return Values

<Options>	The query returns a list of options. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed.
Usage	Query only

Recall

***RCL** <Number>

Calls up the instrument status which was stored under the specified number using the `*SAV` command, e.g. `*SAV 4`. It also activates the instrument settings which are stored in a file and loaded using the `MMEMory:LOAD <number>,<file_name.extension>` command.

Reset

***RST**

Sets the instrument to a defined default status. It is equivalent to SYSTem:PRESet. The default settings are indicated in the description of commands.

Usage	Setting only

Save

***SAV** <Number>

Stores the current device state under the specified number (see also "Recall" on page 243). The command is used to store the current instrument state in an intermediate memory. The instrument state can be recalled by using the command *RCL with the associated number.

To transfer the stored instrument settings in a file, use the command:

`MMEMory:STORe:STATe <number>,<file_name.extension>,`

see "Store - Memory" on page 255.

8.2 General R&S EX-IQ-BOX Remote Control Commands

8.2.1 EBOX Subsystem

The EBox subsystem describes all remote-control commands regarding the configuration of an R&S EX-IQ-BOX. Configuration parameters are set via the configuration software R&S DigIConf.

The remote-control commands are listed in alphabetical order, structured by function.

Note: Find a list of all commands for the R&S EX-IQ-BOX at the end of the manual in chapter "Alphabetical List of Commands".

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 more devices are in use, the keyword is mandatory, i.e. the command must contain the keyword with suffix.

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.

8.2.1.1 Table of Commands

8.2.1.2 Description of Commands

ARB Catalog

[:SOURce]: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?`

read out all the waveform filesin the default directory.

Response: `wav1, wav2`

the directory contains the configuration files '`wav1.wv`' and '`wav2.wv`'.

Usage Query only

ARB Delete

[:SOURce]: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> **<directory>**

String parameter to select the directory where the waveform file is stored.

<file_name>

String parameter to specify the file name.

<ext>

File extension for ARB waveform files "*.wv".

Example `SOUR:EBOX:ARB:DEL "D:/USER/wav1.wv"`

delete the file `'wav1.wv'` in the `'USER'` directory on drive `'d:/'`.

EX-IQ-BOX Catalog

[:SOURce]:EBOX:CATalog?
[:SOURce]:DEVice:CATalog?

The command queries the R&S EX-IQ-BOX devices 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-BOX devices.

Response: `'Undefined, 900002, 900010'`

R&S DigIConf currently operates with the R&S EX-IQ-BOXes `'90002'` and `'90010'`.

Usage Query only

EX-IQ-BOX Count

[:SOURce]:EBOX:COUNt <Count>

The command queries / sets the number of connected R&S EX-IQ-BOXes.

<Count> 1 ... 4

Examples `SOUR:EBOX:COUN?`

check the number of connected devices.

Response: `'2'`

currently two devices are connected.

Instrument Name

[:SOURce<[1]|2|3|4>]:EBOX:INST<[1]|2>:NAME?

Queries type and serial number of an R&S instrument connected to the R&S EX-IQ-BOX.

<Instrument> string

Examples `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

Instrument Port

[:SOURce<[1]|2|3|4>]:EBOX:INST<[1]|2>: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.

<Port> string

Examples `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

Instrument Serial

[:SOURce<[1]|2|3|4>]:EBOX:INST<[1]|2>:SERial?

Queries serial number of the R&S instrument connected to the R&S EX-IQ-BOX.

<Number> string

Examples `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

Instrument Type

[:SOURce<[1]|2|3|4>]:EBOX:INST<[1]|2>:TYPE?

Queries the type of an R&S instrument connected to the R&S EX-IQ-BOX.

<Instrument> string

Examples `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

EX-IQ-BOX Options

[:SOURce<[1]|2|3|4>]:EBOX: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.

<Opt> string

Examples `SOUR:EBOX:OPT?`

check the installed options.

Response: `"EXBOX-B85, EXBOX-K10, EXBOX-K11, EXBOX-K90, EXBOX-K242, ..."`

Usage Query only

EX-IQ-BOX Settings Catalog

[:SOURce<[1]|2|3|4>]:EBOX:USER:SETTing:CATalog?

The command queries previously stored settings files of user defined configurations. The query returns the filenames in a comma-separated string.

Return values:

<Catalog> string

Example `MMEM:CDIR "d:/user/settings"`

set the default directory to '`d:/user/settings`'.

`SOUR1:EBOX:USER:SETT:CAT?`

list the settings files stored in the default directory `"d:/user/settings"`.

Response: `"UserSett1.iqbox, UserSett2.iqbox"`

Usage Query only

EX-IQ-BOX Settings Delete

[:SOURce<HW>]:EBOX:USER:SETTing:DELete <Delete>

The erases all settings files in the specified directory. Determine a file by adding the file name and extension of the file. Enter the directory and also the path to determine exactly what is to be deleted.

Setting parameters

<Delete> **<directory>**

String parameter to select the directory where the settings file is stored.

<file_name>

String parameter to specify the file name.

<ext>

File extension for settings waveform files "*.iqbox".

Example `SOUR1:EBOX:USER:SETT:DEL "d:/user/UserSett1.iqbox"`

delete the settings file `'UserSett1.iqbox'` in the `'user'` directory on drive `'d:/'`.

EX-IQ-BOX Select

[:SOURce<[1]|2|3|4>]:EBOX:SELect?

Select a currently connected R&S EX-IQ-BOX by means of its serial number.

<Device> integer (serial number)

Example `SOUR:EBOX:SELect 100117`

select the connected EX-IQ-BOX with serial number `'10117'`.

8.2.2 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..

8.2.2.1 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 "Extensions for User Files" on page 251 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.

8.2.2.2 Extensions for User Files

The following table lists all available file extensions for user files. The currently available files on the instrument depends on the installed options.

List of the automatically assigned file extensions in R&S DigIConf

Function	Type	Contents	File suffix
CPRI	Settings	CPRI configuration, vendor data included	*.cpri
User Defined	Settings	User Defined Configuration	*.iqbox
Recording Memory	Waveform	waveforms and multisegment waveforms	*.wv
Configuration Software	Settings	R&S DigIConf configuration	*.savrcl
Waveform Memory	Waveform	Waveforms and multisegment waveforms	*.wv

8.2.2.3 Table of Commands

8.2.2.4 Description of Commands

Catalog - Memory

:MMEMory:CATalog? <path>

Returns the content of the current or a specified directory.

<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.

*RST:

<path> <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.

Example `MMEM:CAT? '\\Server\DATA\*.LOG'`

Read back all files in \\Server\DATA with the extension ".LOG".

`MMEM:CAT? 'E:/user'`

reads out all files at the highest directory level of the memory stick.

Response: `127145265,175325184,"test,DIR, 0","temp,DIR,0","readme.txt,ASC, 1324","state.savracl,STAT, 5327","waveform.wv,BIN,2342"`

the directory `E:/user` contains the subdirectories `test` and `temp` as well as the files `readme.txt`, `state.savrcl` and `waveform.wv` which have different file types.

Usage Query only

Change Directory - Memory

: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> <string>

String parameter to select the directory to be changed to.

Example `MMEM:CDIR 'test'`

Change from the current directory level to the subdirectory 'test'.

Usage Setting only

SCPI conform

Delete - Memory

:MMEMory:DELete <Delete>

Removes a file from the specified directory.

Setting parameters

<Delete> <string>

String parameter to specify the name and directory of the file to be removed.

Example `MMEM:DEL 'D:/USER/test1.savrcl'`

delete the file 'test1.savrcl' in the 'USER' directory.

Usage Event

SCPI conform

Load - Memory

:MMEMory:LOAD:STATe <sav_rcl_state_number>, <file_name>

Loads the specified file stored under the specified name in an internal memory.

After the file has been loaded, the instrument setting must be activated using an `*RCL` command.

<sav_rcl_state_number>	<integer> Determines to the specific <number> defined with the `*RCL` command, e.g. `*RCL 4`.
<file_name>	<string> String parameter to specify the file name with the extension `*.savrcl`.

Example	`*SAV 4`
	store the current setting in an intermediate memory with number 4. This setting can be recalled using command `*RCL` and the associated number of the memory, e.g. `*RCL 4`.
	`MMEM:STOR:STAT 4,'D:/user/test4.savrcl'`
	store the instrument setting stored with the `*SAV` command under memory number 4 in the file `test4.savrcl` in the `user` directory.
	`MMEM:LOAD:STAT 4,'D:/user/test4.savrcl'`
	load the file `test4.savrcl` in the `user` directory.
	`*RCL 4`
	activates the settings of the file `test4.savrcl`.

Usage	Setting only

Make Directory - Memory

: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.

<MDirectory>	<string> String parameter to specifiy the name of a new directory.
Example	`MMEM:MDIR 'carrier'` create the subdirectory 'carrier' in the current directory.
Usage	Setting only

Remove Directory - Memory

: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.

<RDirectory> <string>

String parameter to specifiy the directory to be deleted..

Example `MMEM:RDIR 'carrier'`

deletes the subdirectory 'carrier' in the current directory.

Usage Setting only

Store - Memory

:MMEMory:STORe:STATe <sav_rcl_state_number>, <file_name>

Stores the current instrument setting in the specified file.

The instrument setting must first be stored in an internal memory with the same number using the common command *SAV.

<sav_rcl_state_number> <integer>

Corresponds to the specific <number> defined with the `*SAV` command, e.g. `*SAV 4`.

<file_name> <string>

String parameter to specify the file name with the extension `*.savrcl`.

Example `*SAV 4`

store the current setting in an intermediate memory with number 4. This setting can be recalled using command `*RCL` and the associated number of the memory, e.g. `*RCL 4`.

`MMEM:STOR:STAT 4,'D:/user/test4.savrcl'`

store the instrument setting stored with the `*SAV` command under memory number 4 in the file `test4.savrcl` in the `user` directory.

Usage Event

8.2.3 SYSTem Subssystem

8.2.3.1 Table of commands

8.2.3.2 Command Description

Error Queue - System

[:SYSTem]:ERRor?

The command queries the error queue and then deletes the entries.

Return values

<file_name> **0**

"No error", i.e. the error queue is empty.

positve value

Positive error numbers denote device specific errors.

negative value

Negative error numbers denote error messaged defined by SCPI.

Example `SYST:ERR?`

query the error queue.

Response: `0, 'no error'`

No errors have occurred since the error queue was last read out.

Usage Query only

8.3 User Defined - Remote Control Commands

This chapter describes all remote-control functions for user defined protocols, including their parameters and value ranges. R&S uses SCPI (**S**tandard **C**ommands for **P**rogrammable **I**nstruments) commands and messages for remote control.

> **Note:** In user-defined mode, you can adjust the parameters of the R&S EX-IQ-BOX either directly from an instrument, or with the aid of the configuration software R&S DigIConf. The same is in the remote control mode, i.e. you can remotely control the device in the same manner.

Beside the main controls, like activating, transmission direction and save/recall settings, the interface is controlled by parameters, which are grouped by function. These include fundamental protocol type settings, data representation and interface clock settings.

The following description lists the remote-control commands by alphabetical order, structured by function.

> **Note:** You can find a list of all commands for the R&S EX-IQ-BOX at the end of the manual in chapter "Alphabetical List of Commands".

As described in chapter Explanation to the SCPI Syntax Used in this Section the SCPI commands are abbreviated in the settings description.

This chapter however covers the SCPI commands fully notated.

All applicable versions of a command are listed at the beginning of a topic. I.e. the notation is described completely for every transmission direction, for R&S DigIConf and for every R&S instrument.

> **Note:** For examples to specific notation for the instruments and for R&S DigIConf refer to Examples of Similar SCPI Commands with Different Root. Section Syntax Modification explains the abbreviations that are used in the settings description.

8.3.1 Root Notation (*) of the Respective R&S Instruments

8.3.1.1 R&S DigIConf

Root command syntax for remote control R&S DigIConf:

```
[SOURce<hw>]:EBOX:USER:...
```

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 more devices are in use, the keyword is mandatory, i.e. the command must contain the keyword with suffix.

8.3.1.2 R&S Signal Generators

Root syntax of the commands for **digital I/Q In (BBIN)** and **digital I/Q Out**:

```
[SOURce<[1]|2>:]BBIN:EXTernal:...
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:...
```

The numerical suffix at SOURce distinguishes between path A and path B for two-path instruments:

`SOURce[1]` = path A

`SOURce2` = path B

Keywords in brackets are optional and can be omitted. E.g. the keyword SOURce is optional with commands for path A , but path B, the command must include the keyword with the suffix 2.

Note: Provided that an R&S Instrument is configured as a two-path instrument, the external baseband signal A can be routed to path A, path B, or both paths. An external baseband signal B can be routed to path B only.

8.3.1.3 Signal Analyzers

Command for **receiver** and **transmitter**:

```
[SOURce:]RECeiver:...
[SOURce:]TRANsmitter:...
```

Keywords in brackets are optional and can be omitted.

8.3.2 Main Settings Subsystem

8.3.2.1 Table of Commands

8.3.2.2 Description of Commands

(*):DIRection - Transmission Direction

[:SOURce<[1]|2|3|4>]:EBOX:USER:DIRection <Direction>
[SOURce<[1]|2>:]BBIN:EXTernal:DIRection <Direction>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:DIRection <Direction>

Note: This command applies to R&S Signal Generators and R&S DigIConf. Setting the direction of transmission for analyzers, refer to "(*):SENDto - Transmission Direction for Analyzers" on page 266.

The command determines the direction of signal transmission from the DUT to the R&S EX-IQ-BOX or 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 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 "Dialogs".

  To toggle between the different types, press the TX SETTINGS or RX SETTINGS softkey to select the type from the combo box.

- 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 generators

  The direction of signal transmission is distinguished as input and output settings dialogs "EX-IQ-BOX BBIN" and "EX-IQ-BOX BBOUT". Therefore, the **direction** access field is not required for R&S signal generators.

The transmission is activated by switching On the "State" button.

<Direction> TRANSmitter | RECeiver

TRANsmitter (Output)

The connected R&S EX-IQ-BOX receives data from an R&S instrument and transmits this data to the DUT.

The baseband signal is transmitted in **S**ingle **D**ata 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.

RECeiver

The connected R&S EX-IQ-BOX receives data from the DUT and transmits this data to an R&S instrument.

*RST: TRANsmitter

Examples

R&S DigIConf

Transmitter	`SOUR2:EBOX:USER:DIR TRAN`
Receiver	`SOUR2:EBOX:USER:DIR REC`

Generator

(*):DRATe - Data Rate

[:SOURce<[1]|2|3|4>]:EBOX:USER:DRATe <DataRate>
[SOURce<[1]|2>:]BBIN:EXTernal:DRATe <DataRate>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:DRATe <DataRate>
SOURce:TRANsmitter:DRATe <DataRate>
SOURce:RECeiver:DRATe <DataRate>

This command 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

<DataRate> SDR | DDR

SDR

The baseband signal is transmitted in **S**ingle **D**ata 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.

DDR

The baseband signal is transmitted in **D**ouble **D**ata **R**ate (DDR) mode from the DUT to the R&S EX-IQ-BOX or vice versa. The data transmission is triggered by the rising edge and the falling edge of the data clock (double speed transfer).

*RST: SDR

Example Set the data rate mode to "Single":

R&S DigIConf

`SOUR1:EBOX:USER:DRAT SDR`

Generator:

I/Q In: `SOUR:BBIN:EXT:DRAT SDR`

I/Q Out: `SOUR:IQ:OUTP:EXT:DRAT SDR`

Analyzer:

Transmitter: `SOUR:TRAN:DRAT SDR`

Receiver: `SOUR:REC:DRAT SDR`

SCPI Device -specific

(*):FORMat - Transmission Format

[:SOURce<[1]|2|3|4>]:EBOX:USER:FORMat <format>
[SOURce<[1]|2>:]BBIN:EXTernal:FORMat <format>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:FORMat <format>
SOURce:TRANsmitter:FORMat <format>
SOURce:RECeiver:FORMat <format>

This command 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

Each sample is transmitted serially, i.e. **bitwise** from the DUT to the R&S EX-IQ-BOX or vice vera. Using the serial protocol, I data and Q data are sent via the input and output pins IO and QO, respectively.

PARAllel

Each sample is transmitted 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 Set the transmission protocol of the R&S EX-IQ-BOX to "serial":

R&S DigIConf

`SOUR1:EBOX:USER:FORM SER`

Generator:

I/Q In: `SOUR:BBIN:EXT:FORM SER`

I/Q Out: `SOUR:IQ:OUTP:EXT:FORM SER`

Analyzer:

Transmitter: `SOUR:TRAN:FORM SER`

Receiver: `SOUR:REC:FORM SER`

SCPI Device -specific

(*):ILEaving - Interleaving

[:SOURce<[1]|2|3|4>]:EBOX:USER:ILEaving <mode>
[SOURce<[1]|2>:]BBIN:EXTernal:ILEaving <mode>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:ILEaving <mode>
SOURce:TRANsmitter:ILEaving <mode>
SOURce:RECeiver:ILEaving <mode>

This command switches on or off interleaving and selects the interleaving mode.

Depending on the interleaving settings, the baseband signal is transmitted in different orders. The data is either sent simultaneously or in I/Q or Q/I order from the external device to the R&S EX-IQ-BOX or vice versa.

Parameters

<mode> OFF | IQ | QI

OFF

The baseband signal is transmitted without interleaving (not Interleaved) on the I and Q data lines.

IQ

The baseband signal is transmitted 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. With the first clock cycle the I data is triggered, the second cycle triggers 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 triggers the Q data.

QI

The baseband signal is transmitted 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 Set the interleaving mode to "IQ":

R&S DigIConf

`SOUR1:EBOX:USER:ILE IQ`

Generator:

I/Q In: `SOUR:BBIN:EXT:ILE IQ`

I/Q Out: `SOUR:BBIN:EXT:ILE IQ`

Analyzer:

Transmitter: `SOUR:TRAN:ILE IQ`

Receiver: `SOUR:REC:ILE IQ`

SCPI Device- specific

(*):LOGic:Type - Logic Type

[:SOURce<[1]|2|3|4>:]EBOX:USER:LOGic:TYPE <Type>
[SOURce<[1]|2>:]BBIN:EXTernal:LOGic[:TYPE] <Type>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:LOGic[:TYPE] <Type>
SOURce:TRANsmitter:LOGictype <Type>
SOURce:RECeiver:LOGictype <Type>

This command selects the signaling system used from the DUT for transmitting the baseband signal.

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 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.

Parameters

Note: The notation of the parameters differ in the SCPI notation for R&S signal generators, R&S DigIConf and R&S signal analyzers. The following description explains the varying notation clearly.

<Type> LVTTL | LVDS | CMOS33 | CMOS25 | CMOS18 | CMOS15 | CMOS12 | SSI18 | SSI28 (R&S DigIConf, R&S signal generators)

LVTTL | LVDS | CM33 | CM25 | CM18 | CM15 | CM12 | SS18 | SS28 (R&S analyzers)

LVDS

The signal is transmitted by using the signaling system LVDS.

LVTT

The signal is transmitted by using the LVTTL technology with a level voltage of 3.3 V.

CMOS33 (DigIConf, generators), CM33 (analyzers)

The signal is transmitted by using the CMOS technology with a level voltage of 3.3 V.

CMOS25 (DigIConf, generators), CM25 (analyzers)

The signal is transmitted by using the CMOS technology with a level voltage of 2.5 V.

CMOS18 (DigIConf, generators), CM18 (analyzers)

The signal is transmitted by using the CMOS technology with a level voltage of 1.8 V.

CMOS15 (DigIConf, generators), CM15 (analyzers)

The signal is transmitted by using the CMOS technology with a level voltage of 1.5 V.

CMOS12 (DigIConf, generators), CM12 (analyzers)

The signal is transmitted by using the CMOS technology with a level voltage of 1.5 V.

SSI18 (DigIConf, generators), SS18 (analyzers)

The signal is transmitted by using the SSI Technology (**S**erial **S**ynchronous **I**nterface) with a voltage level of 1.8 V.

SSI15 (DigIConf, generators), SS15 (analyzers)

The signal is transmitted by using the SSI Technology (**S**erial **S**ynchronous **I**nterface) with a voltage level of 2.8 V.

*RST: CMOS33 (DigIConf, generators)

*RST: CM33 (analyzers)

Example Set the logic type of the R&S EX-IQ-Box to LVDS for receiving a LVDS signal from an external device.

R&S DigIConf

```
SOUR1:EBOX:USER:LOG LVDS
```

Example	**Generator:**
I/Q In:	`BBIN:EXT:LOG LVDS`
I/Q Out:	`IQ:OUTPut:EXT:LOG LVDS`
	Analyzer:
Transmitter:	`SOUR:TRAN:LOG:TYPE LVDS`
Receiver:	`SOUR:REC:LOG:TYPE LVDS`

SCPI Device -specific

(*):PRESet - User Defined (R&S DigIConf)

[:SOURce<[1]|2|3|4>]: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

(*):SENDto - Transmission Direction for Analyzers

SOURce:TRANsmitter:SENDto
SOURce:RECeiver:SENDto

Note: This command refers to R&S Signal Analyzers.

The command determines the direction of signal transmission from the DUT to the R&S EX-IQ-BOX or vice versa.

Examples The connected R&S EX-IQ-BOX receives data from an R&S signal analyzer and transmits this data to the DUT or vice versa.

	Analyzer:
Transmitter	`SOUR:TRAN:SEND`
Receiver	`SOUR:REC:SEND`

(*):SETTing:LOAD - Recall Settings

[:SOURce<[1]|2|3|4>]:EBOX:USER:SETTing:LOAD <Load>

The command loads a previously saved User Defined configuration. Load a settings file by specifying directory and file name. When saving R&S DigIConf automatically assigns the file extension "`*.iqbox`", therefore only files with this extension will be loaded.

Note: This command applies to R&S DigIConf.

Setting parameters

<Load> **<directory>**

String parameter to select the directory where the settings file is stored.

<file_name>

String parameter to specify the file name.

Example `SOUR1:EBOX:USER:SETT:LOAD "D:/USER/Settings/UserSett1.iqbox"`

load the file `'UserSett1.iqbox'` from the `'USER/Settings'` directory on drive `'d:/'`.

(*):SETTing:STORe - Save Settings

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:SETTing:STORe <Store>

Saves the current user defined signal configuration. Specify the directory and file name. R&S DigIConf automatically assigns the file extension `'*.iqbox'` to User Defined configuration files.

Note: This command applies to R&S DigIConf.

Setting parameters

<Store> **<directory>**

String parameter to defined the target directory for storing the settings file.

<file_name>

String parameter to specify the file name.

Example `SOUR1:EBOX:USER:SETT:STOR "UserSett1.iqbox"`

saves the currently defined settings in the file `'UserSett1.iqbox'` in the default directory.

`SOUR:EBOX:CPRI:SETT:STOR "D:/USER/Settings/UserSett1.iqbox"`

saves the currently defined settings in the file `'UserSett1.iqbox'` in the directory `'USER/Settings'` on drive `'d:/'`.

Usage Setting only

(*):SRATe - Sample Rate

[:SOURce<[1]|2|3|4>]:EBOX:USER:SRATe?
[SOURce<[1]|2>:]BBIN:EXTernal:SRATe?
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal: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.

The command is a query command and therefore does not have an *RST value.

Example Query the "sample rate" of the external baseband signal:

R&S DigIConf

`SOUR1:EBOX:USER:SRAT?`

Generator:

I/Q In: `BBIN:EXT:SRAT?`

I/Q Out: `IQ:OUTPut:EXT:SRAT?`

SCPI Device –specific

Comment Query only

(*):STATe - Transmission State

[SOURce<[1]|2|3|4>:]EBOX:USER:STATe <state>

Note: This command applies to R&S DigIConf.

Activates signal transmission.

Data transmission requires that the respective breakout board is connected.

<state> 0 | 1, ON | OFF

Example Switch on signal data transmission.

R&S DigIConf:

`EBOX:USER:STAT ON`

SCPI Device -specific

8.3.3 Clock Subsystem

8.3.3.1 Table of Commands

8.3.3.2 Description of Commands

(*):CLOCk:PHASe - Clock Phase

[:SOURce<[1]|2|3|4>:]EBOX:USER:CLOCk:PHASe <phase>
[SOURce<[1]|2>:]BBIN:EXTernal:CLOCk:PHASe <phase>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:CLOCk:PHASe <phase>
SOURce:TRANsmitter:CLOCk:PHASe <phase>
SOURce:RECeiver:CLOCk:PHASe <phase>

This command sets a phase shift of the active clock edge in 90° steps related to the data bits.

Note: For this setting, the SCPI notation lightly differs between the commands for R&S generators or R&S DigIConf and the commands for the R&S analyzers. This notation is pointed out specially.

<phase> 0 | 90 | 180 | 270 (DigIConf, signal generators)

P0 | P90 | P180 | P270 (analyzers)

Example Set the phase shift of the clock edge to "180" degree:

R&S DigIConf

`SOUR1:EBOX:USER:CLOC:PHAS 180`

Generator:

I/Q In: `SOUR:BBIN:EXT:CLOC:PHAS 180`

I/Q Out: `SOUR:IQ:OUTP:EXT:CLOC:PHAS 180`

Analyzer:

Transmitter `SOUR:TRAN:CLOC:PHAS P180`

Receiver `SOUR:REC:CLOC:PHAS P180`

*RST: 0

Resolution: 90

(*):CLOCk:RATE - Clock Rate

[:SOURce<[1]|2|3|4>]:EBOX:USER:CLOCk:RATE <clockrate>
[SOURce<[1]|2>:]BBIN:EXTernal:CLOCk:RATE <clockrate>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:CLOCk:RATE <clockrate>
SOURce:TRANsmitter:DRATe <clockrate>
SOURce:RECeiver:DRATe <clockrate>

The command 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).

$f_{CLK} = (f_s \cdot WS \cdot Int) / (DDR \cdot SCR)$

		Value range	
f_s =	Sample rate	1 kHz ... 100 MHz	
f_{CLK} =	Clock rate	**LVTTL:** 1 (25) kHz - 400 MHz*)	**LVDS:** 1 (25) kHz - 100 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 stands for the internal clock source, fed in from the R&S Instrument, 25 kHz stands for the external reference from the user interface.

The value range of the clock rate depends on **Protocol**, **Logic Type** and **Signal Type** settings.

Parameters

<clockrate> 1 kHz ...400 MHz

*RST: 10 MHz

Resolution: 1 MHz

Example Query the current frequency of the clock signal of the R&S EX-IQ-BOX:

R&S DigIConf

`SOUR1:EBOX:USER:CLOC:RATE?`

Generator:

I/Q In: `SOUR:BBIN:EXT:CLOC:RATE?`

I/Q Out: `SOUR:IQ:OUTP:EXT:CLOC:RATE?`

Set the clock rate of the R&S EX-IQ-BOX to 10 MHz:

R&S DigIConf

`SOUR1:EBOX:USER:CLOC:RATE 10MHZ`

	Generator:
I/Q In:	`SOUR:BBIN:EXT:CLOC:RATE 10MHZ`
I/Q Out:	`SOUR:IQ:OUTPut:EXT:CLOC:RATE 10MHZ`
	Analyzer:
Transmitter	`SOUR:TRAN:CLOC:RATE 10MHZ`
Receiver	`SOUR:REC:CLOC:RATE 10MHZ`
SCPI	Device -specific
Unit	Hz

(*):CLOCk:REFerence:FREQuency - Reference Frequency

[:SOURce<[1]|2|3|4>]:EBOX:USER:CLOCk:REFerence:FREQuency <frequency>

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

The command 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
	Resolution:
Example	Set the reference frequency to "13 MHz":
	`SOUR1:EBOX:USER:CLOC:RATE 13MHZ`
SCPI	Device -specific
Unit	MHz

(*):CLOCk:REFerence:SOURce - Reference Source

[:SOURce<[1]|2|3|4>]:EBOX:USER:CLOCk:REFerence:SOURce <refsource>

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

This command selects the input connector for an external reference frequency.

If the clock source is set to internal, the R&S EX-IQ-BOX synthesizes the clock frequency and outputs this clock to the user interface. In this operating mode, the internal synthesizer requires a reference frequency from the R&S instrument.

Currently the input of the reference frequency is firmly set to REF IN. The signal is fed into the R&S EX-IQ-BOX at the BNC connector REF IN on the rear panel.

Parameters

<refsource> EXTernal

*RST: EXTERNAL

Resolution: -

Example Set the reference clock source to external:

`SOUR1:EBOX:USER:CLOC:RATE 13MHZ`

SCPI Device -specific

(*):CLOCk:SKEW - Clock Skew

[:SOURce<[1]|2|3|4>]:EBOX:USER:CLOCk:SKEW <skew>
[SOURce<[1]|2>:]BBIN:EXTernal:CLOCk:SKEW <skew>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:CLOCk:SKEW <skew>
SOURce:TRANsmitter:CLOCk:SKEW <skew>
SOURce:RECeiver:CLOCk:SKEW <skew>

The command 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> -5 ns ... +5 ns

*RST: 0

Unit s

Example Assign a time shift of 2 ns:

R&S DiglConf

`SOUR1:EBOX:USER:CLOC:SKEW 2ns`

Generator:

I/Q In: `SOUR:BBIN:EXT:CLOCk:SKEW 2ns`

I/Q Out: `SOUR:IQ:OUTP:EXT:CLOCk:SKEW 2ns`

Analyzer:

Transmitter `SOUR:TRAN:CLOC:SKEW 2ns`

Receiver `SOUR:REC:CLOC:SKEW 2ns`

(*):CLOCk:SOURCe - Clock Source

[:SOURce<[1]|2|3|4>]:EBOX:USER:CLOCk:SOURce <clocksource>
[SOURce<[1]|2>:]BBIN:EXTernal:CLOCk:SOURce <clocksource>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:CLOCk:SOURce <clocksource>
SOURce:TRANsmitter:CLOCk:SOURce <clocksource>
SOURce:RECeiver:CLOCk:SOURce <clocksource>

This command selects the clock source for data transmission. Either the R&S instrument or the external device (DUT) can be set for delivering the reference, irrespective of the direction of transmission.

Parameters

<clocksource> INTernal | EXTernal

INTernal

The BNC reference of the frequency input is used. The R&S EX-IQ-BOX sythesizes 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 (see Rear Panel View). 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: INT

Example Select the "EXTernal" clock source:

R&S DigIConf

`SOUR1:EBOX:USER:CLOC:SOUR EXT`

Generator:

I/Q In: `SOUR:BBIN:EXT:CLOC:SOUR EXT`

I/Q Out: `SOUR:IQ:OUTP:EXT:CLOC:SOUR EXT`

Analyzer:

Transmitter `SOUR:TRAN:CLOC:SOUR EXT`

Receiver `SOUR:REC:CLOC:SOUR EXT`

(*):SCRatio - Sample Clock Rate Ratio

[:SOURce<[1]|2|3|4>]:EBOX:USER:SCRatio <ratio>
[SOURce<[1]|2>:]BBIN:EXTernal:SCRatio <ratio>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:SCRatio <ratio>

Note: This command refers to parallel data transmission.

This command sets the sample to clock rate ratio. This parameter characterizes the ratio of the sample rate to the clock rate.

Parameters

Note: For this setting, the SCPI notation lightly differs between the commands for R&S signal generators or R&S DigIConf and the commands for the R&S analyzers. This notation is pointed out specially.

<ratio> SCR1 | SCR4D5 | SCR2D5 | SCR1D5 | SCR1D10 | SCR1D20 (R&S DigIConf, R&S signal generators)

1 | 0.8 | 0.4 | 0.2 | 0.1 | 0.05 (R&S analyzers)

For SCR < 1:

- dummy samples are added.
- the signal SCR_VALID output at the Reserved0 pin (UI_RESERVE_P0) of the user interface marks the validity of the data.

SCR = 1, 4/5, 2/5, 1/5, 1/10, 1/20

Note: The values of the sample/clock rate depend on the parameter settings of **Word Size**, **Interleaving** and **Data Rate** (see also "(*):CLOCk:RATE - Clock Rate" on page 270).

*RST: 1

Example Set the sample clock rate ratio to "4/5":

R&S DigIConf

`SOUR1:EBOX:USER:SCR SCR4D5`

Generator:

I/Q In: `BBIN:EXT:SCR SCR4D5`

I/Q Out: `IQ:OUTPut:EXT:SCR SCR4D5`

Analyzer:

Transmitter: `SOUR:TRAN:CLOC:SCR 0.8`

Receiver: `SOUR:REC:CLOC:SCR 0.8`

SCPI Device -specific

8.3.4 Data Subsystem

8.3.4.1 Table of Commands

8.3.4.2 Description of Commands

(*):DATA:ALIGnment - Word Alignment

[:SOURce<[1]|2|3|4>]:EBOX:USER:DATA:ALIGnment <align>
[SOURce<[1]|2>:]BBIN:EXTernal:DATA:ALIGnment <align>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:DATA:ALIGnment <align>
SOURce:TRANsmitter:DATA:ALIGnment <align>
SOURce:RECeiver:DATA:ALIGnment <align>

Note: This command refers to parallel transmission mode!

This command 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: Graphics in the dialog of the generators and in R&S DigIConf shows the presently set word alignment in the **User Interface Bits Alignment** section.

Parameters

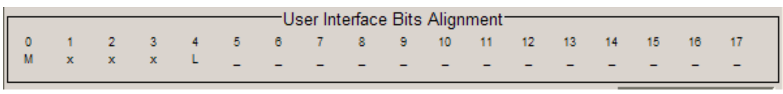
<align> MSB | LSB

MSB

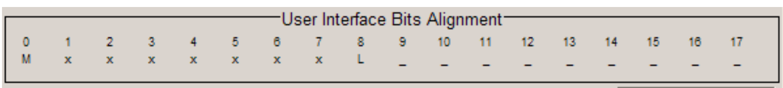
The MSB (**M**ost **S**ignificant **B**it) is mapped firmly to the same data line and the data line of the LSB varies in dependency of the word size.

Examples:

word size = 5, bit order = MSB



word size = 9, bit order = MSB

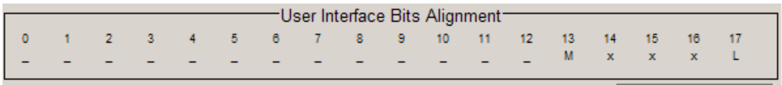


LSB

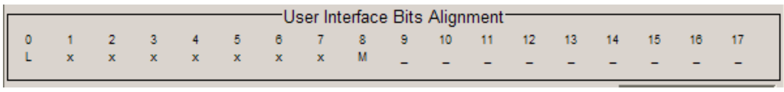
The LSB (**L**ast **S**ignificant **B**it) is mapped firmly to the same data line and the data line of the MSB varies in dependency of the word size.

Examples:

word size = 5, bit order = MSB



word size = 9, bit order = LSB



*RST: MSB

Example Set the word alignment to "LSB".

R&S DiglConf

`SOUR1:EBOX:USER:DATA:ALIG LSB`

Generator:

I/Q In: `SOUR:BBIN:EXT:DATA:ALIG LSB`

I/Q Out: `SOUR:IQ:OUTP:EXT:DATA:ALIG LSB`

Analyzer:

Transmitter `SOUR:TRAN:DATA:ALIG LSB`

Receiver `SOUR:REC:DATA:ALIG LSB`

SCPI Device -specific

(*):DATA:BORDer - Bit Order

[:SOURce<[1]|2|3|4>]:EBOX:USER:DATA:BORDer <bitorder>
[SOURce<[1]|2>:]BBIN:EXTernal:DATA:BORDer <bitorder>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal: DATA:BORDer < bitorder >
SOURce:TRANsmitter: DATA:BORDer < bitorder >
SOURce:RECeiver: DATA:BORDer < bitorder >

This command 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

< bitorder > MSB | LSB

MSB

Transmits the MSB (**M**ost **S**ignificant **B**it) first.

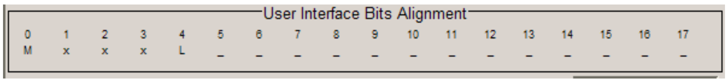
- Parallel transmission

  The MSB is transmitted on the first used data line, depending on the word size and alignment.

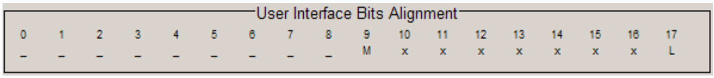
  The graphical display shows the currently set bit order.

  Examples:

  word alignment = MSB, word size = 5



  word alignment = LSB and word size = 9



- Serial transmission

  The MSB (**M**ost **S**ignificant **B**it) is transmitted first.

LSB

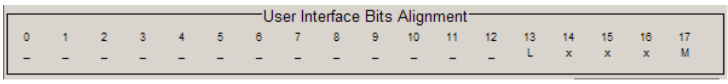
Transmits the LB (**L**ast **S**ignificant **B**it) first.

- Parallel transmission

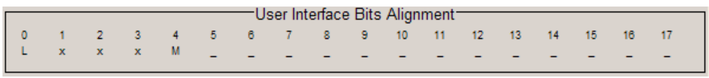
  The LSB (**L**ast **S**ignificant **B**it) is transmitted on the first data line.

  Examples:

  word alignment = MSB, word size = 5



  word alignment = LSB, word size = 5



- **Serial transmission**

  The LSB (**L**ast **S**ignificant **B**it) is transmitted first.

*RST:LBS

Example Set the data bit order to MSB.

R&S DigIConf

`SOUR1:EBOX:USER:DATA:BORD MSB`

	Generator:
I/Q In:	`SOUR:BBIN:EXT:DATA:BORD MSB`
I/Q Out:	`SOUR:IQ:OUTP:EXT:DATA:BORD MSB`
	Analyzer:
Transmitter	`SOUR:TRAN:DATA:BORD MSB`
Receiver	`SOUR:REC:DATA:BORD MSB`
SCPI	Device -specific

(*):DATA:NFORmat - Numeric Format

[:SOURce<[1]|2|3|4>]:EBOX:USER:DATA:NFORmat <numform>
[SOURce<[1]|2>:]BBIN:EXTernal:DATA:NFORmat <numform>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:DATA:NFORmat < numform >
SOURce:TRANsmitter:DATA:NFORmat < numform >
SOURce:RECeiver:DATA:NFORmat < numform >

This command sets the format of the transmitted data.

Allowed number range for word size n Bit: $-2^{n-1} \leq n \leq +2^{n+1}$

2´s Complement

The most significant bit has a value of -2^{n-1}, the bits of lesser significance follow as: $+2^{n-2}$ ... $+2^{0}$

Binary Offset

A binary offset of -2^{n-1} is added such that the final values are always positive.

Example:

n = 4 → -8 ≤ z < 8

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

<numform> TCOMplement | OBINary

TCOMplement

The value of the transmitted data is formatted in two´s-complement.

OBINary

The value of the transmitted data is formatted in binary offset.

*RST: TCOMplement

Example Set the numeric format to two´s-complement.

R&S DigIConf

`SOUR1:EBOX:USER:DATA:NFOR TCOM`

Generator:

I/Q In: `SOUR:BBIN:EXT:DATA:NFOR TCOM`

I/Q Out: `SOUR:IQ:OUTP:EXT:DATA:NFOR TCOM`

Analyzer:

Transmitter `SOUR:TRAN:DATA:NFOR TCOM`

Receiver `SOUR:REC:DATA:NFOR TCOM`

SCPI Device -specific

(*):DATA:SIZE - Word Size

[:SOURce<[1]|2|3|4>]:EBOX:USER:DATA:SIZE <size>
[SOURce<[1]|2>:]BBIN:EXTernal:DATA:SIZE <size>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:DATA:SIZE <size>
SOURce:TRANsmitter:DATA:SIZE <size>
SOURce:RECeiver:DATA:SIZE <size>

This command 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 16 bits. The R&S EX-IQ-BOX supports word sizes from 4 to 18 bits.

Parameters

<size> 4 Bit ... 16 (max. 20) Bit

*RST: 16 Bit

Example Set the word size resolution to 8 bit.

R&S DigIConf

`SOUR1:EBOX:USER:DATA:SIZE 8`

	Generator:
I/Q In:	`SOUR:BBIN:EXT:DATA:SIZE 8`
I/Q Out:	`SOUR:IQ:OUTP:EXT:DATA:SIZE 8`
	Analyzer:
Transmitter	`SOUR:TRAN:DATA:SIZE 8`
Receiver	`SOUR:REC:DATA:SIZE 8`
SCPI	Device -specific

(*):DATA:SPOLarity - Strobe Marker Polarity

[:SOURce<[1]|2|3|4>]:EBOX:USER:DATA:SPOLarity <spolarity>
[SOURce<[1]|2>:]BBIN:EXTernal:DATA:SPOLarity <spolarity>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:DATA:SPOLarity <spolarity>
SOURce:TRANsmitter:DATA:SPOLarity <spolarity>
SOURce:RECeiver:DATA:SPOLarity <spolarity>

Note: This command refers to serial data transmission.

This command describes 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..

The settings of **Clock Phase** or **Clock Skew** do not affect the strobe marker signal.

Parameters

<spolarity> POSitive | NEGative

Positive

The strobe position is indicated by high level.

Negative

The strobe position is indicated by low level.

*RST: POSitive

Example Set the inversion of the strobe marker signal.

R&S DiglConf

`SOUR1:EBOX:USER:DATA:SPOL NEG`

	Generator:
I/Q In:	`SOUR:BBIN:EXT:DATA:SPOL NEG`
I/Q Out:	`SOUR:IQ:OUTP:EXT:DATA:SPOL NEG`
	Analyzer:

Transmitter	`SOUR:TRAN:DATA:SPOL NEG`
Receiver	`SOUR:REC:DATA:SPOL NEG`
SCPI	Device -specific

(*):DATA:SPOSition - Strobe Marker Position

[:SOURce<[1]|2|3|4>]:EBOX:USER:DATA:SPOSition <sposition>
[SOURce<[1]|2>:]BBIN:EXTernal:DATA:SPOSition <sposition>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:DATA:SPOSition <sposition>
SOURce:TRANsmitter:DATA:SPOSition <sposition>
SOURce:RECeiver:DATA:SPOSition <sposition>

Note: This command refers to serial data transmission!

The command sets the sample position of the strobe marker output. The strobe marker is output at the UI_GP5 of the user interface.

Parameters

<sposition>	0 ... word size-1 (max. 20)
	*RST: 0
	Resolution: 1
Example	Set the strobe marker output to sample position 10.
	R&S DigIConf
	`SOUR1:EBOX:USER:DATA:SPOS 10`
	Generator:
I/Q In:	`SOUR:BBIN:EXT:DATA:SPOS 10`
I/Q Out:	`SOUR:IQ:OUTP:EXT:DATA:SPOS 10`
	Analyzer:
Transmitter	`SOUR:TRAN:DATA:SPOS 10`
Receiver	`SOUR:REC:DATA:SPOS 10`
SCPI	Device -specific

(*):DATA:SType - Signal Type

[:SOURce<[1]|2|3|4>]:EBOX:USER:STYPe <signaltype>
[SOURce<[1]|2>:]BBIN:EXTernal:DATA:STYPe <signaltype>
[SOURce<[1]|2>:]IQ:OUTPut:EXTernal:STYPe <signaltype>
SOURce:TRANsmitter:STYPe <signaltype>
SOURce:RECeiver:STYPe <signaltype>

This command 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).

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

<signaltype> IQ | IF

IQ

Transmits the digital I and Q signals separately.

IF

Assembles and modulates the digital I and Q samples to a carrier frequency (IF). The frequency of the IF signal is set to a quarter of the clock rate, e.g. with a clock rate of 400 MHz the value of the IF frequency is 100 MHz.

Note: IF is available in parallel signal output.

*RST: IQ

Example Set the signal type for transmission to "IQ".

R&S DigIConf

`SOUR1:EBOX:USER:DATA:STYP IQ`

Generator:

I/Q In: `SOUR:BBIN:EXT:DATA:STYP IQ`

I/Q Out: `SOUR:IQ:OUTP:EXT:DATA:STYP IQ`

Analyzer:

Transmitter `SOUR:TRAN:DATA:STYP IQ`

Receiver `SOUR:REC:DATA:STYP IQ`

8.3.5 Test Subsystem

8.3.5.1 Table of Commands

8.3.5.2 Description of Commands

(*):Rx Test BER

[:SOURce<[1]|2|3|4>]:EBOX:USER:TEST:RX:BER?

Queries the bit error rate. 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.

Parameters

<BER> integer

*RST: 0

Example **R&S DigIConf**

`SOUR1:EBOX:USER:DIR REC`

set direction `'Receiver'`.

`SOUR1:EBOX:USER:TEST:RX:STAT ON`

switch on Rx test.

`SOUR1:EBOX:USER:TEST:RX:BER?`

check the bit error rate.

(*):Rx Test Signal

[:SOURce<[1]|2|3|4>]:EBOX:USER:TEST:TX:STATe <State>

Selects the expected test signal to be analyzed.

The test receiver can analyze PRBS 16 or counter test signals.

Parameters

<Signal> PRBS | COUNter | SINE

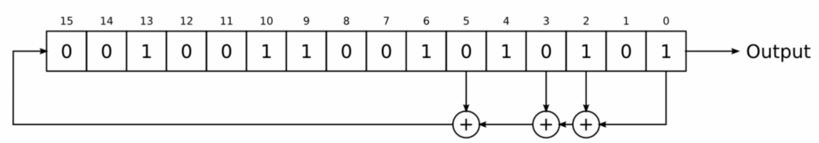
PRBS

A PRBS 16 (**P**seudo **R**andom **B**inary **S**equence) sequence is generated. The output of this sequence is according to the **protocol**, **data** and **clock** settings of the R&S EX-IQ-BOX

E.g. if the I/Q sample is set to a word size of 7 bits, then the PRBS 16 sequence is output in pieces of 7 bits.

The I and Q values always contain the same copy of one test sample.

The PRBS 16 sequence is fully described by the generator polynomial $G(x) = 1 + x^2 + x^3 + x^5 + x^{16}$. The functional implementation of this PRBS generator is also defined by the following linear feedback shift register (LFSR):



COUNter

A counter test signal is generated. The counter size is adjusted to the word size of the **data** settings. Each output sample the counter value will be incremented by 1.

*RST: PRBS

Example **R&S DigIConf**

`SOUR1:EBOX:USER:DIR REC`

set direction `'Receiver'`.

`SOUR1:EBOX:USER:TEST:TX:SIGN COUN`

select a counter signal for testing.

(*):Rx Test State

[:SOURce<[1]|2|3|4>]:EBOX:USER:TEST:RX:STATe <State>

Switches the test receiver on or off.

The R&S EX-IQ-BOX expects a test signal to be input at the user interface. After switching on, the test receiver synchronizes to the last received data word. From that time onward, the test receiver generates its own test sequence and compares each generated sample with the corresponding received sample.

Parameters

<State> ON | OFF

*RST: OFF

Example **R&S DigIConf**

`SOUR1:EBOX:USER:DIR REC`

set direction `'Receiver'`.

`SOUR1:EBOX:USER:TEST:RX:STAT ON`

switch on Rx test.

(*):Rx Test Words

[:SOURce<[1]|2|3|4>]:EBOX:USER:TEST:RX:WORDS?

Queries the total number of received words. This functions consecutively counts the number of received words in order to compare them with the sent data and to determine the error rate.

Parameters

<Words> integer

*RST: 0

Example **R&S DigIConf**

`SOUR1:EBOX:USER:DIR REC`

set direction `'Receiver'`.

`SOUR1:EBOX:USER:TEST:RX:STAT ON`

switch on Rx test.

`SOUR1:EBOX:USER:TEST:RX:WORD?`

check the number of received words.

(*):Tx Test Signal

[:SOURce<[1]|2|3|4>]:EBOX:USER:TEST:TX:SIGNal <Signal>

Selects a test signals of the test generator. Three different signals are available.

Parameters

<Signal> PRBS | COUNter | SINE

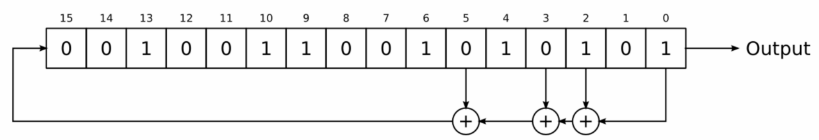
PRBS

A PRBS 16 (**P**seudo **R**andom **B**inary **S**equence) sequence is generated. The output of this sequence is according to the **protocol**, **data** and **clock** settings of the R&S EX-IQ-BOX

E.g. if the I/Q sample is set to a word size of 7 bits, then the PRBS 16 sequence is output in pieces of 7 bits.

The I and Q values always contain the same copy of one test sample.

The PRBS 16 sequence is fully described by the generator polynomial $G(x) = 1 + x^2 + x^3 + x^5 + x^{16}$. The functional implementation of this PRBS generator is also defined by the following linear feedback shift register (LFSR):



COUNter

A counter test signal is generated. The counter size is adjusted to the word size of the **data** settings. Each output sample the counter value will be incremented by 1.

SINE

A complex sine signal is generated, following the formula below:

$$s(n) = e^{j2\pi\frac{f}{f_s}n} = \cos\left(2\pi\frac{f}{f_s}n\right) + j\sin\left(2\pi\frac{f}{f_s}n\right)$$

The real component is

$$I(n) = \cos\left(2\pi\frac{f}{f_s}n\right)$$

and the imaginary component is

$$Q(n) = \sin\left(2\pi\frac{f}{f_s}n\right)$$

Here, **n** is the discrete time index, **f** is the frequency of the test sine signal, and $\mathbf{f_s}$ is the sampling frequency that results from the settings in the sections **protocol**, **data** and **clock**.

*RST: PRBS

Example **R&S DigIConf**

`SOUR1:EBOX:USER:DIR TRAN`

set direction `'Transmitter'`.

`SOUR1:EBOX:USER:TEST:TX:SIGN COUN`

select a counter signal for testing.

(*):Tx Test State

[:SOURce<[1]|2|3|4>]:EBOX:USER:TEST:TX:STATe <State>

Switches the test generator on or off. While the test generator is switched on, the I/Q data source coming from DIG IQ IN is replaced by the test signal.

Parameters

<State> ON | OFF

*RST: OFF

Example **R&S DigIConf**

`SOUR1:EBOX:USER:DIR TRAN`

set direction `'Transmitter'`.

`SOUR1:EBOX:USER:TEST:TX:STAT ON`

switch on the test generator.

(*):Tx Test Sine Amplitude

[:SOURce<[1]|2|3|4>]: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 ... 0 dBFS

Resolution: 1 dBFS

Example **R&S DigIConf**

`SOUR1:EBOX:USER:DIR TRAN`

set direction `'Transmitter'`.

`SOUR1:EBOX:USER:TEST:TX:SINE:AMPL -50DBFS`

set the Amplitude to `'-50 dBFS'`.

(*):Tx Test Sine Frequency

[:SOURce<[1]|2|3|4>]: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 settings, the double data rate setting and the interleaving mode.

Parameters

<Frequency> float

Range: -4 MHz ... 4 MHz

Resolution: 1 kHz

Example **R&S DigIConf**

`SOUR1:EBOX:USER:DIR TRAN`

set direction `'Transmitter'`.

`SOUR1:EBOX:USER:TEST:TX:SINE:FREQ 100KHZ`

set the test frequency to `'100 kHz'`.

8.4 CPRI - Remote Control Commands

This chapter describes all remote-control commands for the standardized protocol CPRI, including their parameters and value ranges. R&S uses SCPI (**S**tandard **C**ommands for **P**rogrammable **I**nstruments) commands and messages for remote control. For standardized protocols the parameters of the R&S EX-IQ-BOX are set with the aid of 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 "Remote Control Basics".

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

The following description lists the remote-control commands in alphabetical order, structured by function.

Note: Find a list of all commands for the R&S EX-IQ-BOX at the end of the manual in chapter "Alphabetical List of Commands".

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 more devices are in use, the keyword is mandatory, i.e. the command must contain the keyword with suffix.

8.4.1 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.

Tip: Refer also to "ARB - Catalog" in order to get a list of available ARB files.

The numeric suffix to `ARB<ch>` distinguishes the channel of the waveform memory (`ARB1...4`).

8.4.1.1 Table of Commands

8.4.1.2 Description of Commands

ARB Preset - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:ARB:PRESet

Calls the default settings of the Wavefom Memory.

Example `SOUR1:EBOX:CPRI:ARB:PRES`
set the waveform memory parameters to default.

Usage Event

ARB Reload - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:ARB:RELoad

Refreshes all currently loaded waveform files.

Setting parameters

Example `SOUR1:EBOX:CPRI:ARB:REL`
update assigned files in the waveform memory of R&S DigIConf.

Usage Event

ARB Total Samples - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:ARB:SAMPles:TOTal?

Queries the number of samples including all active waveform files.

Example `SOUR1:EBOX:CPRI:ARB:SAMP:TOT?`
check the entire number of samples.
Response: `'0.154 MSamples'`

Usage Query only

ARB Options Conflict - CPRI

[:SOURce<[1]|2|3|4>]: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.

Example `SOUR1:EBOX:CPRI:ARB:CONF?`
check whether an option conflict is given.
Response: `"0"` if OK, `"1"` if not OK

Usage Query only

ARB File - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:ARB<ch>:FILE <Select>

The command selects a stored waveform file. Enter directory and file name with the file extension ***. wv** for waveform files..

Setting parameters

<Select> <Path>, <File_Name>

<Path>

String parameter to select the directory where the waveform file is stored.

<File_Name>

String parameter to specify the file name.

<ext>

File extension for waveform files "*.wv".

Example
`SOUR1:EBOX:CPRI:ARB2:FILE "..//DigIConf/Waveforms/p4DQPSK7.wv"`
Load the file "waveform" into the second ARB waveform memory.

SCPI Device-specific

ARB Samples - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:ARB<ch>:SAMPles?

The command queries the number of samples the loaded signal is composed of.

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"

SCPI Device-specific

ARB Sample Rate - CPRI

[:SOURce<[1]|2|3|4>]: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.

Example
`SOUR1:EBOX:CPRI:ARB1:SRAT?`
query the sample rate of the signal loaded in ARB1 wavefiorm memory.

`Response: 122.88`
the current sample rate is "122.88 Mbit/s"

SCPI Device-specific

ARB State - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:ARB<ch>:STATe <State>

The command switches on the transmission of the test data.

<State>	ON | OFF
	*RST: OFF
Example	`SOUR1:EBOX:CPRI:ARB1:STAT ON`
	activate waveform loaded in ARB1.
SCPI	Device-specific

8.4.2 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 (**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-**L**evel **D**ata **L**ink **C**ontrol) and the fast Ethernet.

8.4.2.1 Table of Commands

8.4.2.2 Description of Commands

Ethernet Active - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:ETH:ACTive?

The command queries whether the interface is active.

Parameters

<Active> 0 | 1

*RST: 0

Example `SOUR1:EBOX:CPRI:CM:ETH:ACT?`

check the activity of the Ethernet interface.

`Response: 0`

the interface is not active.

SCPI Device-specific

Usage Query only

Ethernet Bit Rate - CPRI

[:SOURce<[1]|2|3|4>]: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.

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"

SCPI Device-specific

Unit Mbit/s

Ethernet Command - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:ETH:COMMand <Command>

This command enters a control command in fast C&M interactive mode.

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.

SCPI Device-specific

Usage Event

Ethernet Execute - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:ETH:EXECute

The command sends the entered fast C&M data.

Parameters

Example `SOUR1:EBOX:CPRI:CM:ETH:EXEC`
execute the control command of fast C&M data.

SCPI Device-specific

Usage Event

Ethernet Preferred Pointer - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:ETH:PPTR <Pptr>

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

<Pptr> 20...63

*RST: 20

Example `SOUR1:EBOX:CPRI:CM:ETH:PPTR 25`
set the ethernet pointer to "25"

SCPI Device-specific

Ethernet Pointer - CPRI

[:SOURce<[1]|2|3|4>]: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 EXBOX-B85 and the DUT.

Parameters

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.

SCPI Device-specific

Ethernet State - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:ETH:STATe <State>

The command activates the C&M data exchange via the Ethernet interface.

Parameters

<State> ON | OFF
*RST: OFF

Example `SOUR1:EBOX:CPRI:CM:ETH:STAT ON`
switch on fast C&M.

SCPI Device-specific

HDLC Active - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:HDLC:ACTive?

The command queries whether the interface is active.

Parameters

<Active> 0 | 1
*RST: 0

Example `SOUR1:EBOX:CPRI:CM:HDLC:ACT?`
checks the activity of the HDLC interface.
Response: `0`
the interface is not active.

SCPI Device-specific

Usage Query only

HDLC Bit Rate - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:HDLC:BRATe <Brate>

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

<Brate> 240 | 480 | 960 | 1920 | 2400

*RST: 240 kbit/s

Unit kbit/s

Example `SOUR1:EBOX:CPRI:CM:HDLC:BRAT 480`

select a bit rate of "480 kbit/s" for slow C&M transmission.

Usage SCPI conform

HDLC Command - CPRI

[:SOURce<[1]|2|3|4>]: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 interface, this control is not active (CPRI REC Test mode).

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.

Usage Event

HDLC Execute - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:HDLC:EXECute

The command sends the entered slow C&M data.

This command applies Slow C&M Source "Terminal". In direct mode, i.e. control data coming via the RS-232 interface, this control is not active (CPRI REC Test mode).

Example `SOUR1:EBOX:CPRI:CM:HDLC:EXEC`

executes the control command of slow C&M data.

Usage Event

HDLC FCS Error - CPRI

[:SOURce<[1]|2|3|4>]: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.

Parameters

<Fcs> 0 | 1

*RST: 1

Example `SOUR1:EBOX:CPRI:CM:HDLC:FCS?`

query the result of the CRC check.

Usage Query only

HDLC Mode - CPRI

[:SOURce<[1]|2|3|4>]: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 EXBOX-B85 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 (HDLC EN/DE Coding)

The R&S EXBOX-B85 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".

*RST: ECODing

Example `SOUR1:EBOX:CPRI:CM:HDLC:MODE DIR`

send the data without internal encodin/decoding.

SCPI Device-specific

HDLC Frames Received - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:HDLC:RFRames?

The command queries the number of received HDLC frames.

Parameters

Example `SOUR1:EBOX:CPRI:CM:HDLC:RFR?`

query the number of received HDLC frames.

SCPI Device-specific

Usage Query only

HDLC Frames Sent- CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:HDLC:SFRames?

The command queries the number of sent HDLC frames.

Parameters

Example `SOUR1:EBOX:CPRI:CM:HDLC:SFR?`

query the number of sent HDLC frames.

SCPI Device-specific

Usage Query only

HDLC Source - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM:HDLC:SOURce <Source>

The command selects the source of the HDLC C&M data.

Parameters

<Source> TERMinal | RS232

TERMinal

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.

This method is applicable to both, 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.

SCPI Device-specific

HDLC State - CPRI

[:SOURce<[1]|2|3|4>]: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> ON | OFF

*RST: OFF

Example `SOUR1:EBOX:CPRI:CM:HDLC:STAT ON`
switch on slow C&M.

SCPI Device-specific

8.4.3 Hardware Subsystem

The **Hardware** 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.

8.4.3.1 Table of Commands

8.4.3.2 Description of Commands

Alarm Status- CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:ALARm?

This command queries, if any alarm is detected on the CPRI communication link, i.e. it acts as a summary warning indicator.

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

Breakout Board Revision - CPRI

[:SOURce<[1]|2|3|4>]: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

CPRI Mode - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:CMODe?

This command indicates the role of the R&S EX-IQ-BOX, i.e. either master (CPRI RE test) or slave (CPRI REC test).

Return values

<CpriMode> <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

Core Mode - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:CORE?

This command queries the current state of the CPRI core.

Return values

<CoreMode> <string>

Link is up

normal operating mode

Reset

at the starting point of establishing the link

L1 Synchronization

attempting of L1 synchronization

Setup protocol version

protocol version setup

Setup C&M parameter

C&M parameter setup

Example `SOUR1:EBOX:CPRI:HW:CORE?`
check the current mode of the CPRI core.

Response: `'Link is up'`
the CPRI conmmunication link operaties in normal mode.

Usage Query only

EX-IQ-BOX Board Revision - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:EBRevision?

This command indicates 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 EX-IQ-BOX board has revision 123.

Usage Query only

FPGA Base Version - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:FBVersion?

This command queries the version of the FPGA (**F**ield **P**rogrammable **G**ate **A**rray) basic design.

Return values

<fbversion> <string>

Example `SOUR1:EBOX:CPRI:HW:FBV?`
query the version of the FPGA basic design.

Response: `02.01.123`
the CPRI FPGA has revision 02.01.123.

Usage Query only

FPGA Version - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:FCVersion?

This command queries the version of the FPGA (**F**ield **P**rogrammable **G**ate **A**rray) 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

GPIO Direction - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:GPIO<dir>:DIRection <Direction>

The command determines the direction of transmission of the connected GPIO interfaces. You can individually activate each of the three interfaces separately.

The numeric suffix to `GPIO<dir>` distinguishes between the available GPIO interfaces.

Parameters

<Direction> OFF | OUTPut | INPut

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.

*RST: OFF

Example `SOUR1:EBOX:CPRI:HW:GPIO1:DIR OUTP`
Define GPIO interface 1 for, e.g. control signal output.

SCPI Device-specific

GPIO Signal - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:GPIO<dir>: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 to `GPIO` distinguishes between the available GPIO interfaces.

GPIO Output Parameters

<Signal> CLOW | CHIGh | DLBF | ULBF | DLHF | ULHF | DLNBF| ULNBF | TMC | RCLock

CLOW | CHIGh

Set the control signal to constant level high or low.

DLBF | ULBF

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.

DLHF| ULHF

Use the CPRI hyper frame clock for control. The hyper frame clock rate amounts 15 kHz.

DLNBF | ULNBF

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.

TMC

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..

RCLock

Use this signal as clock reference output in order to feed the clock reference to connected instruments and/or the DUT.

*RST:

Example `SOUR1:EBOX:CPRI:HW:GPIO1:SIG DLNBF`

use the information in the CPRI Node B frame for control.

SCPI Device-specific

GPIO Input

In input mode, each of the three GPIO ports provide connection of an external trigger signal.

Input (High Speed Serial Switch) - CPRI

[:SOURce<[1]|2|3|4>]: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 one of the optical interfaces SFP1, or SFP2.

Parameters

<Input> SFP1 | SFP2 | SMA | LOOPback | NONE

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 to receive the signal.

SMA

Select the SMA (**S**ub**M**iniatur version **A**) interface, if the R&S EX-IQ-BOX is receiving the signal from the DUT via this transmission line.

LOOPback

Assign the internal loopback, if the signal is routed back internally.

NONE

Deactivate the input, if no connection is established.

*RST: SFP1

Example `SOUR1:EBOX:CPRI:HW:HSSS:INP SFP2`

Assign the second "SFP2" interface for signal input .

SCPI Device-specific

Output SFP / SMA (High Speed Serial Switch) - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP1[:STATe] <Output>
[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:HSSS:OUTPut:SMA[:STATe] <Output>

The command determines 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.

SFP<ch>

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.

The numeric suffix to `SFP` distinguishes between the available SFP interfaces.

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 via this transmission line.

Use the command
[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:HSSS:OUTPut:SMA[:STATe] **<Output>** in order to assign the output signal to this interface.

Parameters

<Output> ON | OFF

*RST: SFP1

Example
`SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SFP1 ON`
`SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SMA ON`
activate the "SFP1" and the "SMA" interfaces for signal output.

SCPI Device-specific

Line Bit Rate - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:LBRate <Lbrate>

The command 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 | LRAuto

LR2X

2x1228.8 Mbit/s

LR2X

4x2457.6 Mbit/s

LR2X

5x3072.0 Mbit/s

*RST: LR2X

Example
`SOUR1:EBOX:CPRI:HW:LBR LR2X`
Set the line bit rate 2x1228.8 Mbit/s.

SCPI Device-specific

LOF (Loss of Frame) - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:LOF?

The command queries the CPRI frame delimiter K28.5.

<lof>	0 | 1
	*RST: `0`
Examples	`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

LOS (Loss of Signal) - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:LOS?

The command queries data synchronization.

<los>	0 | 1
	*RST: `0`
Examples	`SOUR1:EBOX:CPRI:HW:LOS?` check if data is synchronized.
	Response: `1 (0 =` no error) data lost their synchronization .
Usage	Query only

Clock Recovery Locked - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:RCLock:CRLocked?

This command queries, if clock recovery is unlocked. Clock recovery must be locked in CPRI REC test mode.

Parameters

<cslocked> 0 | 1

*RST: `0`

Example `SOUR1:EBOX:CPRI:HW:RCL:CRL?`

check if clock recovery is locked.

Response: `1 (0 =` no error)
clock recovery is unlocked.

Usage Query only

Clock Synthesis Locked - CPRI

[:SOURce<[1]|2|3|4>]: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.

Parameters

<cslocked> 0 | 1

*RST: `0`

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

10MHz Reference Output locked - CPRI

[:SOURce<[1]|2|3|4>]: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.

Parameters

<cslocked> 0 | 1

*RST: 0

Example `SOUR1:EBOX:CPRI:HW:RCL:ROL?`

check if the reference clock output is available.

Response: `1 (0 =` no error)
clock output is not available.

Usage Query only

Clock Source - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:RCLock:SOURce <Source>

The command 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.

Parameters

<Source> RIN | INTernal | CRECovery

RIN

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.

Applies to a CPRI RE test setup with an external connected R&S instrument.

INTernal

The R&S EX-IQ-BOX uses its internal reference oscillator for synchronization.

Applies to a CPRI RE test setup if the R&S EX-IQ-BOX is working stand-alone.

CRECovery

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.

*RST: RIN

Example `SOUR1:EBOX:CPRI:HW:RCL:SOUR RIN`

set the internal clock source for reference.

Differential Output Swing

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:SMA:DOSWing <Doswing>

Determine the differential output voltage swing of the CML (**C**urrent **M**ode **L**ogic) transmitter.

Parameters

<Doswing> 0.1...1.6 Vpp

*RST: 0.8

Example `SOUR1:EBOX:CPRI:HW:SMA:DOSW 1.0`

Set the differential output voltage of the CML to 1.0 Vpp

SCPI Device-specific

Unit V

Rx Equalizer Gain - CPRI

[:SOURce<[1]|2|3|4>]: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.

Parameters

<Rxegain> 0...15 dB

*RST: 0 dB

Example `SOUR1:EBOX:CPRI:HW:SMA:RXEG 10`

Set the equalizer gain to "10 dB".

SCPI Device-specific

Unit dB

Timing Valid - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW:TIMing?

The command indicates, if the R21 timing calculation is invalid (CPRI requirement 21).

<Timing> 0 | 1

*RST: `0`

Examples `SOUR1:EBOX:CPRI:HW:TIM`

check if timing calculation is correct.

Response: `1`

the R21 timing calculation is invalid.

Usage Query only

8.4.4 Main Settings Subsystem

The **Main Settings** command provides the selection of the "CPRI Test Mode". Additionally, the subsystem encloses all commands with regard to the common main controls as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading previously defined settings.

8.4.4.1 Table of Commands

8.4.4.2 Description of Commands

Mode - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:MODE <Mode>

The command selects the CPRI test mode. 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.

<Mode> RETest | RECTest

*RST: RETest

Examples `SOUR1:EBOX:CPRI:MODE RECT`

activate CPRI REC test mode.

Preset - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:PRESet

Set all parameters to default values. Refer to table Preset - CPRI default settings which contains an overview of the most important default settings.

Example `SOUR1:EBOX:CPRI:PRES`

setup all CPRI parameters to the default value.

Usage Event

Settings Catalog - CPRI

[:SOURce<[1]|2|3|4>]: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.

Setting parameters

<Catalog> <string>

String parameter to select the directory where settings files are stored.

Example `MMEM:CDIR "D:/USER/CPRISettings"`

Set the default directory and path to `'D:/USER:/CPRISettings'`.

`SOUR1:EBOX:CPRI:SETT:CAT?`

read out all settings files of the `'user/CPRISettings'` directory on drive `'d:/'`.

Usage Query only

Settings Delete - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI: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>**

String parameter to select the directory where the settings file is stored.

<file_name>

String parameter to specify the file name.

<ext>

File extension for CPRI settings files "*.cpri".

Example `SOUR1:EBOX:CPRI:SETT:DEL "D:/USER/CPRISettings/RETtest.cpri"`

delete the file `'RETtest.cpri'` in the `'USER/CPRISettings'` directory on drive `'d:/'`.

Settings Recall - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:SETTing:LOAD <Load>

The command loads a previously saved CPRI configuration. Load a settings file by specifying directory and file name. When saving R&S DigIConf automatically assigns the file extension '*.cpri', therefore only files with this extension will be loaded.

Setting parameters

<Load> **<directory>**

String parameter to select the directory where the settings file is stored.

<file_name>

String parameter to specify the file name.

Example

```
SOUR1:EBOX:CPRI:SETT:LOAD
"D:/USER/CPRISettings/RETtest.cpri"
```

load the file `'RETtest.cpri'` from the `'USER/CPRISettings'` directory on drive `'d:/'`.

Save - CPRI

[:SOURce<[1]|2|3|4>]: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>**

String parameter to defined the target directory for storing the settings file.

<file_name>

String parameter to specify the file name.

Example

```
SOUR1:EBOX:CPRI:SETT:STOR
"D:/USER/CPRISettings/RETtest.cpri"
```

saves the currently defined CPRI settings in the file `'RETtest.cpri'` in the directory `'USER/CPRISettings'` on drive `'d:/'`.

Usage Event

State - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:STATe <State>

The command activates and deactivates the CPRI standardized protocol. The corresponding FPGA (**F**ield **P**ro**g**rammable **A**rray) is loaded automatically into the R&S EX-IQ-BOX.

<State>	ON | OFF *RST: OFF
Examples	`SOUR1:EBOX:CPRI:STAT ON` activate CPRI protocol transmission.

8.4.5 Recorder Subsystem

The **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.

8.4.5.1 Table of Commands

8.4.5.2 Description of Commands

Recorder Abort/Discard - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RECorder:ABORt

Stops and cancels the recording. The process of recording can be aborted at any time.

After recording (Record Done), this command discards the recorded data.

Avoid data loss!

Discard erases the recorder memory. In order to keep the data, save it first with the command: `SOUR1:EBOX:CPRI:REC:FILE:CRE`, see "Recorder File New - CPRI" on page 320

"Discard" changes the recording status from "Record Done" back to "Idle" and is ready for a new recording.

Example `SOUR1:EBOX:CPRI:REC:ABOR`
stop recording.

Usage Event

Recorder Data Source - CPRI

[:SOURce<[1]|2|3|4>]: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 to "DIG OUT 2 IQ / Recorder" or "Recorder" under "RX Signal Output - CPRI". Switch on signal state, see "TX/RX State - CPRI".

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.

SCPI Device-specific

Recorder Catalog - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RECorder:DATA:SOURce:CATalog?

Returns a list of data sources, i.e. output signals in the current, or specified directory.

Example `SOUR1:EBOX:CPRI:REC:DATA:SOUR:CAT?`

read out all waveform files of the current directory.

Usage Query only

Recorder Sample Rate - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RECorder:DATA:SRATe?

Queries the sample rate of the signal determined for recording.

Return values:

<actual> float

Example `SOUR1:EBOX:CPRI:REC:DATA:SRAT?`

query the sample rate value of the selected signal.

Unit Hz

SCPI Device-specific

Recorder Signal State - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RECorder:DATA:STATe?

Queries the state of the selected data source signal. If the signal is inactive the IQ Recorder cannot be started.

Return parameters

<state>	ON | OFF (1 | 0)

Example	`SOUR1:EBOX:CPRI:REC:DATA:STAT?`
	query whether the selected signal is active.
	Response: 0
	The signal is not acite, i.e. recording can not be executed.
	Note: A signal is activated with the command:
	`SOUR1:EBOX:CPRI:TX:SIGN1:STAT ON`

Usage	Query only

Recorder Execute - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RECorder:EXECute

Starts the recording.

Parameters

Example	`SOUR1:EBOX:CPRI:REC:EXEC` starts recording of the currently selected signal.
Usage	Event

Recorder File New - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RECorder:FILE:CREate <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> **Path** String parameter to specify directory and path.

File Name

String parameter to specify the name of the new file.

Example `SOUR1:EBOX:CPRI:REC:FILE:CRE "D:\3GPP_CPRIRE.wv"`

save the recorded data in the new created file `'3GPP_CPRIRE'` on `'D:/'` directory

SCPI Device-specific

Recorder File Select - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RECorder:FILE:SELect <Select>

This command selects a file in which recorded data is stored. If the file is not on the default path, the path must be specified within the command.

If no file of the specified name exists, it is created. The file extension may be omitted. Only files with the file extension *.wv will be created or loaded.

Parameters

<Select> <Path>,<File_Name>

Path

String parameter to select directory and path.

File Name

String parameter with the name of the file.

Example `SOUR1:EBOX:CPRI:REC:FILE:SEL "D:\3GPP_CPRIRE.wv"`

select the recorded file '`3GPP_CPRIRE.wv`' from `'D:/'` directory.

Usage Setting only

Recorder Data Length - CPRI

[:SOURce<[1]|2|3|4>]: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.

*RST: 100 Samples

Example `SOUR1:EBOX:CPRI:REC:RLENgth 1024`

record "1024" samples of the signal.

SCPI Device-specific

Recorder Data Duration - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RECorder:RTIMe?

Queries the duration of recording. The recording time results from the recording length and the sample rate.

Return values

<Time> <integer>

Returns the data length in seconds.

Example `SOUR1:EBOX:CPRI:REC:RTIM?`

returns the time value needed for recording.

Unit s

SCPI Device-specific

Recorder Status - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RECorder:STATus <Status>

Queries graphically the current process step of the recording.

Parameters

<Status> STOPped | FRUN | READy | WTRigger | TRIGgered | DONE

STOPped

The recording process is inactive. Configure the recorder in that state. The recorder remains in Idle state until you start with the "EXECute"

FRUN

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.

WTRigger

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).

DONE

If all post-trigger data are recorded, the recording is completed and the recorder stops. All data are available in memory.

*RST: STOPped

Example `SOUR1:EBOX:CPRI:REC:STAT WTR`

recording prrocess is waiting for trigger event.

Usage Query only

Recorder Trigger Position - CPRI

[:SOURce<[1]|2|3|4>]: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 in the range of 0 to 99.

*RST: 0

Example `SOUR1:EBOX:CPRI:REC:TRIG:POS 2`

Set the trigger position to "2"

SCPI Device-specific

Recorder Trigger Source - CPRI

[:SOURce<[1]|2|3|4>]: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 | EXTernal

SOFTware

Software trigger starts the recording immediately after the "Record" button is pressed. No other event is necessary.

EXTernal

Start recording with an external trigger event. Define the external trigger in "Trigger Source".

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

*RST: SOFTware

Example `SOUR1:EBOX:CPRI:REC:TRIG:SOUR EXT`

start recording with an external trigger event specified in "Trigger Source".

SCPI Device-specific

8.4.6 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`).

8.4.6.1 Table of Commands

8.4.6.2 Description of Commands

Rx BER - CPRI

[:SOURce<[1]|2|3|4>]: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.

*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.

SCPI Device-specific

PRBS Rx Test - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:BER:RX:STATe <State>

The command switches on the transmission of the test data.

<State> ON | OFF

*RST: OFF

Example `SOUR1:EBOX:CPRI:TEST:BER:RX:STAT ON`
switch on receiver test.

SCPI Device-specific

IQ Words - CPRI

[:SOURce<[1]|2|3|4>]: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.

<Words> ON | OFF

*RST: OFF

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.

SCPI Device-specific

PRBS Tx - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:BER:TX:STATe <State>

The command switches on the transmission of the test data.

<State> ON | OFF

*RST: OFF

Example `SOUR1:EBOX:CPRI:TEST:BER:TX:STAT ON`
switch on Low Level BER transmitter test.

SCPI Device-specific

LOF Rx Alarm- CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:RX:LOF?

The command queries data synchronization in receiver mode.

<Lof> 0 | 1

*RST: 0

Examples `SOUR1:EBOX:CPRI:TEST:RX:LOF?`

check if received data is synchronized.

Response: `0`

Response: `"1"` (error)

data lost their synchronization.

Usage Query only

LOS Rx Alarm - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:RX:LOS?

The command queries, whether a loss of signal occured.

<Lof> 0 | 1

*RST: 0

Examples `SOUR1:EBOX:CPRI:TEST:RX:LOS?`

check if loss of signal happened.

Response: `"0"` (no error)

no signal transmission error occurred.

Usage Query only

RAI Rx Alarm - CPRI

[:SOURce<[1]|2|3|4>]: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.

<Rai> 0 | 1

*RST: 0

Examples `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

Reset Rx Alarm - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:RX:RESet?

In CPRI RE test mode, the command queries whether a reset of the DUT was performed. In CPRI REC test mode, the command checks if a reset is requested.

<Reset> 0 | 1

*RST: 0

Examples `SOUR1:EBOX:CPRI:TEST:RX:RES?`
check the reset of the DUT.

Response: `1` (error)
indicates a reset alarm.

Usage Query only

SDI Rx Alarm - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:RX:SDI?

The command queries if the data communication failed (**SDI S**ervice Access Point **D**efect **I**ndication).

<Sdi> 0 | 1

*RST: 0

Examples `SOUR1:EBOX:CPRI:TEST:RX:SDI?`
check the data communication.

Response: `1` (error)
data communication failed..

Usage Query only

SFP Info - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:SFP<st>:INFO?

The command provides information on all SFP module parameters.

Example `SOUR1:EBOX:CPRI:TEST:SFP:INFO?`
check 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

SFP LOS - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:SFP<st>:LOS?

Queries whether data communication via the SFP module failed and the signal was lost.

<Sloss> ON | OFF

*RST: OFF

Example `SOUR1:EBOX:CPRI:TEST:SFP: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

SFP Tx Disabled - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:SFP<st>:TX:DISabled?

Queries whether the interface of the breakout board and the SFP transmission line are disabled.

<Disabled> ON | OFF

*RST: OFF

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

SFP Tx Fault - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:SFP<st>:TX:FAULt?

Queries whether a transmission error has occurred. If the SFP is disconnected, R&S DigIConf responses with "0" (error).

<Fault> 0 | 1

*RST: OFF

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

Reset Layer 1 Event - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:TX:REReset <Reset>

The command sets or clears the bit on the downlink connection which requests the RE to reset.

Note: The command applies to 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 is reacting to this events.

Parameters

<Reset> ON | OFF

*RST: 0

Examples `SOUR1:EBOX:CPRI:TEST:TX:RER` **`ON`**

request the RE to reset.

Usage Event

SDI Layer 1 Event - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST:TX:SDI <State>

The command 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 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 is reacting to this events.

Parameters

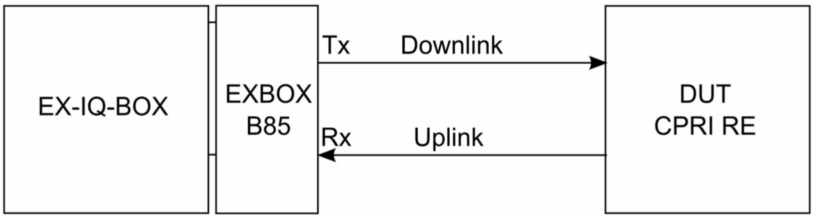
<State>	ON | OFF *RST: 0
Example	`SOUR1:EBOX:CPRI:TEST:TX:SDI ON` activate transmitter SAP Defect Indication.
Usage	Event

8.4.7 TX/RX - Downlink/Uplink Subsystem

The **TX/RX** subsystem comprises the remote control commands related to the CPRI Uplink and Downlink.

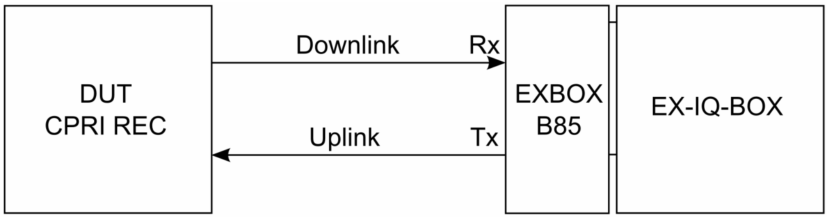
Depending on the CPRI test mode, the R&S EX-IQ-BOX works either as a transmitter (Tx) or receiver (Rx), as illustrated in the following diagrams.

- 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).



CPRI RE test - schematic representation

- In **CPRI REC** test mode, the EX-IQ-BOX works in the DL as a receiver (Rx) and in the UL as a transmitter (Tx).



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.

> **Note:** `<ch>` exclusively addresses the position of the signal in the list. It does not select a signal with an index in the signal name.

8.4.7.1 Table of Commands

8.4.7.2 Description of Commands

TX/RX Apply - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:APPLy

Assign the downlink/uplink settings in order to become effective.

Example `SOUR1:EBOX:CPRI:TX:APPL`
accept the settings.

Usage Event

TX/RX AxC Count - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:AXC:COUNt?

Queries the number of used AxCs.

Example `SOUR1:EBOX:CPRI:TX:AXC0:SOUR?`
check the number of used AxCs.
Response: `"18"`
'18' AxCs are currently in use.

Usage Query only

TX/RX Bit Address AxC Table - CPRI

[:SOURce<[1]|2|3|4>]: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 "TX/RX Word Address AxC Table - CPRI" on page 336.

<Baddress> float
Range: 0 to 38
*RST: 0

Example `SOUR1:EBOX:CPRI:TX:AXC0:BADD 0`
set the starting bit to `"0"`.

SCPI Device-specific

TX/RX Conflict AxC Table - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:AXC<CH0>:CONFlict?

A conflicht arises, when AxCs overlap. The command queries the status of overlapping.

<Conflict> 0 | 1

0

No overlapping occurred.

1

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

TX/RX AxC Size AxC Table - CPRI

[:SOURce<[1]|2|3|4>]: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_size_{axc} [bit] = I/Q $Resolution_{signal} \cdot 2$

For Sync Pattern signals, calculate the source with the formula:

AxC_size_{axc} [bit] = Pattern $Length_{signal}$

<Size> num

Example `SOUR1:EBOX:CPRI:TX:AXC1:SIZE?`

check the AxC size.

Response: `"32"`

the length of AxC1 is `'32'` bit.

Usage Query only

TX/RX Source AxC Table - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:AXC<CH0>:SOURce?

Queries the signal name the AxC is assigned to.

Note: This command applies to downlink.

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

TX/RX Word Address AxC Table - CPRI

[:SOURce<[1]|2|3|4>]: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 "TX/RX Bit Address AxC Table - CPRI" on page 334.

<WAddress> float

Range: 0 to 38

*RST: 1

Example `SOUR1:EBOX:CPRI:TX:AXC0:WADD 15`

start at word address 20 with the signal in the first AxC.

TX/RX AxC Status - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:AXCStatus?

The command queries the status of all AxCs.

Note: This command applies to downlink.

<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

TX/RX Assigned Data Rate AxC - CPRI

[:SOURce<[1]|2|3|4>]: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:

Assigned (AxC)

Data $Rate_{assigned}$ [Mbit/s] = $\sum AxC\_size_{axc}$ · 3.84 [MHz]

<Assigned> float

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

TX/RX Available Data Rate I/Q - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:DRATe:AVAilable?

Queries the available data rate for the I/Q data in the AxC container.

The data rate is calucalted with the formula:

Available Data Rate (I/Q)

Data $Rate_{available}$ [Mbit/s] = Data Word Count · Word Length [bit] 3.84 [MHz]

= 15 · Word Length [bit] 3.84 [MHz]

Note: The word length depends on the line bit rate, refer also to "CPRI Basic Frame Graph".

Example `SOUR1:EBOX:CPRI:TX:DRAT:AVA?`

query the available I/Q data rate.

Response: 921.60 Mbit/s

the CIPRI basic frame provides a data rate of `'921.6'` Mbit/s' for I/Q.

Usage Query only

TX/RX Append - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:APPend

The command 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`

add a new signal as second list item to the signal list.

Usage Event

TX/RX Signal Count - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal:COUNt?

This command queries the number of active signals.

Note: This command applies to downlink.

Example `SOUR1:EBOX:CPRI:TX:SIGN:COUNt?`

check the number of used signals.

Response: `"3"`

'3' signals are currently in use.

Usage Query only

TX/RX ARB Signal Conflict - CPRI

[:SOURce<[1]|2|3|4>]: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.

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

TX/RX Wave File - CPRI

[:SOURce<[1]|2|3|4>]: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.

<Name> string

Example `SOUR1:EBOX:CPRI:TX:SIGN:ARB:FILE?`

query the currently loaded wave file.

Response: "`p4DQPSK7_68M_OV4_2016Samples.wv`"

SCPI Device-specific

TX/RX AxC Allocation - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:AXC:ALLocation <Allocation>

Define how to allocate the AxCs to the signal. R&S DigIConf automatically assigns the AxCs to a signal, but this parameter specifies the method.

Parameters

<Allocation> PACKed | FLEXible

Range: 1 to 4

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.

Example `SOUR1:EBOX:CPRI:TX:SIGN:AXC:ALL FLEX`
select 'flexible' to manually assign the AxC position.

SCPI Device-specific

TX/RX Assigned AxC(s) / Data Rate - CPRI

[:SOURce<[1]|2|3|4>]: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:

AxC / Data Rate (Assigned)

Data $Rate_{assigned}$ [Mbit/s] =

$$3.84\,[\mathrm{MHz}] \cdot 2 \cdot \mathrm{I/Q\ Resolution}\ (\sum(\mathrm{AxC\_on\_count}_{grp} \cdot \mathrm{Repetition}_{grp}) / \sum \mathrm{Repetition}_{grp})$$

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 $Rate_{assigned}$ = Sample Rate * Pattern Length

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 "TX/RX AxC(s) / Data Rate Status - CPRI" on page 342.

Usage Query only

TX/RX Needed AxC(s) / Data Rate - CPRI

[:SOURce<[1]|2|3|4>]: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:

AxC / Data Rate

$AxCs_{needed}$ = ceil (Sample Rate · Oversampling / 3.84 [MHz])

The data rate is calculated with the formula:

AxC / Data Rate needed

Data $Rate_{needed}$ [Mbit/s] = Sample Rate · Oversampling · 2 · I/Q Resolution

Note: For signal source "Pattern" the needed number of AxCs is 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 SCPI conform

TX/RX Assigned Signal Data Rate - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:AXC:DRATe:ASSigned?

Queries the data rate assigned to the signal.

Note: This command applies to downlink.

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

TX/RX Needed Signal Data Rate - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:AXC:DRATe:NEEDed?

Queries the data rate required from the signal.

Note: This command applies to downlink.

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

TX/RX AxC(s) / Data Rate Status - CPRI

[:SOURce<[1]|2|3|4>]: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 what to do if the values do not fit.

<Status> 0 | 1

0

The needed and the assigned data rates values are the same.No error occurs.

1

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".

*RST: 1

Example `SOUR1:EBOX:CPRI:TX:SIGN:AXC:DRAT:STAT?`

check if the assigned values fit to the values required from the signal.

Response: "`0`" if OK, "`1`" if not OK

Usage SCPI conform

TX/RX AxC List - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:AXC:LIST?

The command queries the assigned AxCs of a signal.

Note: This command applies to downlink.

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

TX/RX AxC Allocation - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:AXC:ALLocation <Allocation>

Define how to allocate the AxCs to the signal. R&S DigIConf automatically assigns the AxCs to a signal, but 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.

*RST: PACKed

Example `SOUR1:EBOX:CPRI:TX:SIGN:AXC:ALL FLEX`

select 'flexible' to manually assign the AxC position.

SCPI Device-specific

TX/RX Copy + Append - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:COPY

Create a copy of a signal selected by the index <ch>. 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, ie the index of the copied signal is incremented by 1 after the last signal.

Parameters

Example `SOUR1:EBOX:CPRI:TX:SIGN3:COPY`

copy the third signal from the list of downlink signals.

Usage Event

TX/RX Crest Factor - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:CRESt <Crest>

This parameter is required for the correct indication of the RMS Level value, see TX/RX RMS Level - CPRI.

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.

<Crest> float

Range: 0 to 30

Increment: 0.01 dB

*RST: 0

Unit dB

Example `SOUR1:EBOX:CPRI:TX:SIGN:CRES 10dB`

set the crest factor to '10 dB'.

SCPI Device-specific

TX/RX Delete - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:DELete

Remove 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`

remove the second signal from the list of downlink signals.

Usage Event

TX/RX Gain - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:GAIN <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.

<Gain> float

Range: -40 to 6

Increment: 0.01 dB

*RST: 0

Unit dB

Example `SOUR1:EBOX:CPRI:TX:SIGN:GAIN -20`

set a gain of '-20 dB'.

SCPI Device-specific

TX/RX Number of Groups - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:GROup:COUNt <Count>

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.

<Count> integer

Range: 1 to 4

*RST: 1

Example `SOUR1:EBOX:CPRI:TX:SIGN:GRO:COUN 2`

specify 2 groups for distribution of the first signal in the CPRI frame.

SCPI Device-specific

TX/RX AxC Group Pattern - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:GROup<USER0>:AXC<CH0>:PATTern <Pattern>

Queries the binary data pattern of an AxC and responses in hexadecimal format.

Enter the required pattern with the 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 "TX/RX Pattern Length - CPRI".

<Pattern> integer

*RST: 0000

Example `SOUR1:EBOX:CPRI:TX:SIGN:GRO1:AXC0:PATT "0101"`

insert the pattern for the first signal, and assign the signal to AxC1 in the first group of the AxC allocation table.

SCPI Device-specific

TX/RX AxC Group State - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:GROup<USER0>:AXC<CH0>:STATe <State>

Indicates the status of the respective AxCs. By default, all states are set to On. Click into the desired field or press the enter key to switch between On and Off.

<State>	ON | OFF *RST: OFF
Example	`SOUR1:EBOX:CPRI:TX:SIGN2:GRO1:AXC1:STAT ON` activate the AxC1 in the first group of the AxC allocation table.
SCPI	Device-specific

TX/RX Group Repetition - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:GROup<USER0>:REPetition <Repeat>

Select the AxC group and specifiy the repetitions for the signal.

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.

Setting Parameters

<User0>	suffix The numeric suffix `<user0>` to `GROUP` distinguishes the selected group. Up to 4 groups can be specified, i.e. `'G #0'` to `'G #3'`.
<Repeat>	integer Enter the number of repetitions, i.e. how many CPRI basic frames follow the current group setting. Range: 1 to 20000 *RST: 1
Example	`SOUR1:EBOX:CPRI:TX:SIGN:GRO1:REP 3` repeat the signal of group `'1'` `'3'` times.
SCPI	Device-specific

TX/RX I/Q Resolution - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:IQResolution <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.

<Resolution> float

Range: 4 to 18

*RST: 16

Example `SOUR1:EBOX:CPRI:TX:SIGN:IQR 16`

set the I/Q resolution of the signal to '16'.

SCPI Device-specific

TX/RX Signal Name - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:NAME <Name>

Enter or change the signal name.

<Name> string

Example `SOUR1:EBOX:CPRI:TX:SIGN4:NAME "sig_3gpp"`

name the fourth signal in the transmitter mode 'sig_3gpp.

SCPI Device-specific

TX/RX Numeric Format - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:NFORmat <Nformat>

Select a numeric representation for data transmission.

Note: The parameter applies to downlink mode.

Parameters

<Nformat> COMPlement | C9E2 | BOFFset

COMPlement

Format the signal in two´s-complement.

The most significant bit has a value of -2^{n-1}, the bits of lesser significance follow as:

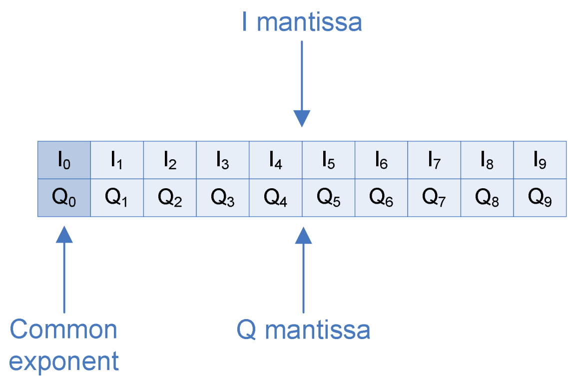
$+2^{n-2} \ldots +2^{0}$

C9E2

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 illustrated in the figure:



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 samples of 2's complement 9E2

$$I = \left(\left(\sum_{i=0}^{7} 2^i \cdot I_{i+1} \right) - 2^8 \cdot I_9 \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

► Q sample 10 bits: 9 bits Q mantissa + 1 bit, i.e. bit_1 exponent

Q samples of 2's complement 9E2

$$Q = \left(\left(\sum_{i=0}^{7} 2^i \cdot Q_{i+1} \right) - 2^8 \cdot Q_9 \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

BOFFset

Format the data in binary offset.

A binary offset of -2^{n-1} is added such that the final values are always positive.

Example:

n = 4 → -8 ≤ z < 8

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

*RST: COMPlement

Example `SOUR1:EBOX:CPRI:TX:SIGN2:NFOR COMP`

set the numeric format of the second signal to 2's complement '2'.

SCPI Device-specific

TX/RX Oversampling - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:OSAMpling <Osample>

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

<Osample> 1 | 2 | 4

Range: 1 to 4

*RST: 1

Example `SOUR1:EBOX:CPRI:TX:SIGN:OSAM 2`

set the oversapling factor to '2'.

SCPI Device-specific

TX/RX Pattern Length - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:PLENgth <Plength>

Define the length of the pattern used by the internal pattern generator.

Note: The parameter applies to the physical source "Sync Pattern" in downlink mode.

Parameters

<Plength> number

Range: 2 to 40

*RST: 2

Example `SOUR1:EBOX:CPRI:TX:SIGN:PLEN 4`

set the pattern length to '4'.

SCPI Device-specific

TX/RX RMS Level - CPRI

[:SOURce<[1]|2|3|4>]: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(I^2+Q^2)).

In order to get the RMS value correctly, the crest factor of the signal must be specified, see "TX/RX Crest Factor - CPRI" on page 344.

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.

Unit dBFS

Example `SOUR1:EBOX:CPRI:TX:SIGN:RMS?`

query the crest factor.

Response: "`-10 dbFS`"

SCPI Device-specific

RX Signal Output - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:RX:SIGNal<ch>:OUTPut <Output>

Assign a signal destination to the received signal in order to transmit it to an instrument and/or to the built-in I/Q recorder.

Notes:

- In **RE** test mode, Signal Output refers to the uplink signal. The R&S EX-IQ-BOX receives a signal from the DUT and forwards it to an R&S instrument via the digital interface. In downlink, the equivalent parameter is TX Physical Source - CPRI".
- In REC test mode, Signal Output refers to the downlink signal. The R&S EX-IQ-BOX receives a signal from the DUT and forwards it to an R&S instrument via the digital interface. In uplink, the equivalent parameter is TX Physical Source - CPRI".
- Currently, the output interface is firmly set to DIG IQ OUT 2, indicated by the yellow LED of this port.

Parameters

<Output> IQOutput | RECorder

IQOutput (DIG IQ OUT <n> / Recorder)

Select the digital output interface for signal transmission from the R&S EX-IQ-BOX to an R&S instrument.

The R&S EX-IQ-BOX receives a baseband signal from the CPRI link. The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, and sends the signal to an R&S instrument via one of the digital interfaces DIG IQ OUT, 1 or 2.

RECorder

Select the built-in I/Q recorder as the destination for the received signal.

The R&S EX-IQ-BOX receives a baseband signal from the CPRI link. The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, and routes it to the R&S EX-IQ-BOX I/Q recorder.

*RST: IQO

Example `SOUR1:EBOX:CPRI:RX:SIGN:OUTP IQO`

assign the digital interface to signal output.

Usage Select

TX Physical Source - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TX:SIGNal<ch>:SOURce <Source>

Assigns the signal source for the transmitted signal to the DUT. This parameter applies to downlink in CPRI RE test mode, uplink in REC test mode. The signal comes either from an R&S instrument via one of the digital interfaces of the R&S EX-IQ-BOX, or the signal is generated by means of a waveform memory in the R&S EX-IQ-BOX.

Notes:

- In **RE** test mode,this parameter refers to downlink, when the R&S EX-IQ-BOX sends a signal. In uplink mode, the R&S EX-IQ-BOX receives the signal from the DUT, and forwards it to an R&S instrument. Select, therefore, in the uplink panel instead of the signal source the interface for signal output.
- In **REC** test mode, the parameter refers to uplink, when the R&S EX-IQ-BOX sends a signal. In downlink mode, the R&S EX-IQ-BOX receives the signal from the DUT, and forwards it to an R&S instrument. Select, therefore, in the downlink panel instead of the signal source the interface for signal output.
- Currently, the interface DIG IQ IN 1 is firmly set to input. The IN / OUT LED of this interface indicates in green, that the port operates in input mode.

Parameters

<Source> PATTern | IQIN | ARB1 | ARB2 | ARB3 | ARB4

IQIN (DIG IQ IN 1...2)

Select the digital interface for signal input from an R&S instrument to the R&S EX-IQ-BOX.

The R&S EX-IQ-BOX receives a digital I/Q baseband signal at one of its interfaces DIQ IQ IN, 1 or 2 from an R&S instrument. The R&S EX-IQ-BOX converts the R&S I/Q format into the CPRI protocol, which additionally contains control data. The CPRI link then transmits the data to the DUT.

ARB 1 ... 4

Select an I/Q signal in a waveform memory for transmission.

> **Note:** This feature requires, that the R&S EX-IQ-BOX is equipped with an appropriate waveform memory option.

The R&S EX-IQ-BOX then embeds the ARB signal in the CPRI frame.

> **Tip:** The Multi Waveform options support simultaneous playback of up to four signals.

*RST: IQIN

Example `SOUR1:EBOX:CPRI:TX:SIGN:SOUR ARB1`

assign the signal of the first waveform memory as signal source.

Usage Select

TX/RX Sample Rate - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:SRATe <Srate>

Queries the sample rate. User-defined signals, you can assign a sample rate 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.

Sample rate values, depending on the signal type

Standard	Frequency variant	Sample Rate
GSM/EDGE		270.8333 kHz
3GPP FDD		3.84 MHz

Standard	Frequency variant	Sample Rate
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

Parameters

<Srate> number

Example `SOUR1:EBOX:CPRI:TX:SIGN:SRATe?`

query the sample rate of the first signal in transmitter mode.

SCPI Device-specific

TX/RX Standard - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:STANdard <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.

<Standard> CDMA2K | GSM | LTE_1M4 | LTE_3M | LTE_5M | LTE_10M | LTE_15M | LTE_20M | W3GPP | WIMAX_3M5 | WIMAX_5M | WIMAX_7M | WIMAX_8M75 | WIMAX_10M | WIMAX_20M | PATTern | USER

CDMA2K

Select a signal that follows te CDMA standard.

CDMA2000 (**C**ode **D**ivision **M**ultiple **A**ccess) uses a multiple access scheme for digital radio, to send voice, data, and signalling data (such as a dialed telephone number) between mobile phones and cell sites.

GSM

Select a signal that follows te GSM/EDGE standard.

GSM/EDGE (…/…) 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.

LTE_1M4 | LTE_3M | LTE_5M | LTE_10M | LTE_15M | LTE_20M

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 bandwiths: 1.4 | 3.0 | 5.0 | 10.0 | 15.0 | 20.0 MHz

W3GPP

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.

WIMAX_3M5 | WIMAX_5M | WIMAX_7M | WIMAX_8M75 | WIMAX_10M | WIMAX_20M

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 transmmission modes, as e.g. point-to-multipoint links or mobile internet access.

WiMAX bandwiths: 3.5 | 5.0 | 7.0 | 8.75 | 10.0 MHz

PATTern

Pattern uses an internal pattern generator as signal source.

> **Note:** As this feature uses the internal signal source, the parameter is only provided in downlink mode.

USER

Specify a user defined signal for transmission, define a signal with arbitrary parameters.

Example `SOUR1:EBOX:CPRI:TX:SIGN:STAN LTE_20M`

select an LTE signal with 20 MHz bandwidth.

SCPI Device-specific

TX/RX State - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:SIGNal<ch>:STATe <State>

The command activates a signal for transmission selected with <ch>.

<State> ON | OFF

*RST: OFF

Example `SOUR1:EBOX:CPRI:RX:SIGN:STAT ON`

activate the fist signal for transmission in reciever mode.

SCPI Device-specific

TX/RX Apply Warning State - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:{TX|RX}:WARNing?

The command asks if settings have been changed, but not accepted.

<Warning> 0 | 1

*RST: 0

Example `SOUR1:EBOX:CPRI:{TX|RX}:WARNing?`

check if cahnged settings have been accepted.

Response: `"1"` if settings are not yet accepted, `"0"` if OK.

Usage Query only

8.4.8 Vendor Data Subsystem

The **Vendor Data** command subsystem provides input of user-specific information via remote control commands.

8.4.8.1 Table of Commands

8.4.8.2 Description of Commands

Vendor Data - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:VENDor:DATA <Address>,<Data>

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.

Use this command to enter data for transmission or read vendor data for reception.

Note: Find detailed information on vendor data exchange in the CPRI specification.

Parameters

<Address> decimal value

This value represents the CPRI hyper frame number, starting at 16.

<Data> hexadecimal value

The value range depends on the word width.

Example `SOUR1:EBOX:CPRI:VEND:DATA 16,#H2A`
determine vendor-specific data for transmission.

SCPI Device-specific

Vendor Direction - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:VENDor:DIRection <Direction>

The command selects the data direction for vendor data exchange.

Parameters

<Direction> DLINk | ULINk

CPRI RE **DLINk (Tx)**

User data entered in the table is embedded in the CPRI link for transmission to the DUT.

ULINk (Rx)

Vendor data is extracted from the CPRI link and displayed in the table.

CPRI REC **DLINk (Rx)**

Vendor data is extracted from the CPRI link and displayed in the table.

ULINk (Tx)

User data entered in the table is embedded in the CPRI link for transmission to the DUT.

Example `SOUR1:EBOX:CPRI:VEND:DIR DLIN`

determine the direction for vendor data transmission.

SCPI Device-specific

Vendor State - CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:VENDor:STATe <State>

The command starts and stops vendor data exchange.

Parameters

<State> ON | OFF

*RST: OFF

Example `SOUR1:EBOX:CPRI:VEND:STAT ON`

start vendor data exchange.

SCPI Device-specific

Vendor Word Width - CPRI

[:SOURce<[1]|2|3|4>]: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.

Line bit rate [Mbit/s]	Word width [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 "Line Bit Rate - CPRI" on page 308.

Parameters

Example `SOUR1:EBOX:CPRI:VEND:WWID?`
query the word width.

SCPI usage Device-specific
Query only

9 Interfaces

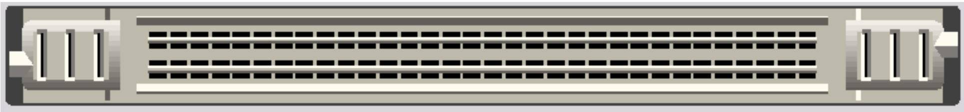
The following chapters describe the characteristics of the user interface and the available breakout boards.

9.1 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.

9.1.1.1 Z-DOK-Adapter Board Connector



Type:	**Z-DOK-Adapter Board Connector**
Manufacturer:	**Tyco Electronics**
Part number:	**6367557-1**

9.1.1.2 Pin Description

The user interface consists of a specific part with pins assigned individually for each breakout board. They are located on the left and the right side of the connector. A 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 table "Pinout Z-DOK-Adapter Board Connector (User Interface)" on page 362. Additionally the specific pin assignments of the user interface are pictured in the respective drawings of the breakout boards, which are attached to the operating manual.

User Interface of the R&S EX-IQ-BOX

Information on Z-DOK-Adapter Board Connector

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.

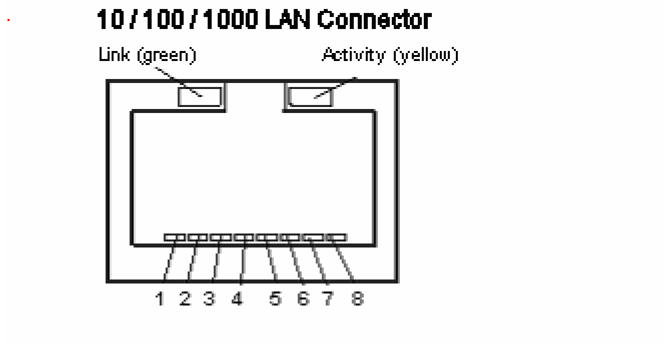
Pinout Z-DOK-Adapter Board Connector (User Interface)

Signal Name	Pin	Direction	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 driven 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 is concerned to differential interface standards (LVDS). For single ended standards (e.g. LVTTL) only the P signals are used.

9.2 LAN Connector



10/100/1000 LAN connector pinouts

Pinouts LAN connector

Pin Number	Signal Description
1	TXP
2	TXN
3	RXP
4	Not used
5	Not used
6	RXN
7	Not used
8	Not used

9.3 Breakout Boards

9.3.1 User Defined

Various interchangeable breakout boards are available for adjusting customer specific signal formats to the common R&S 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.

9.3.1.1 Breakout Board Single Ended 3585.7280.00

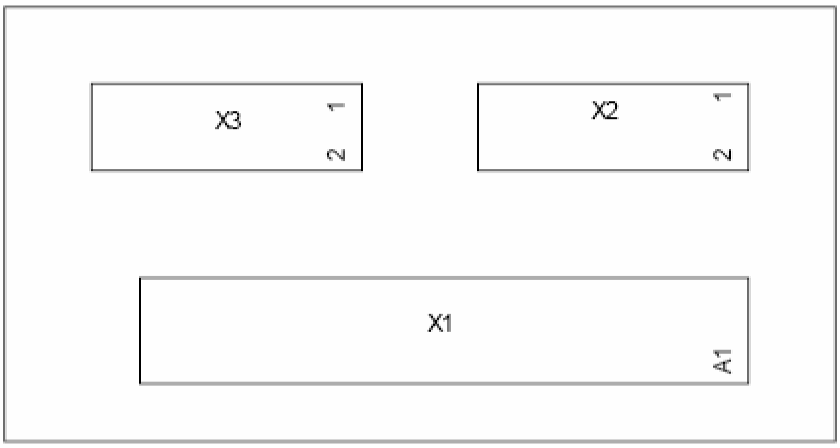
This breakout board consists of the connector to the R&S EX-IQ-BOX and two connectors for adjusting the external user signals.

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



Connector locations on Single Ended breakout board

Pin Description - Single Ended

Pinout 2 x 50-pin connectors (BreakOut-Board 2, 3585.7280.00)

Pin Number	Signal Name	Comment
X2.1	UI_I_P0	I component (single ended)
X2.3	UI_I_P1	
X2.5	UI_I_P2	
X2.7	UI_I_P3	
X2.9	UI_I_P4	
X2.11	UI_I_P5	
X2.13	UI_I_P6	
X2.15	UI_I_P7	
X2.17	UI_I_P8	
X2.19	UI_I_P9	
X2.21	UI_I_P10	
X2.23	UI_I_P11	
X2.25	UI_I_P12	
X2.27	UI_I_P13	
X2.29	UI_I_P14	
X2.31	UI_I_P15	
X2.33	UI_I_P16	
X2.35	UI_I_P17	
X2.37	AUX_IO_P0	auxiliary signals
X2.39	AUX_IO_P1	
X2.41	GP_GP0	additional protocol dependent control / signaling
X2.43	GP_GP1	
X2.45	GP_GP2	
X2.47	D_CLK_UOUT_P	interface clock output
X2.49	UI_VALID_P	indicates valid data blocks
even numbered pins	GND	

Pin Number	Signal Name	Comment
X3.1	UI_Q_P0	Q component (single ended
X3.3	UI_Q_P1	
X3.5	UI_Q_P2	
X3.7	UI_Q_P3	
X3.9	UI_Q_P4	
X3.11	UI_Q_P5	
X3.13	UI_Q_P6	
X3.15	UI_Q_P7	
X3.17	UI_Q_P8	
X3.19	UI_Q_P9	
X3.21	UI_Q_P10	
X3.23	UI_Q_P11	
X3.25	UI_Q_P12	
X3.27	UI_Q_P13	
X3.29	UI_Q_P14	
X3.31	UI_Q_P15	
X3.33	UI_Q_P16	
X3.35	UI_Q_P17	
X3.37	AUX_IO_P2	auxiliary signals
X3.39	AUX_IO_P3	
X3.41	GP_GP4	additional protocol dependent control / signaling
X3.43	GP_GP5	
X3.45	GP_GP3	
X3.47	D_CLK_UIN_P	interface clock input
X3.49	n.c.	
even numbered pins	GND	

The signal UI_VALID_P/N must be driven 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 - 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.

9.3.1.2 Breakout Board Differential 3585.7296.00

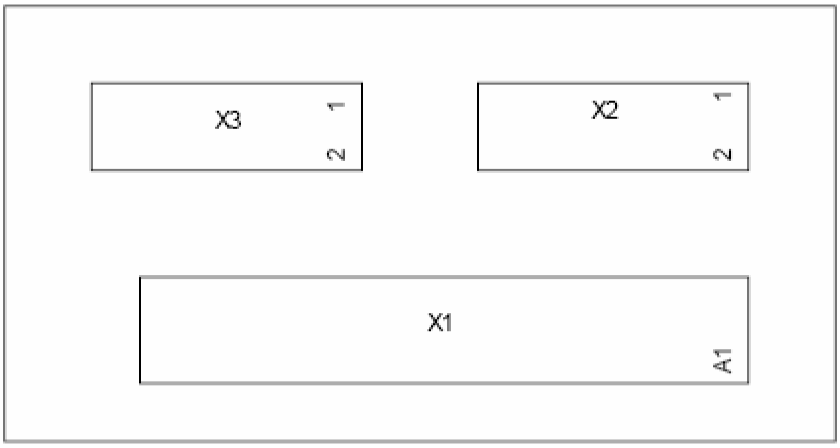
This breakout board consists of the connector to the R&S EX-IQ-BOX and two connectors for adjusting the external user signals.

The breakout board is intended for testing differential signals. The signals are assigned to two 50-pole SMD connectors.

Connector Type X2, X3 - Differential

Type:	**2x50-pole connector**
Manufacturer:	**Samtec**
Part number:	**ASP-65067-01**

Connector Locations - Differential



Connector locations on Differential breakout board

Pin Description - Differential

Pinout 2 x 100-pin Samtec Connectors (BreakOut-Board 3, 3585.7296.00)

Pin Number	Signal Name	Comment
X2.1, X2.2	GND	I component (differential)
X2.3	UI_I_N0	
X2.4	UI_I_P0	
X2.5, X2.6	GND	
X2.7	UI_I_N1	
X2.8	UI_I_P1	
X2.9, X2.10	GND	
X2.11	UI_I_N2	
X2.12	UI_I_P2	
X2.13, X2.14	GND	
X2.15	UI_I_N3	
X2.16	UI_I_P3	
X2.17, X2.18	GND	
X2.19	UI_I_N4	
X2.20	UI_I_P4	
X2.21, X2.22	GND	
X2.23	UI_I_N5	
X2.24	UI_I_P5	
X2.25, X2.26	GND	
X2.27	UI_I_N6	
X2.28	UI_I_P6	
X2.29, X2.30	GND	
X2.31	UI_I_N7	
X2.32	UI_I_P7	
X2.33, X2.34	GND	
X2.35	UI_I_N8	
X2.36	UI_I_P8	
X2.37, X2.38	GND	
X2.39	UI_I_N9	
X2.40	UI_I_P9	
X2.41, X2.42	GND	
X2.43	UI_I_N10	
X2.44	UI_I_P10	
X2.45, X2.46	GND	
X2.47	UI_I_N11	
X2.48	UI_I_P11	
X2.49, X2.50	GND	
X2.51	UI_I_N12	
X2.52	UI_I_P12	
X2.53, X2.54	GND	
X2.55	UI_I_N13	
X2.56	UI_I_P13	
X2.57, X2.58	GND	
X2.59	UI_I_N14	
X2.60	UI_I_P14	
X2.61, X2.62	GND	
X2.63	UI_I_N15	
X2.64	UI_I_P15	
X2.65, X2.66	GND	

Pin Number	Signal Name	Comment
X3.1, X3.2	GND	Q component (differential)
X3.3	UI_Q_N0	
X3.4	UI_Q_P0	
X3.5, X3.6	GND	
X3.7	UI_Q_N1	
X3.8	UI_Q_P1	
X3.9, X3.10	GND	
X3.11	UI_Q_N2	
X3.12	UI_Q_P2	
X3.13, X3.14	GND	
X3.15	UI_Q_N3	
X3.16	UI_Q_P3	
X3.17, X3.18	GND	
X3.19	UI_Q_N4	
X3.20	UI_Q_P4	
X3.21, X3.22	GND	
X3.23	UI_Q_N5	
X3.24	UI_Q_P5	
X3.25, X3.26	GND	
X3.27	UI_Q_N6	
X3.28	UI_Q_P6	
X3.29, X3.30	GND	
X3.31	UI_Q_N7	
X3.32	UI_Q_P7	
X3.33, X3.34	GND	
X3.35	UI_Q_N8	
X3.36	UI_Q_P8	
X3.37, X3.38	GND	
X3.39	UI_Q_N9	
X3.40	UI_Q_P9	
X3.41, X3.42	GND	
X3.43	UI_Q_N10	
X3.44	UI_Q_P10	
X3.45, X3.46	GND	
X3.47	UI_Q_N11	
X3.48	UI_Q_P11	
X3.49, X3.50	GND	
X3.51	UI_Q_N12	
X3.52	UI_Q_P12	
X3.53, X3.54	GND	
X3.55	UI_Q_N13	
X3.56	UI_Q_P13	
X3.57, X3.58	GND	
X3.59	UI_Q_N14	
X3.60	UI_Q_P14	
X3.61, X3.62	GND	
X3.63	UI_Q_N15	
X3.64	UI_Q_P15	
X3.65, X3.66	GND	

Pin Number	Signal Name	Comment
X2.67	UI_I_N16	
X2.68	UI_I_P16	
X2.69,X2.70	GND	
X2.71	UI_I_N17	
X2.72	UI_I_P17	
X2.73, X2.74	GND	auxiliary signals
X2.75	AUX_IO_N0	
X2.76	AUX_IO_P0	
X2.77, X2.78	GND	
X2.79	AUX_IO_N1	
X2.80	AUX_IO_P1	
X2.81, X2.82	GND	additional protocol dependent control / signaling
X2.83	GP_N0	
X2.84	GP_P0	
X2.85, X2.86	GND	
X2.87	GP_N2	
X2.88	GP_P2	
X2.89, X2.90	GND	
X2.91	GP_N1	
X2.92	GP_P1	
X2.93, X2.94	GND	interface clock output
X2.95	D_CLK_UOUT_N	
X2.96	D_CLK_UOUT_P	
X2.97, X2.98	GND	indicates valid data blocks
X2.99	UI_VALID_N	
X2.100	UI_VALID_P	

Pin Number	Signal Name	Comment
X3.67	UI_Q_N16	
X3.68	UI_Q_P16	
X3.69,X3.70	GND	
X3.71	UI_Q_N17	
X3.72	UI_Q_P17	
X3.73, X3.74	GND	auxiliary signals
X3.75	AUX_IO_N2	
X3.76	AUX_IO_P2	
X3.77, X3.78	GND	
X3.79	AUX_IO_N3	
X3.80	AUX_IO_P3	
X3.81, X3.82	GND	additional protocol dependent control / signaling
X3.83	GP_N4	
X3.84	GP_P4	
X3.85, X3.86	GND	
X3.87	GP_N3	
X3.88	GP_P3	
X3.89, X3.90	GND	
X3.91	GP_N5	
X3.92	GP_P5	
X3.93, X3.94	GND	interface clock input
X3.95	D_CLK_UIN_N	
X3.96	D_CLK_UIN_P	
X3.97, X3.98	GND	
X3.99	n.c.	
X3.100	n.c.	

The signal UI_VALID_P/N must be driven 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.

9.4 CPRI - Option R&S EXBOX-B85

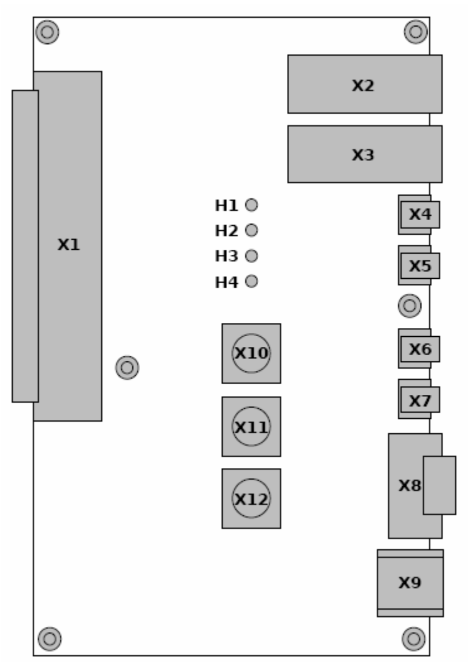
The CPRI breakout board is intended to perform tests directly at the CPRI interface between the REC (base station radio equipment control) and the RE (base station radio equipment).
The board contains the user interface to the R&S EX-IQ-BOX, two different interfaces for data exchange with the DUT, two 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.

> **Note:** 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.

9.4.1 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.



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.

Connector locations on CPRI breakout board

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R

Appendix

The following appendices provide both general information as well as some specific content relating to the standardized protocols.

A Abstract

The appendices under "Abstract" contain general information.

A.1 List of Abbreviations

The following list contains some common abbreviations used in this manual.

For more abbreviations that relate CPRI, see the CPRI specification at http://www.cpri.info/spec.html.

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

Abbreviation	Term
	radio base station (Node B)
IP	Internet Protocol
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
T_c	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)

A.2 Alphabetical List of Commands

*****

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:ARB

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:CM

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:HW

[:SOURce<[1]|2|3|4>]:EBOX:CPRI

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:REC

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:TEST

[:SOURce<[1]|2|3|4>]:EBOX:CPRI:VENDor

[:SOURce<[1]|2|3|4>]:EBOX

[:SOURce<[1]|2|3|4>]:EBOX:USER

[:SOURce<[1]|2>:]BBIN

[:SOURce<[1]|2>:]IQ:OUTPut

SOURce:EBOX

SOURce:RECeiver

SOURce:TRANsmitter

[:SYSTem:]

B Preset

B.1 User defined default settings

General Settings

Parameter	Default value
State	Off
Logic Type	3.3 V CMOS
Direction	Transmitter

Protocol Settings

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

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

B.1 CPRI default settings

General Settings

Parameter	Default value
State	Off
Mode	CPRI RE Test

Hardware Settings

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 Settings

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

Parameter	Default value
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 Settings

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 Settings

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 Settings

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 Settings

Parameter	Default value
File (ARB 1 ... ARB 4)	None
Option(s)	
Sample Rate/Samples	0
State	Off
Total Samples	0.00 / 128 MSamples

Recorder Settings

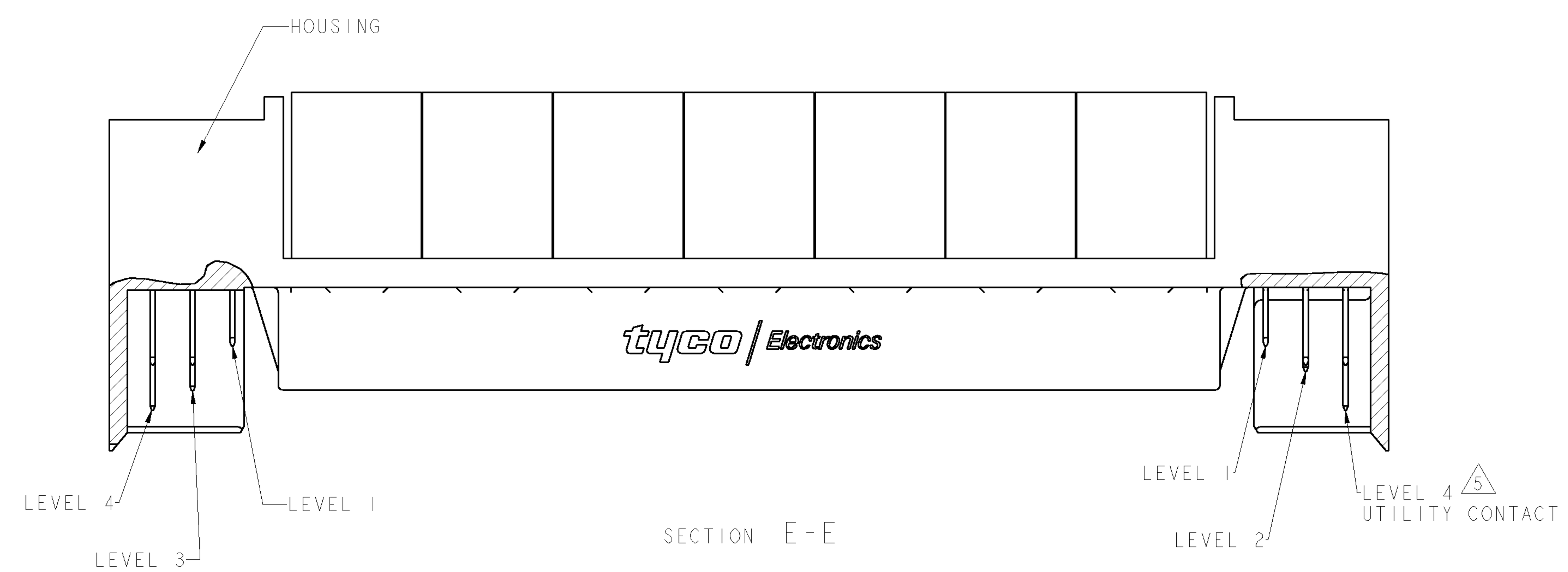
Parameter	Default value
Data Source	(signal_1)
Recording Length	100 Samples
State	Off
Trigger Source	Software
Trigger Position	0 Samples

LOC	DIST
GP	00

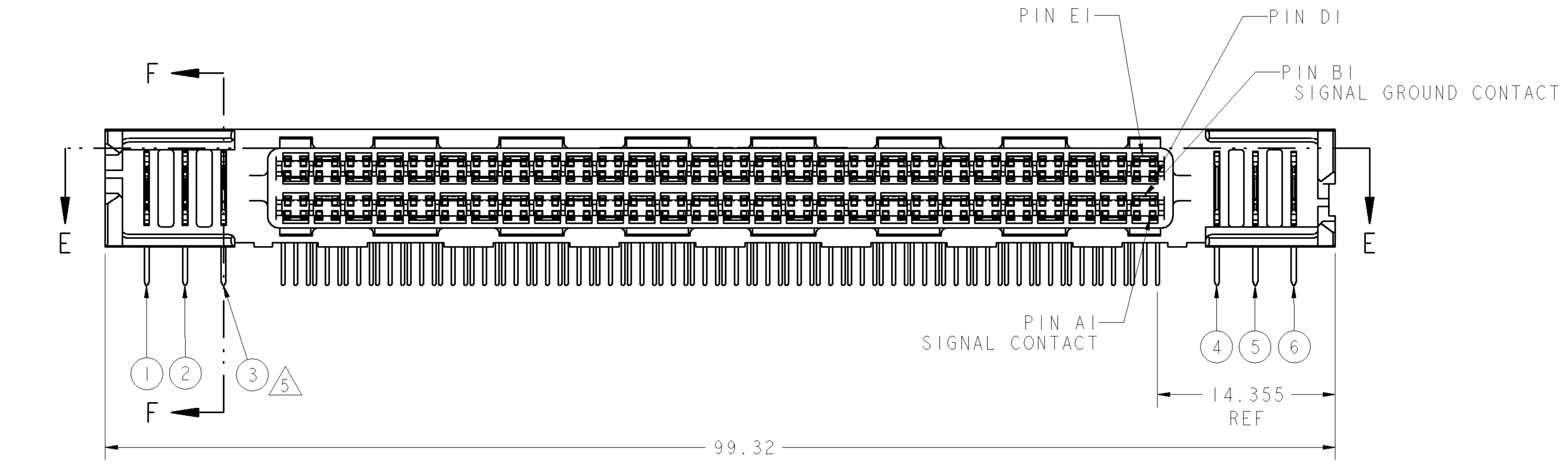
REVISIONS

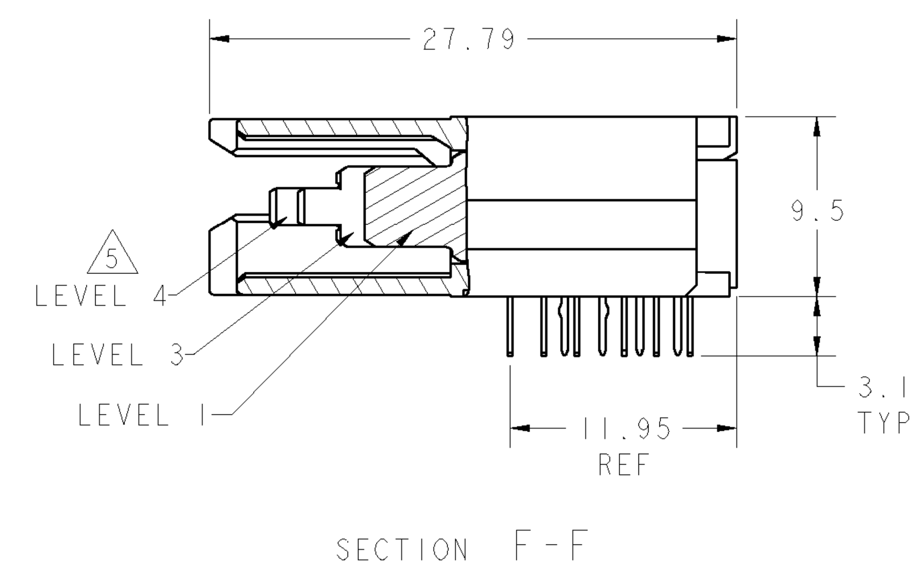
P	LTR	DESCRIPTION	DATE	DWN	APVD
	A	DRAWN	09SEPT05	WVS	EB
	A1	REV PER ECO-06-002399	01FEB2006	EDB	EDB

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.

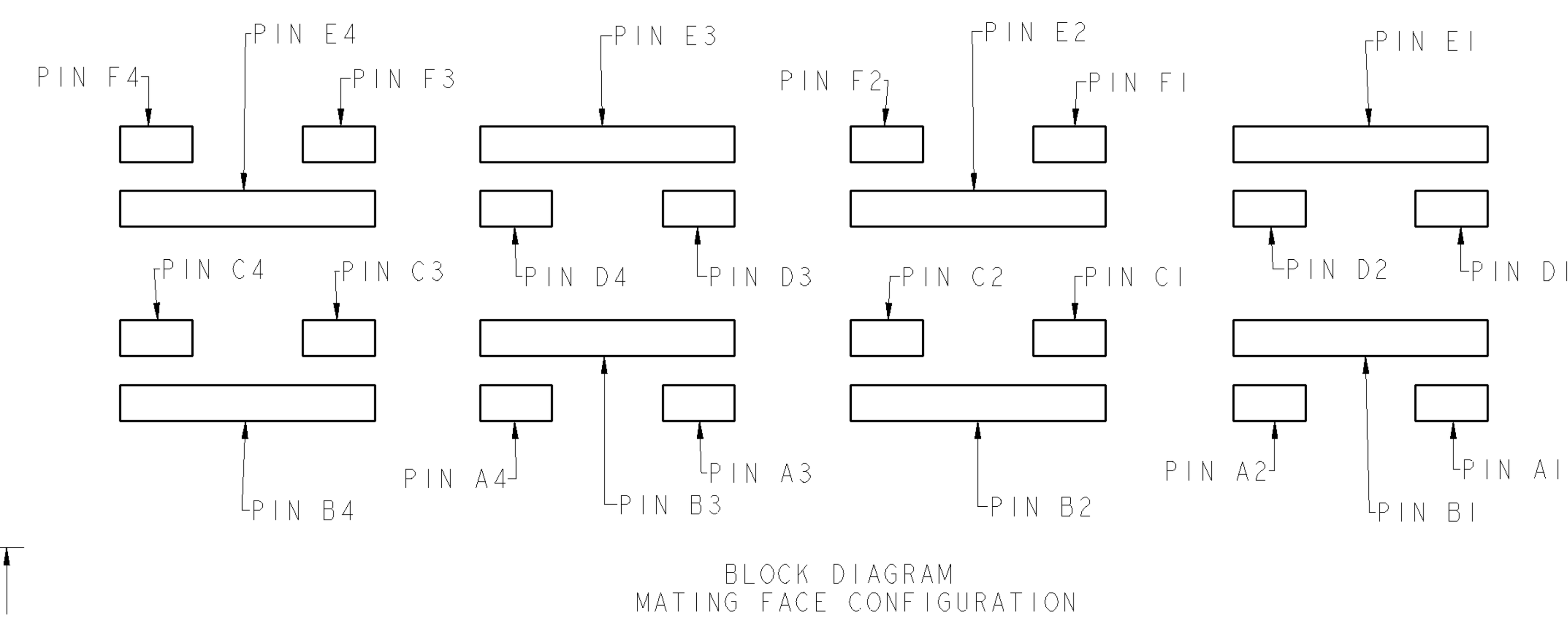


SECTION E-E

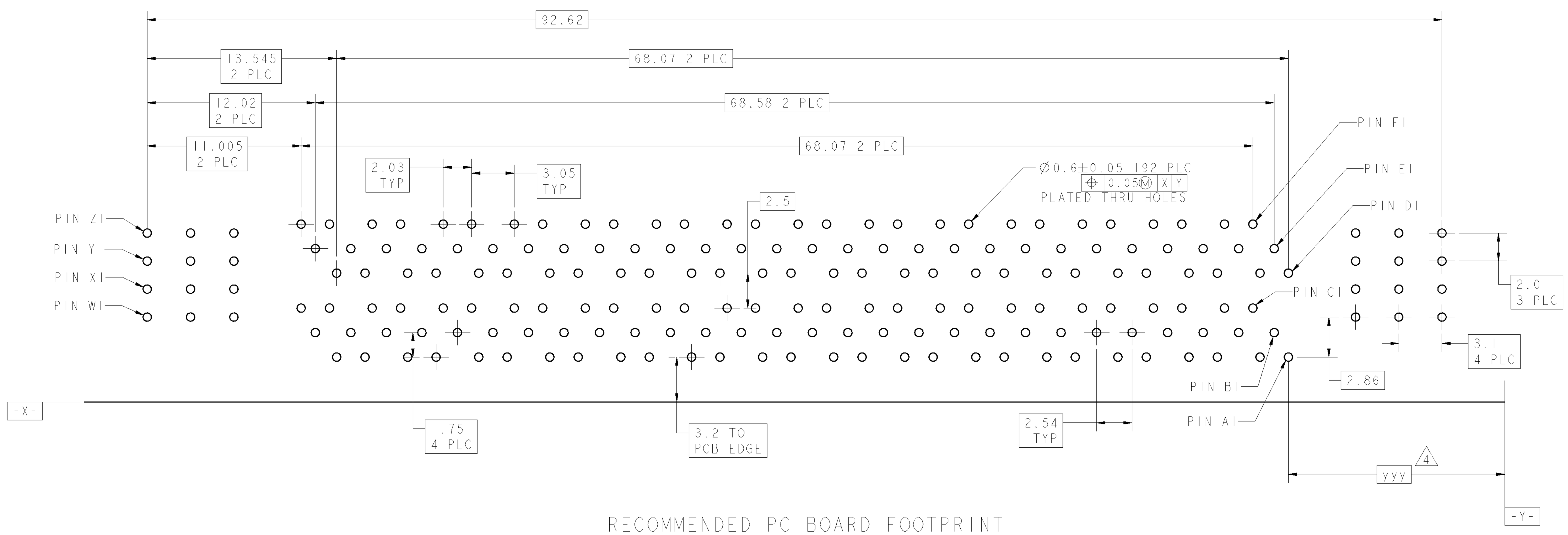




SECTION F-F



BLOCK DIAGRAM
MATING FACE CONFIGURATION



RECOMMENDED PC BOARD FOOTPRINT
COMPONENT SIDE SHOWN
SCALE 5:1

UTILITY CONTACT SEQUENCE TABLE 5
UTILITY CONTACT LEVEL 1, 2, 3, OR 4

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
UTILITY CONTACT LOCATION						

THIS DRAWING IS A CONTROLLED DOCUMENT FOR TYCO ELECTRONICS CORPORATION IT IS SUBJECT TO CHANGE AND THE CONTROLLING ENGINEERING ORGANIZATION SHOULD BE CONTACTED FOR THE LATEST REVISION.

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

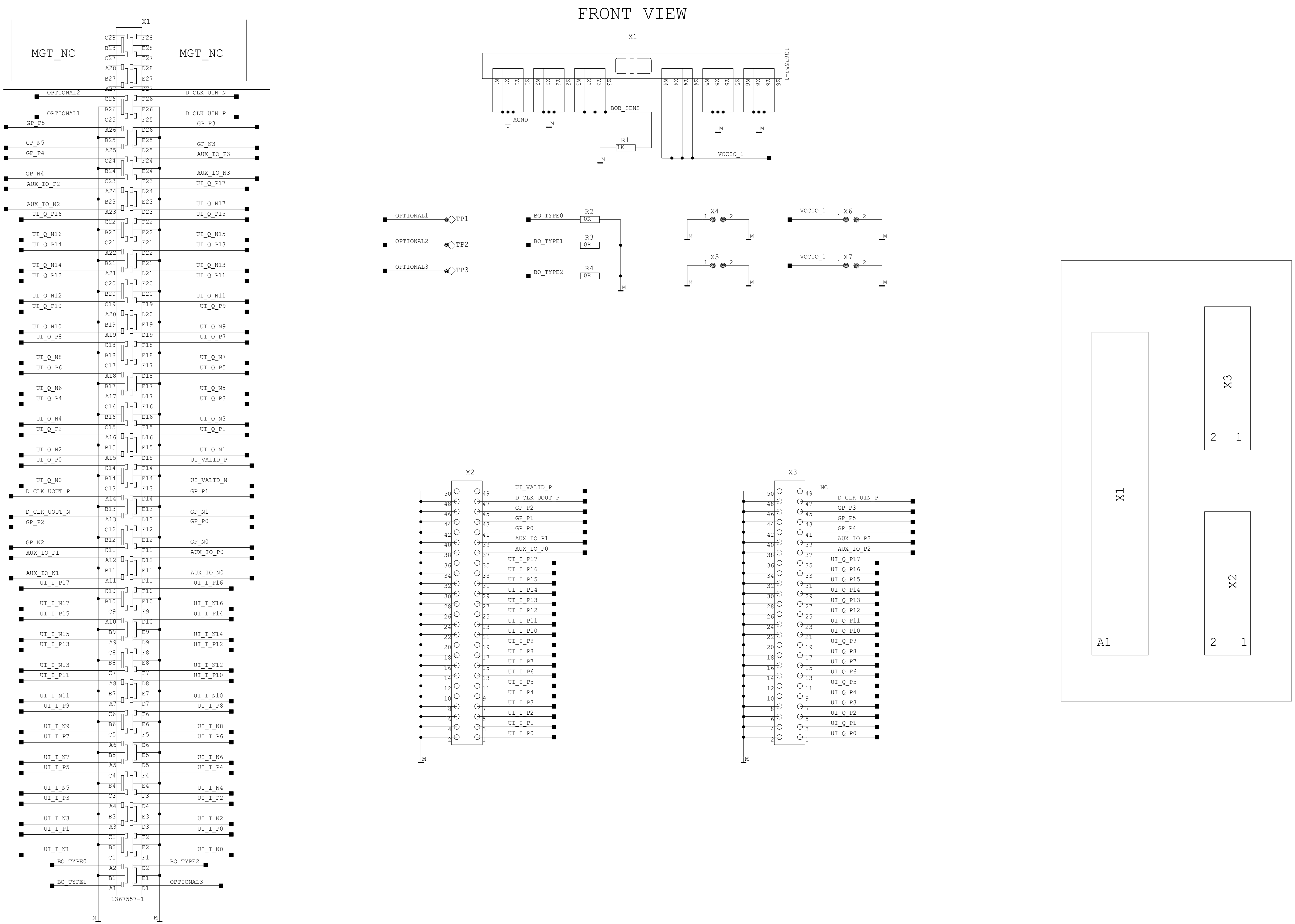
DWN W. VAN SCYOC 09SEPT05
CHK E. BRIANT 09SEPT05
APVD E. BRIANT 09SEPT05
PRODUCT SPEC 108-1985
APPLICATION SPEC 114-13068
WEIGHT -

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 A1 | CAGE CODE 00779 | DRAWING NO C-6367557 | RESTRICTED TO -

CUSTOMER DRAWING | SCALE 3:1 | SHEET 1 OF 1 | REV A1

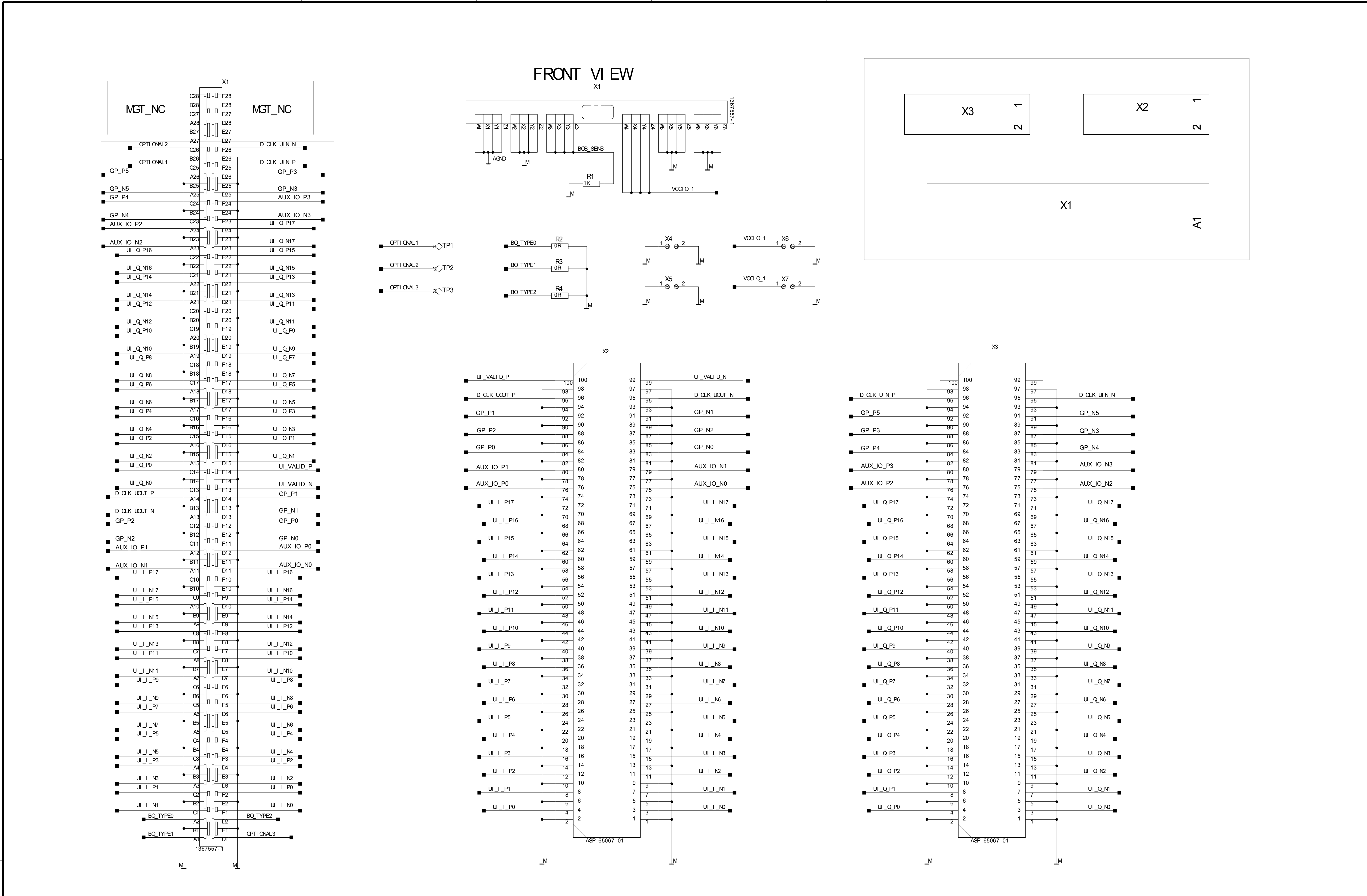


Bindende Angaben ueber Varianten, Trimmwerte, Bauteile und nicht bestueckte Bauteile siehe ST.
For binding information on models, trimming and components values and nonfitted components see parts list.
Electrostatic sensitiv devices require a special handling.
Elektrostatisch gefaehrdete Bauelemente 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 -
	Datum: / Date: 29.07.2007	Abteilung: / Dept.:	Name: / Name:	Zeichn.Nr.:/Drawing No.: 3585.7280.00 090002-222-25(SP)(3)



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 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)