

# R&S®EX-IQ-BOX

## Digital Interface Module

### R&S®DigIConf Software

## User Manual



1409.5570.32 – 06

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

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

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

The firmware of the instrument makes use of several valuable open source software packages. For information, see the "Open Source Acknowledgement" on the user documentation CD-ROM (included in delivery).

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

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Throughout this manual R&S® is abbreviated as R&S and applies to the following R&S products: R&S®EX-IQ-BOX , R&S®DigIConf, R&S®AMU200A, R&S®SMU200A, R&S®SMBV100A, R&S®SMJ100A, R&S®FSQ, R&S®FSW, R&S®FSG, R&S®FMU36, R&S®FSV, R&S®CMW500 and R&S®WinIQSIM2.

# Basic Safety Instructions

## Always read through and comply with the following safety instructions!

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

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

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

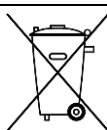
Observing the safety instructions will help prevent personal injury or damage of any kind caused by dangerous situations. Therefore, carefully read through and adhere to the following safety instructions before and when using the product. It is also absolutely essential to observe the additional safety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

## Safety labels on products

The following safety labels are used on products to warn against risks and dangers.

| Symbol                                                                              | Meaning                                                          | Symbol                                                                              | Meaning             |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------|
|  | Notice, general danger location<br>Observe product documentation |  | ON/OFF Power        |
|  | Caution when handling heavy equipment                            |  | Standby indication  |
|  | Danger of electric shock                                         |  | Direct current (DC) |

## Basic Safety Instructions

| Symbol                                                                              | Meaning                                                                                                                                                                                                             | Symbol                                                                             | Meaning                                                                                                                                                                |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | Caution ! Hot surface                                                                                                                                                                                               |   | Alternating current (AC)                                                                                                                                               |
|    | Protective conductor terminal<br>To identify any terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault, or the terminal of a protective earth |   | Direct/alternating current (DC/AC)                                                                                                                                     |
|    | Earth (Ground)                                                                                                                                                                                                      |   | Class II Equipment<br>to identify equipment meeting the safety requirements specified for Class II equipment (device protected by double or reinforced insulation)     |
|    | Frame or chassis Ground terminal                                                                                                                                                                                    |   | EU labeling for batteries and accumulators<br>For additional information, see section "Waste disposal/Environmental protection", item 1.                               |
|    | Be careful when handling electrostatic sensitive devices                                                                                                                                                            |  | EU labeling for separate collection of electrical and electronic devices<br>For additional information, see section "Waste disposal/Environmental protection", item 2. |
|  | Warning! Laser radiation<br>For additional information, see section "Operation", item 7.                                                                                                                            |                                                                                    |                                                                                                                                                                        |

### Signal words and their meaning

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



Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.



Indicates information considered important, but not hazard-related, e.g. messages relating to property damage.

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

These signal words are in accordance with the standard definition for civil applications in the European Economic Area. Definitions that deviate from the standard definition may also exist in other economic areas or military applications. It is therefore essential to make sure that the signal words described here are always used only in connection with the related product documentation and the related product. The use of signal words in connection with unrelated products or documentation can result in misinterpretation and in personal injury or material damage.



## Basic Safety Instructions

### Operating states and operating positions

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

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

### Electrical safety

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

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

## Basic Safety Instructions

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

## Operation

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

## Basic Safety Instructions

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

## Repair and service

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

## Basic Safety Instructions

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

### Batteries and rechargeable batteries/cells

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

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

### 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.

## Instrucciones de seguridad elementales

3. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely and properly. The manufacturer assumes no responsibility for accidents or collisions. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident.

### Waste disposal/Environmental protection

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

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

## Instrucciones de seguridad elementales

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

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

## Instrucciones de seguridad elementales

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

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

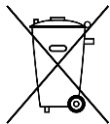
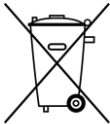
Tener en cuenta las informaciones de seguridad sirve para evitar en lo posible lesiones o daños por peligros de toda clase. Por eso es imprescindible leer detalladamente y comprender por completo las siguientes informaciones de seguridad antes de usar el producto, y respetarlas durante el uso del producto.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

### Señalización de seguridad de los productos

Las siguientes señales de seguridad se utilizan en los productos para advertir sobre riesgos y peligros.

| Símbolo                                                                             | Significado                                                               | Símbolo                                                                             | Significado                                          |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------|
|  | Aviso: punto de peligro general<br>Observar la documentación del producto |  | Tensión de alimentación de PUESTA EN MARCHA / PARADA |
|  | Atención en el manejo de dispositivos de peso elevado                     |  | Indicación de estado de espera (standby)             |
|  | Peligro de choque eléctrico                                               |  | Corriente continua (DC)                              |
|  | Advertencia: superficie caliente                                          |  | Corriente alterna (AC)                               |
|  | Conexión a conductor de protección                                        |  | Corriente continua / Corriente alterna (DC/AC)       |

## Instrucciones de seguridad elementales

| Símbolo                                                                           | Significado                                                                         | Símbolo                                                                           | Significado                                                                                                                                                                           |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Conexión a tierra                                                                   |  | El aparato está protegido en su totalidad por un aislamiento doble (reforzado)                                                                                                        |
|  | Conexión a masa                                                                     |  | Distintivo de la UE para baterías y acumuladores<br>Más información en la sección "Eliminación/protección del medio ambiente", punto 1.                                               |
|  | Aviso: Cuidado en el manejo de dispositivos sensibles a la electrostática (ESD)     |  | Distintivo de la UE para la eliminación por separado de dispositivos eléctricos y electrónicos<br>Más información en la sección "Eliminación/protección del medio ambiente", punto 2. |
|  | Advertencia: rayo láser<br>Más información en la sección "Funcionamiento", punto 7. |                                                                                   |                                                                                                                                                                                       |

### Palabras de señal y su significado

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



Indica una situación de peligro que, si no se evita, causa lesiones graves o incluso la muerte.



Indica una situación de peligro que, si no se evita, puede causar lesiones graves o incluso la muerte.



Indica una situación de peligro que, si no se evita, puede causar lesiones leves o moderadas.



Indica información que se considera importante, pero no en relación con situaciones de peligro; p. ej., avisos sobre posibles daños materiales.

En la documentación del producto se emplea de forma sinónima el término CUIDADO.

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

## Instrucciones de seguridad elementales

### Estados operativos y posiciones de funcionamiento

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

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

### Seguridad eléctrica

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

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



## Instrucciones de seguridad elementales

integran productos sin interruptor en bastidores o instalaciones, se deberá colocar el interruptor en el nivel de la instalación.

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

## Instrucciones de seguridad elementales

17. No utilice el producto en condiciones en las que pueda producirse o ya se hayan producido condensaciones sobre el producto o en el interior de éste, como p. ej. al desplazarlo de un lugar frío a otro caliente. La entrada de agua aumenta el riesgo de choque eléctrico.
18. Antes de la limpieza, desconecte por completo el producto de la alimentación de tensión (p. ej. red de alimentación o batería). Realice la limpieza de los aparatos con un paño suave, que no se deshilache. No utilice bajo ningún concepto productos de limpieza químicos como alcohol, acetona o diluyentes para lacas nitrocelulósicas.

### Funcionamiento

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

## Instrucciones de seguridad elementales

pueden causar perturbaciones radioeléctricas en entornos residenciales debido a posibles perturbaciones guiadas o radiadas. En este caso, se le podrá solicitar al operador que tome las medidas adecuadas para eliminar estas perturbaciones.

- Aparato de clase B:

Aparato adecuado para su uso en entornos residenciales, así como en aquellos conectados directamente a una red de distribución de baja tensión que suministra corriente a edificios residenciales.

### Reparación y mantenimiento

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

### Baterías y acumuladores o celdas

*Si no se siguen (o se siguen de modo insuficiente) las indicaciones en cuanto a las baterías y acumuladores o celdas, pueden producirse explosiones, incendios y/o lesiones graves con posible consecuencia de muerte. El manejo de baterías y acumuladores con electrolitos alcalinos (p. ej. celdas de litio) debe seguir el estándar EN 62133.*

1. No deben desmontarse, abrirse ni triturarse las celdas.
2. Las celdas o baterías no deben someterse a calor ni fuego. Debe evitarse el almacenamiento a la luz directa del sol. Las celdas y baterías deben mantenerse limpias y secas. Limpiar las conexiones sucias con un paño seco y limpio.
3. Las celdas o baterías no deben cortocircuitarse. Es peligroso almacenar las celdas o baterías en estuches o cajones en cuyo interior puedan cortocircuitarse por contacto recíproco o por contacto con otros materiales conductores. No deben extraerse las celdas o baterías de sus embalajes originales hasta el momento en que vayan a utilizarse.
4. Las celdas o baterías no deben someterse a impactos mecánicos fuertes indebidos.
5. En caso de falta de estanqueidad de una celda, el líquido vertido no debe entrar en contacto con la piel ni los ojos. Si se produce contacto, lavar con agua abundante la zona afectada y avisar a un médico.
6. En caso de cambio o recarga inadecuados, las celdas o baterías que contienen electrolitos alcalinos (p. ej. las celdas de litio) pueden explotar. Para garantizar la seguridad del producto, las celdas o baterías solo deben ser sustituidas por el tipo Rohde & Schwarz correspondiente (ver lista de recambios).
7. Las baterías y celdas deben reciclarse y no deben tirarse a la basura doméstica. Las baterías o acumuladores que contienen plomo, mercurio o cadmio deben tratarse como residuos especiales. Respete en esta relación las normas nacionales de eliminación y reciclaje.

## **Instrucciones de seguridad elementales**

8. En caso de devolver baterías de litio a las filiales de Rohde & Schwarz, debe cumplirse las normativas sobre los modos de transporte (IATA-DGR, código IMDG, ADR, RID).

### **Transporte**

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

### **Eliminación/protección del medio ambiente**

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

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

# Customer Support

## Technical support – where and when you need it

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

## Up-to-date information and upgrades

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

### Europe, Africa, Middle East

Phone +49 89 4129 12345  
[customersupport@rohde-schwarz.com](mailto:customersupport@rohde-schwarz.com)

### North America

Phone 1-888-TEST-RSA (1-888-837-8772)  
[customer.support@rsa.rohde-schwarz.com](mailto:customer.support@rsa.rohde-schwarz.com)

### Latin America

Phone +1-410-910-7988  
[customersupport.la@rohde-schwarz.com](mailto:customersupport.la@rohde-schwarz.com)

### Asia/Pacific

Phone +65 65 13 04 88  
[customersupport.asia@rohde-schwarz.com](mailto:customersupport.asia@rohde-schwarz.com)

### China

Phone +86-800-810-8228 /  
+86-400-650-5896  
[customersupport.china@rohde-schwarz.com](mailto:customersupport.china@rohde-schwarz.com)



# Contents

|          |                                                |            |
|----------|------------------------------------------------|------------|
| <b>1</b> | <b>Preface.....</b>                            | <b>5</b>   |
| 1.1      | Documentation Overview.....                    | 5          |
| 1.2      | Typographical Conventions.....                 | 9          |
| <b>2</b> | <b>Welcome to the R&amp;S EX-IQ-BOX.....</b>   | <b>11</b>  |
| <b>3</b> | <b>System Overview.....</b>                    | <b>14</b>  |
| 3.1      | Basic Operating Modes.....                     | 14         |
| 3.2      | Components.....                                | 21         |
| <b>4</b> | <b>Getting Started.....</b>                    | <b>26</b>  |
| 4.1      | Safety Instructions.....                       | 26         |
| 4.2      | Unpacking the R&S EX-IQ-BOX.....               | 29         |
| 4.3      | Control Elements and Connectors.....           | 29         |
| 4.4      | Installing R&S DiglConf.....                   | 34         |
| 4.5      | Connecting the R&S EX-IQ-BOX.....              | 42         |
| 4.6      | Installing R&S EX-IQ-BOX Options.....          | 44         |
| <b>5</b> | <b>Application Examples.....</b>               | <b>47</b>  |
| 5.1      | Baseband Receiver Chip Test.....               | 47         |
| 5.2      | CPRI Test Setup.....                           | 48         |
| 5.3      | In-Circuit Emulation for Wireless Designs..... | 51         |
| <b>6</b> | <b>R&amp;S EX-IQ-BOX Configuration.....</b>    | <b>53</b>  |
| 6.1      | R&S DiglConf Configuration Software.....       | 53         |
| 6.2      | Configuration via R&S Instruments.....         | 83         |
| <b>7</b> | <b>Protocol Settings.....</b>                  | <b>95</b>  |
| 7.1      | User Defined.....                              | 95         |
| 7.2      | CPRI.....                                      | 126        |
| <b>8</b> | <b>Remote Control Basics.....</b>              | <b>213</b> |
| 8.1      | Remote Control Interfaces and Protocols.....   | 213        |
| 8.2      | SCPI Command Structure.....                    | 222        |
| 8.3      | Command Sequence and Synchronization.....      | 231        |
| 8.4      | General Programming Recommendations.....       | 234        |

|           |                                              |            |
|-----------|----------------------------------------------|------------|
| <b>9</b>  | <b>Remote Control Commands.....</b>          | <b>236</b> |
| 9.1       | Common Commands.....                         | 236        |
| 9.2       | R&S EX-IQ-BOX - Remote Control Commands..... | 239        |
| 9.3       | User Defined - Remote Control Commands.....  | 257        |
| 9.4       | CPRI Remote Control Commands.....            | 286        |
| <b>10</b> | <b>Interfaces.....</b>                       | <b>355</b> |
| 10.1      | User Interface of the R&S EX-IQ-BOX.....     | 355        |
| 10.2      | LAN Connector.....                           | 357        |
| 10.3      | Breakout Boards.....                         | 358        |
| <b>A</b>  | <b>Annex.....</b>                            | <b>369</b> |
| A.1       | Abbreviations.....                           | 369        |
| A.2       | Extensions for User Files.....               | 370        |
| A.3       | Preset.....                                  | 371        |
| A.4       | Drawings.....                                | 375        |
|           | <b>List of Commands.....</b>                 | <b>376</b> |
|           | <b>Index.....</b>                            | <b>384</b> |

# 1 Preface

## 1.1 Documentation Overview

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

It consists of the following parts:

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

### 1.1.1 Quick Start Guide



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

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

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

#### **Data Sheet**

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

#### **Introduction**

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

#### **System Overview**

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



## Getting Started

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

## Application Examples

Describes several application examples.

## Interfaces

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



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

---

## Index

Contains an index of the quick start guide.

### 1.1.2 Help System



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

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

### 1.1.3 User Documentation CD-ROM



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



#### Version for pdf and chm

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

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

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## Manuals

Quick Start Guide in printable form, and an Operating Manual and Service Manual in \*.pdf format.

**Online Help**

The standalone help file `eqiqbox.chm`.

**Data Sheet**

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

**Software**

- `DigIConf_*.exe` (Digital Interface Configurator)  
R&S DigIConf is a software for configuring the R&S EX-IQ-BOX settings via USB interface and a PC.

### 1.1.4 Operating Manual



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

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

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

**Data Sheet**

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

**Introduction**

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

**System Overview**

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

**Getting Started**

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

**Application Examples**

Describes several application examples.

**R&S EX-IQ-BOX Configuration**

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

**Protocol Settings**

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

**Remote Control Basics**

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

**Remote Control Commands**

Describes all remote-control commands available including programming examples.

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

**Interfaces**

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

**Index**

Contains an index of the operating manual.

**Appendix**

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

**Open Source**

Covers information on software licensing.

**Attachments**

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

### 1.1.5 Service Manual



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

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

#### **Service and Repair**

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

#### **Maintenance**

Points to maintenance and environmental conditions.

#### **Documents**

Contains the spare parts list and mechanical drawings.

#### **Index**

Contains an index of the service manual.

### 1.1.6 Internet Site



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

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

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

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

## 1.2 Typographical Conventions

The following text markers are used throughout this documentation:

| Convention                          | Description                                                                                                                                                |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "Graphical user interface elements" | All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks. |
| KEYS                                | Key names are written in capital letters.                                                                                                                  |

| Convention                            | Description                                                                             |
|---------------------------------------|-----------------------------------------------------------------------------------------|
| File names, commands,<br>program code | File names, commands, coding samples and screen output are distinguished by their font. |
| <i>Input</i>                          | Input to be entered by the user is displayed in italics.                                |
| <a href="#">Links</a>                 | Links that you can click are displayed in blue font.                                    |
| "References"                          | References to other parts of the documentation are enclosed by quotation marks.         |

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

### ...the Digital Interface Module

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

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

To digitally transmit I/Q signals, R&S instruments like signal generators, signal analyzers, communication testers and the R&S EX-IQ-BOX communicate with each other, using an R&S wide standardized transmission protocol, which is based on **LVDS** (Low Voltage Differential Signaling).

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

In applications with **standardized protocols** the R&S EX-IQ-BOX not only provides the I/Q data, but also the control information of the respective standard. Equipped with the respective options, the R&S EX-IQ-BOX supports the standardized protocol **CPRI** (Common Packet Radio Interface). This protocol defines a combined interface for the transmission of I/Q and control data between the baseband and RF module of a base station.

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

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

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



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

---

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

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

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

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

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



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

---

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



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™.

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

For detailed information on all available options refer to [chapter 3.2.2, "Options"](#), on page 22".

**Latest information on extensions and changes**

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

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

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

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

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## 3 System Overview

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

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

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

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

### 3.1 Basic Operating Modes

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

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

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



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

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

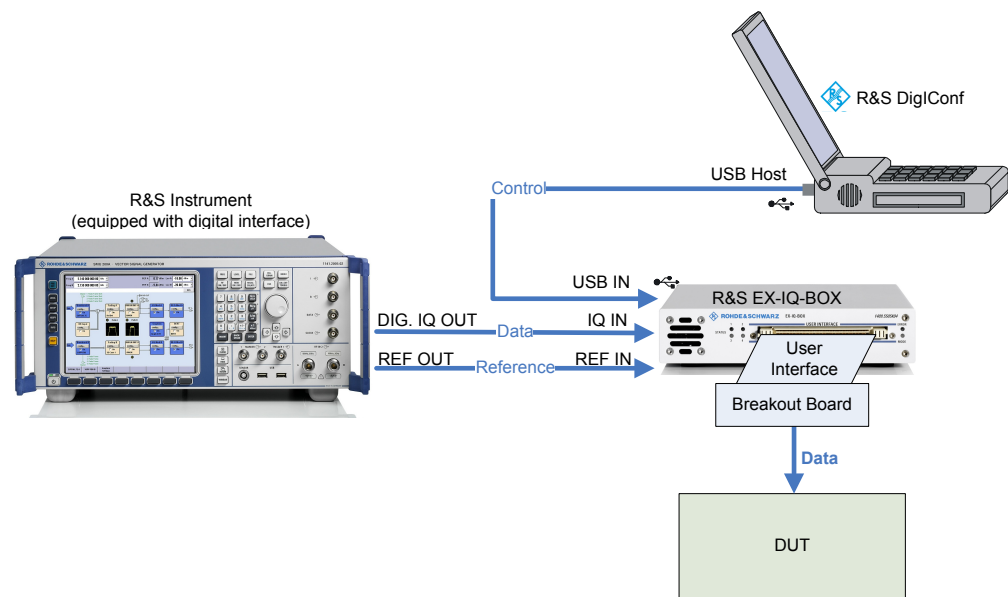


**Fig. 3-1: Configuration example with R&S DigiConf**

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

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

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

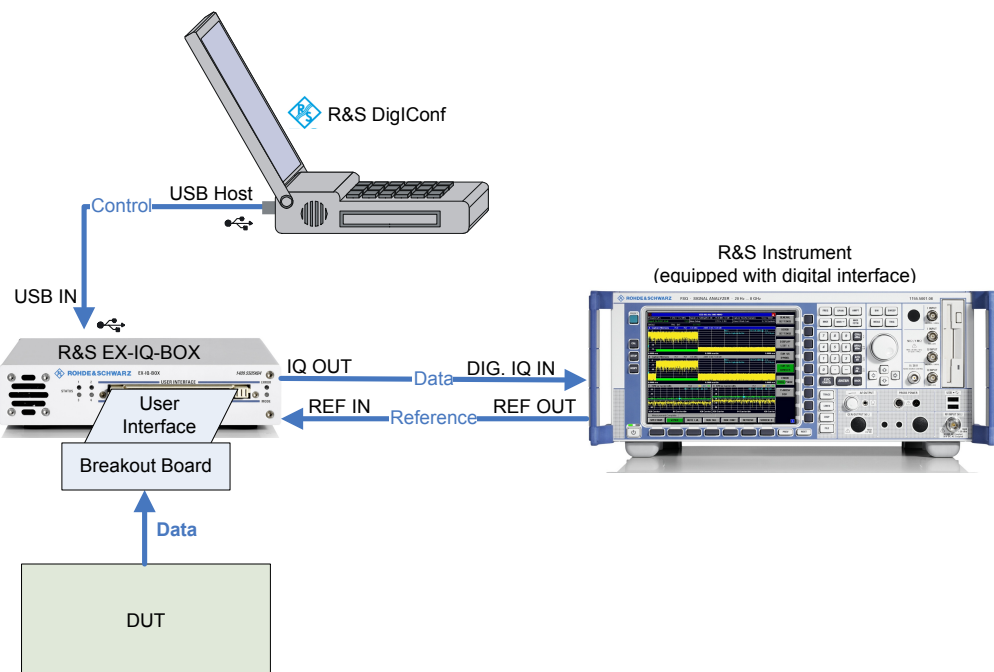


**Fig. 3-2: R&S EX-IQ-BOX and R&S instrument working in receiver mode, controlled by R&S DigiConf**

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



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

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

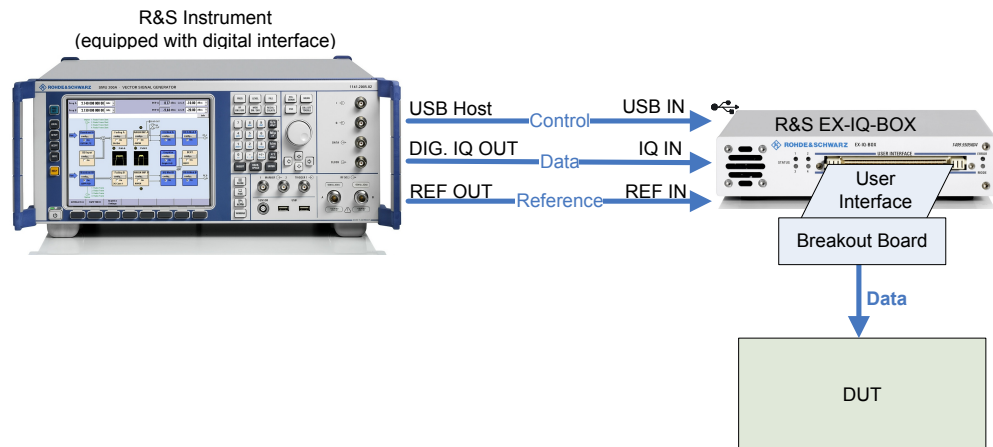


**Fig. 3-3: Configuration example of the R&S EX-IQ-BOX, directly controlled by an R&S instrument**

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

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

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

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

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



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



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

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

For the control, **SCPI (Standard Commands for Programmable Instruments)** commands are used.

An introduction to the structure and to the syntax of SCPI commands is given in the operating manual of the R&S EX-IQ-BOX, see [chapter 8, "Remote Control Basics"](#), on page 213.

#### 3.1.3.1 Remote Control via R&S DigIConf

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

#### Examples of the remote controlled R&S DigIConf

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

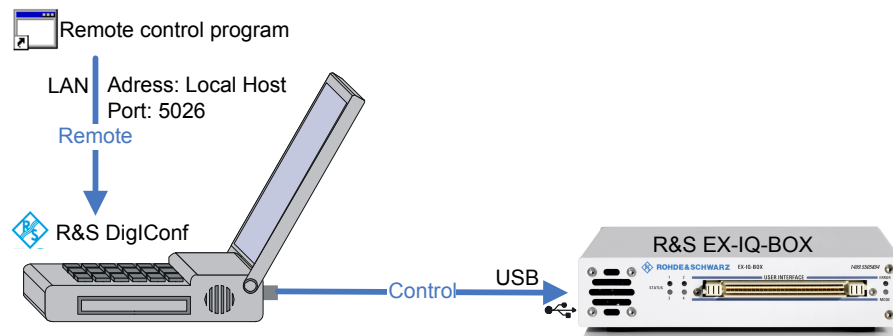


**Fig. 3-4: Remote control program and R&S DigIConf running on the same PC**

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

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

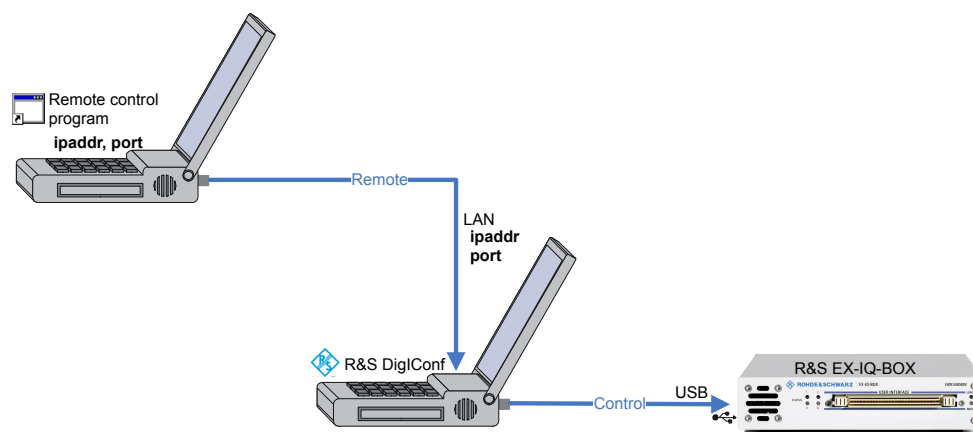


**Fig. 3-5: Remote control program and R&S DigiConf running on different PCs**

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

For further information on LAN connection and IP address, see [chapter 8, "Remote Control Basics"](#), on page 213.

### 3.1.3.2 Remote Control via an R&S Instrument



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

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

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

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

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

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

The remote control commands for setting the parameters of the R&S EX-IQ-BOX are described in the operating manual; see [chapter 9.3, "User Defined - Remote Control Commands"](#), on page 257.

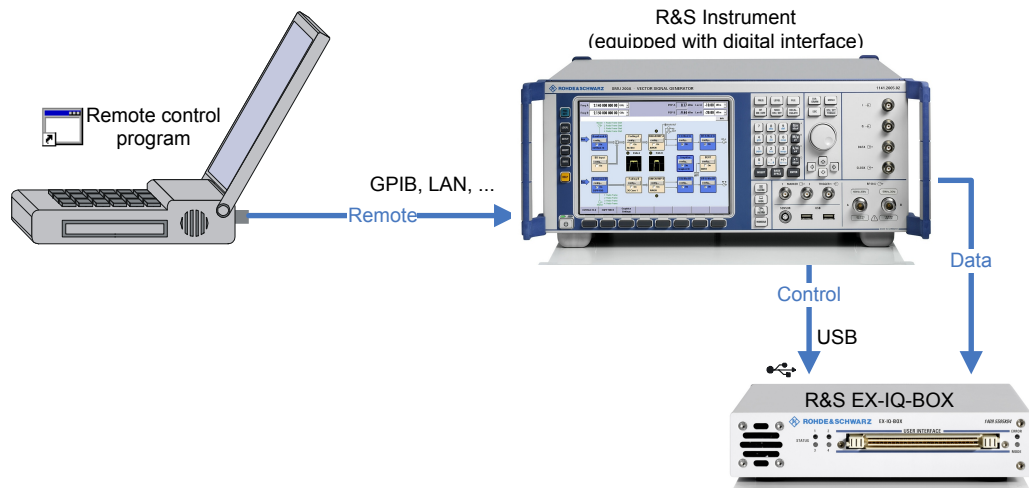


Fig. 3-6: Example of remote control of an R&S instrument with a connected R&S EX-IQ-BOX

### 3.1.4 Waveform Memory, Multi Waveform Playback and Recording Memory



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

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

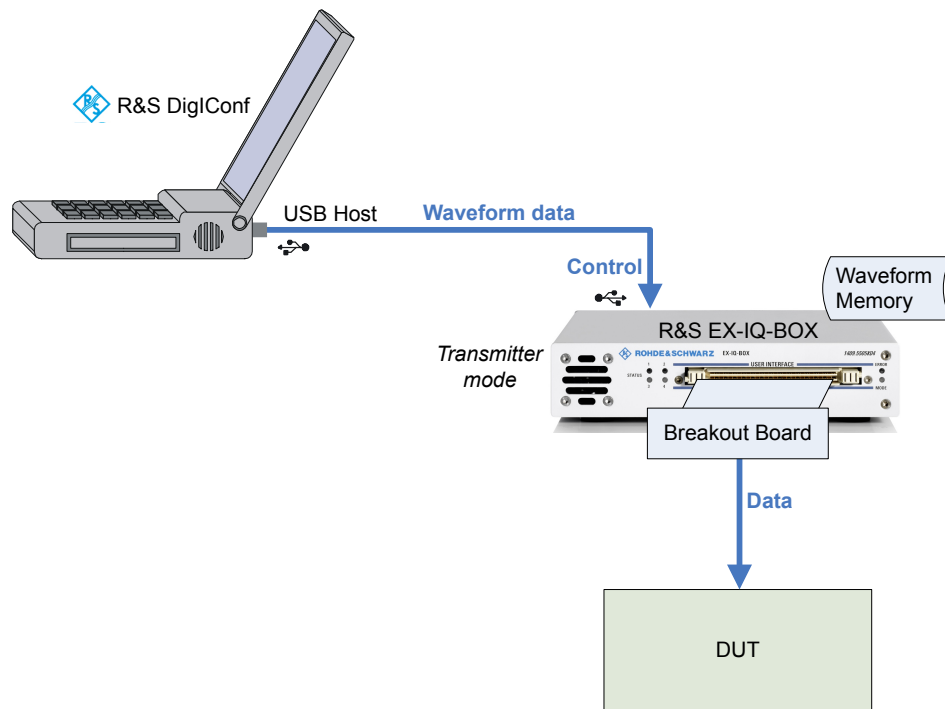


**Fig. 3-7: Configuration example of the R&S EX-IQ-BOX equipped with a Waveform Memory**

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

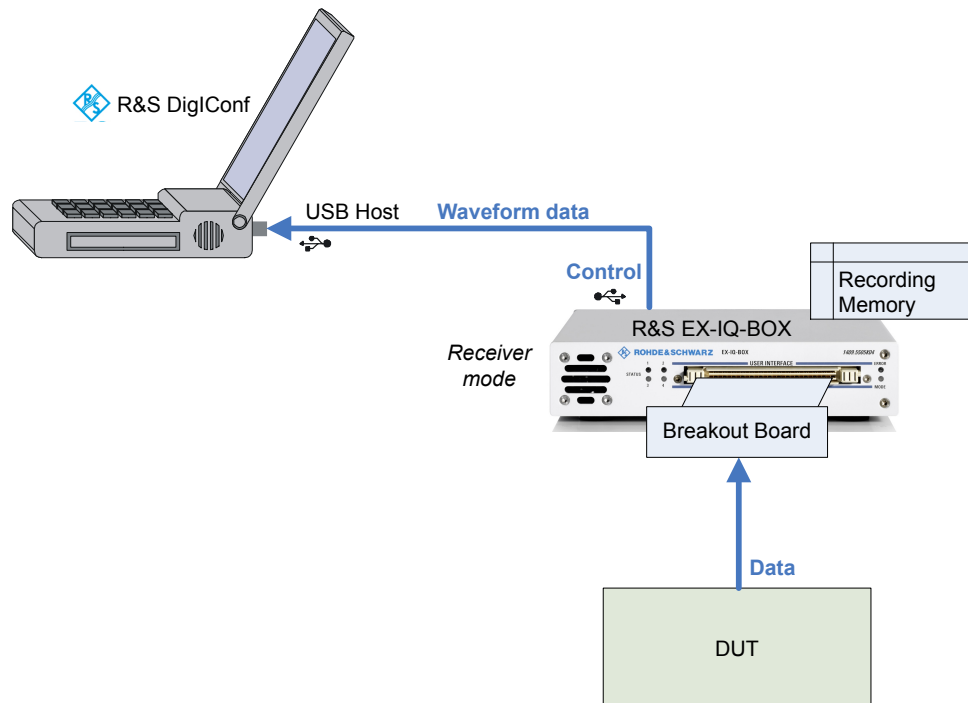


**Fig. 3-8: Configuration example of the R&S EX-IQ-BOX recording incoming data**



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

## 3.2 Components

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



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

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

### 3.2.1 R&S EX-IQ-BOX

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

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



### 3.2.2 Options



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

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

#### 3.2.2.1 Standardized Protocols

For applications with standardized protocols the following options are available:

| Digital Interface Protocol...                                            | Option R&S... | R&S part number |
|--------------------------------------------------------------------------|---------------|-----------------|
| CPRI Breakout Board (16x)                                                | EXBOX-B85     | 1409.7208.04    |
| CPRI Breakout Board (5x)                                                 | EXBOX-B85     | 1409.7208.02    |
| CPRI RE Test                                                             | EXBOX-K10     | 1417.1170.02    |
| CPRI REC Test                                                            | EXBOX-K11     | 1417.1186.02    |
| <b>Note:</b> Each option is delivered with a licence key for activation. |               |                 |

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

#### 3.2.2.2 User Defined Protocols

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

| ...Breakout board                                                                                                                       | Option R&S... | R&S part number |
|-----------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------|
| <b>Cadence Palladium</b> ... 090002-24x                                                                                                 | EXBOX-Z3      | 1417.3566.02    |
| <b>MDR (Mini Delta Ribbon)</b> ... 090002-25x                                                                                           | EXBOX-Z4      | 1417.3614.02    |
| These options only consist of the breakout boards and are used the same way as the breakout boards types single ended and differential. |               |                 |

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

### 3.2.2.3 Waveform Memory, Multi Waveform Playback and Recording Memory

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

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

### 3.2.2.4 Digital Standards with R&S WinIQSIM2

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

| Digital Standard         | Option R&S... | R&S part number |
|--------------------------|---------------|-----------------|
| GSM/EDGE                 | EXBOX-K240    | 1417.1034.02    |
| EDGE Evolution           | EXBOX-K241    | 1417.1040.02    |
| 3GPP FDD                 | EXBOX-K242    | 1417.1057.02    |
| 3GPP FDD Enhanced        | EXBOX-K243    | 1417.1063.02    |
| 3GPP FDD HSUPA           | EXBOX-K245    | 1417.1070.02    |
| CDMA 2000® incl. 1xEV-DV | EXBOX-K246    | 1417.1086.02    |
| 1xEV-DO REV. A           | EXBOX-K247    | 1417.1092.02    |
| IEEE 802.16 (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    |

### 3.2.3 R&S DigIConf - Digital Interface Configurator

The software R&S DigIConf (**D**igital **I**nterface **C**onfigurator 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 of the standardized protocol CPRI ; provided that the appropriate options are available, see [chapter 3.2.2, "Options"](#), on page 22.

**R&S DigIConf provides:**

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

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

For information on installation of R&S DigIConf refer to [chapter 4.4, "Installing R&S DigIConf"](#), on page 34.

Operating R&S DigIConf is described in the operating manual, [chapter 6, "R&S EX-IQ-BOX Configuration"](#), on page 53.

How to proceed for setting up an option refer to [chapter 4.6, "Installing R&S EX-IQ-BOX Options"](#), on page 44.



**Simulation mode**

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

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

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

### 3.2.4 Accessories

Various accessories support specific test configurations or modifications.

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

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

The breakout board R&S EXBOX-Z2 especially supports direct connection of two R&S EX-IQ-BOXes, used for example for demo purposes.



A conceivable scenario is for example: An R&S signal generator connected to the first R&S EX-IQ-BOX, and R&S signal analyzer to the second one. The R&S EX-IQ-BOXes are connected via the R&S EXBOX-Z2 breakout board.

The signal generator sends an I/Q signal to the first R&S EX-IQ-BOX which forwards this signal to the second R&S EX-IQ-BOX via the breakout board. With the signal analyzer you can evaluate and display the transmitted signal.

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

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

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



#### Digital interface options of R&S instruments

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

#### Signal Generation

- R&S AMU200A - Baseband Signal Generator and Fading Simulator
- R&S SMU200A - Vector Signal Generator
- R&S SMBV100A - Vector Signal Generator
- R&S SMJ100A - Vector Signal Generator

#### Signal Analysis

- R&S FMU36 - Baseband Signal Analyzer
- R&S FSV - Signal and Spectrum Analyzer
- R&S FSW - Signal and Spectrum Analyzer
- R&S FSG - Signal Analyzer
- R&S FSQ - Signal Analyzer

#### Radio Communication

- R&S CMW500 - Universal Wideband Radio Communication Tester

## 4 Getting Started

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

### 4.1 Safety Instructions

#### General Precautions

---

##### CAUTION

##### Shock hazard

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

---

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##### 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.

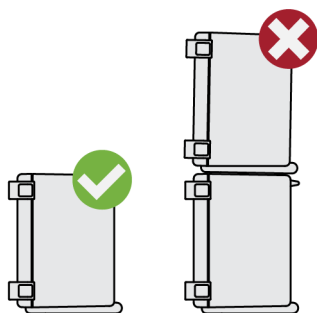
Failure to meet these conditions may cause damage to the R&S EX-IQ-BOX or other devices in the test setup.

---

**⚠ CAUTION****Risk of injury and instrument damage if stacking instruments**

A stack of instruments may tilt over and cause injury and material damage because the instrument's top surface area is too small.

Never stack instruments on top of each other. If you need to stack instruments, install them in a rack.

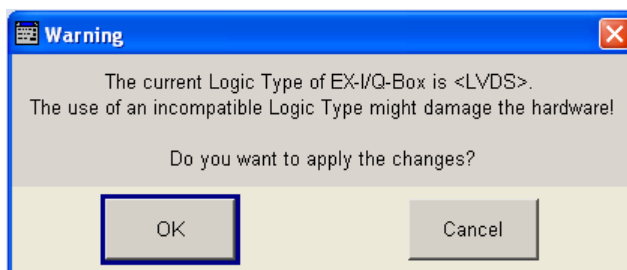
**Protection against Connector Overload****NOTICE****Avoid connector overload**

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

Electromagnetic interference (EMI) may affect the measurement results.

To suppress generated electromagnetic interference (EMI):

- Use suitable double shielded LAN (CAT 7), SMA and BNC cables of high quality.
- All connected cables must not exceed 3m in length.
- All unconnected outputs and lines have to be terminated properly with 50 Ohms.
- Use only the USB cable included in delivery.  
**Note:** USB cables are of varying and often poor quality. Therefore, it is recommended that you use only the supplied USB cable.
- Use only the power supply included in delivery.
- Use the cable R&S SMU-Z6 for connection to the DIG I/Q interfaces of the instrument. The required cable is available under part number 1415.0201.02.
- Note the EMC classification in the data sheet.

## Power supply

### NOTICE

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

Use only with the approved power supply of type:

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

Model: **TR45A05-11A01**

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

Output: **5VDC 6.0A**



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

## 4.2 Unpacking the R&S EX-IQ-BOX

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

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



### Packing material

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

---

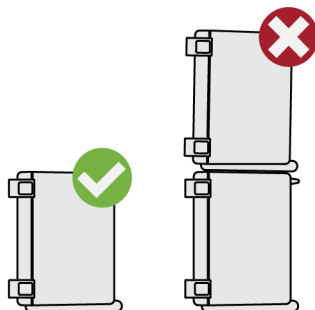


### CAUTION

#### Risk of injury and instrument damage if stacking instruments

A stack of instruments may tilt over and cause injury and material damage because the instrument's top surface area is too small.

Never stack instruments on top of each other. If you need to stack instruments, install them in a rack.



---

## 4.3 Control Elements and Connectors

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



### 4.3.1 Front Panel Tour

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

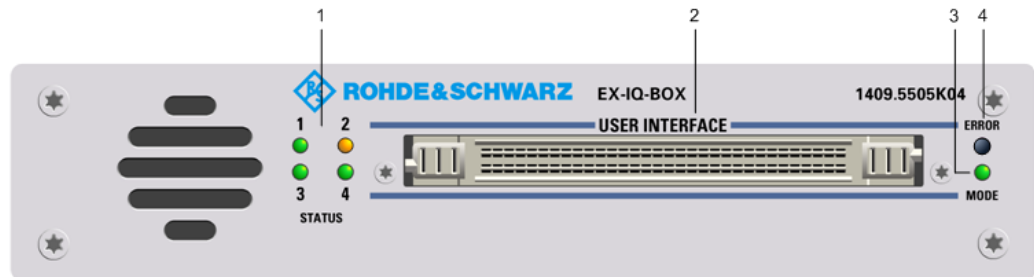
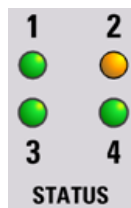


Fig. 4-1: Front panel view

#### 4.3.1.1 STATUS - LEDs



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

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

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

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

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

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

4 Status LED of the breakout board

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

#### 4.3.1.2 User Interface



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

See [chapter 10.1.1, "Z-DOK-Adapter Board Connector"](#), on page 355.

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

This interface is used to connect the breakout boards.

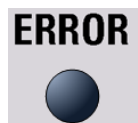
#### 4.3.1.3 MODE - LED



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

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

#### 4.3.1.4 ERROR - LED



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

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

### 4.3.2 Rear Panel View

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

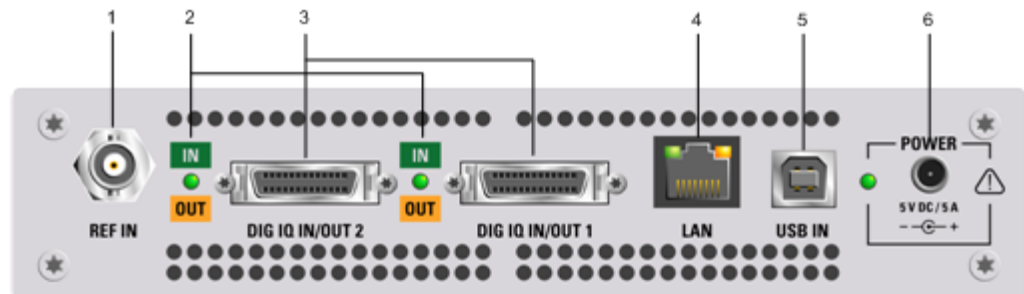


Fig. 4-3: Rear panel view

#### 4.3.2.1 REF IN - Reference signal input



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

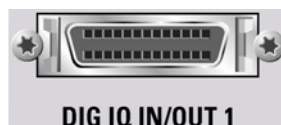
#### 4.3.2.2 IN / OUT - LED



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

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

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



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

One cable for the connection between the digital I/Q interfaces of the R&S EX-IQ-BOX and an R&S instrument is included in delivery. Additional cables are available separately. Refer to [chapter 3.2.4, "Accessories"](#), on page 24 for the R&S part number of the associated cable.

#### 4.3.2.4 LAN - Interface



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

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



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

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

#### 4.3.2.5 USB IN - USB interface type B



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

The interface supports two data rates:

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

An USB cable for the connection is included in delivery.

#### 4.3.2.6 POWER - Power supply



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

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

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

## 4.4 Installing R&S DigiConf

This section describes how to install the software R&S DigiConf (**D**igital **I**nterface **C**onfigurator), the tool for controlling the protocol settings of the R&S EX-IQ-BOX. It also encloses the hardware and software requirements which have to be met for installation.

### Software and Hardware Requirements

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

| Component        | Minimum requirement                                                                                                                   |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Operating system | Windows 2000 SP4 / XP SP1 (32 bit), Windows 7                                                                                         |
| 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<br><b>Tip:</b> USB 1.1 is also supported, but due to the lower transmission speed, it is recommended to operate with USB 2.0. |



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

### Prerequisites

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

## 4.4.1 Installation

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

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

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

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

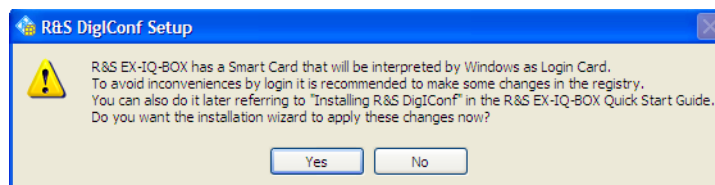


**Fig. 4-4: R&S DigIConf Installation > Modify DisableCAD**

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

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

It is recommended that you accept modification.

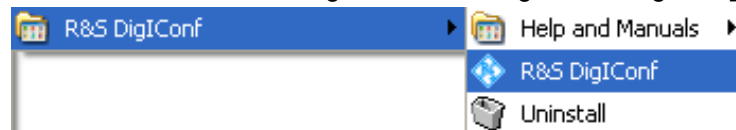
However, it is also possible, to modify the status later on. The installation wizard prepares the respective entries for a later modification.

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

#### 4.4.2 Starting

R&S DigIConf can either be started via:

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



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



or via

- the "application icon" on the desktop.



R&S DigIConf

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

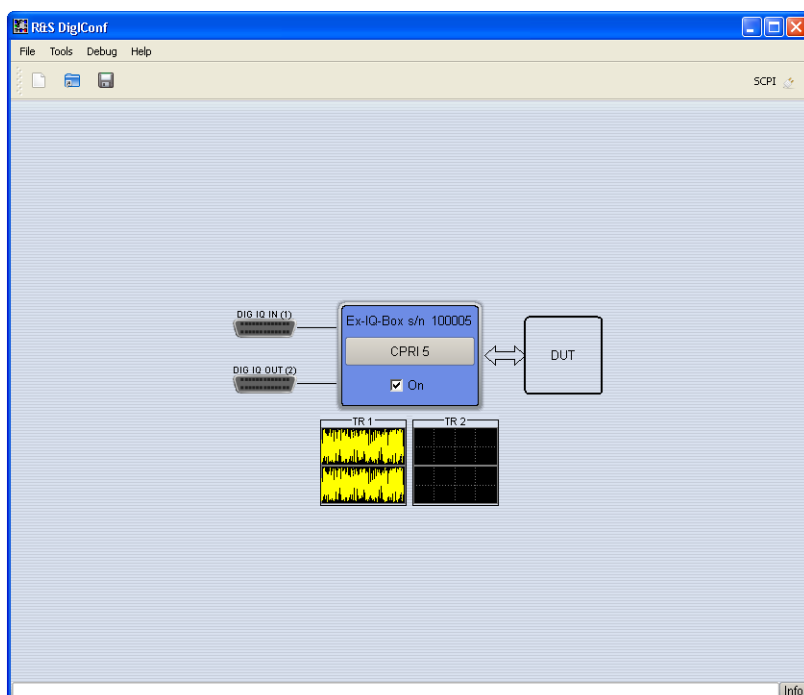


**Fig. 4-5: R&S DigiConf main application window**

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

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

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

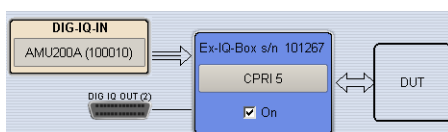


**Fig. 4-6: R&S DigiConf display of the R&S EX-IQ-BOX connected to an R&S AMU200A**

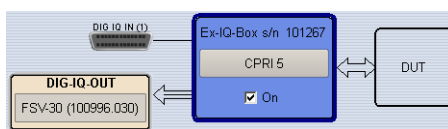


**Fig. 4-7: R&S DigiConf display of the R&S EX-IQ-BOX connected to an R&S FSQ-26**



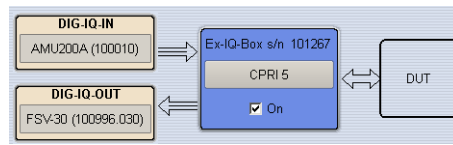


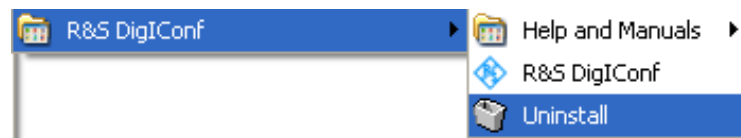
**Fig. 4-8: R&S DigIConf display of the R&S EX-IQ-BOX operating in bidirectional mode**

For a detailed description of the application window and its elements refer to the operating manual, [chapter 6.1, "R&S DigIConf Configuration Software"](#), on page 53.

### 4.4.3 Uninstalling

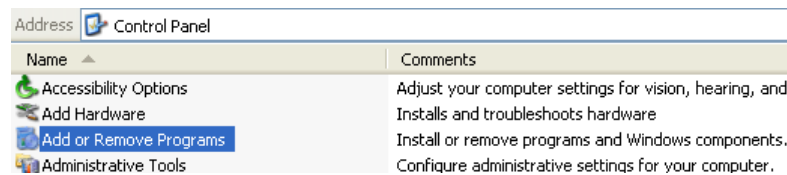
Uninstall the software with the aid of R&S DigIConf uninstaller,

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

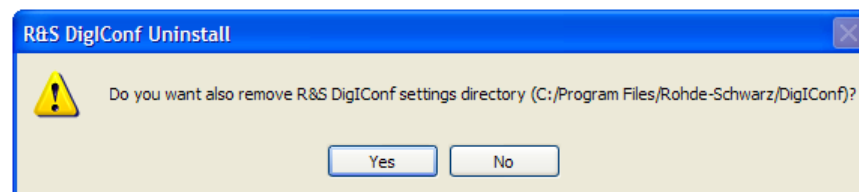


or the PC's control panel,

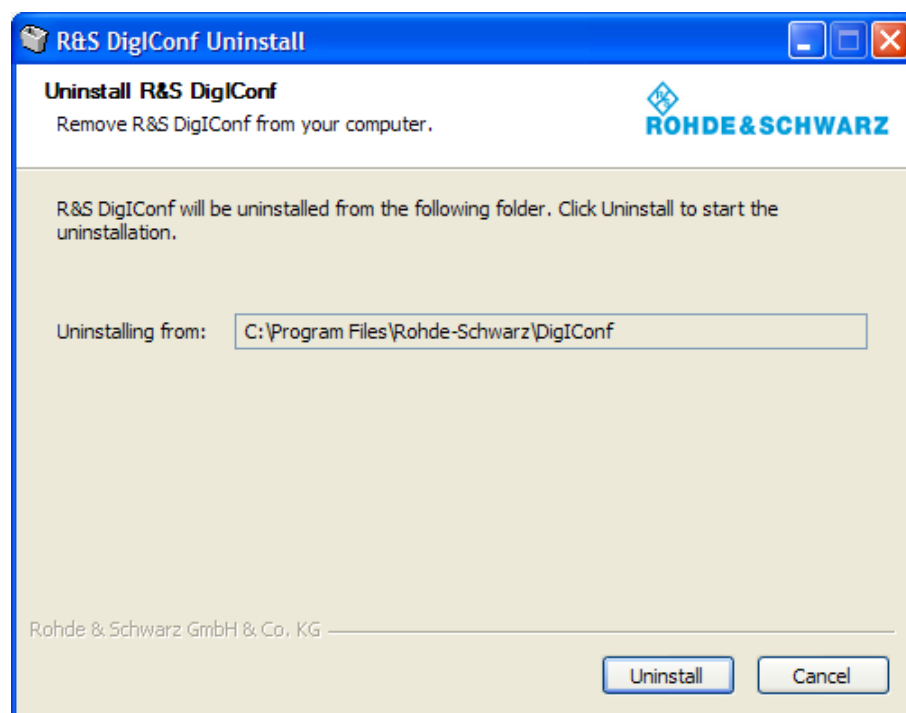
2. "Start > Settings > Control Panel" in the Windows task bar and open the "Add or Remove Programs" dialog. Uninstall the program with "Remove".



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



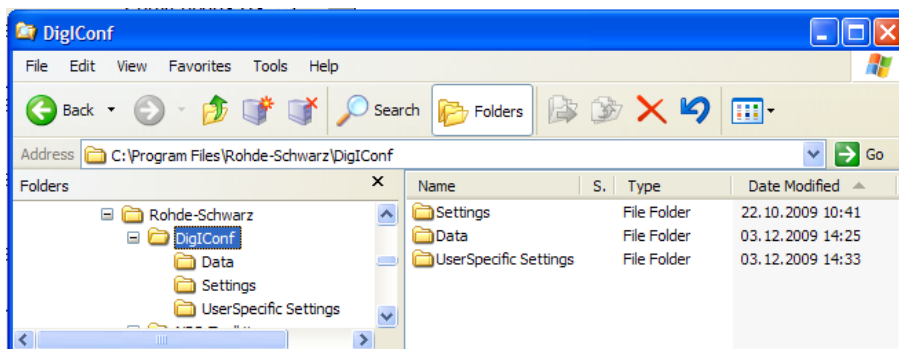
3. Confirm or reject, and start uninstalling.



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



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



#### 4.4.4 Known Restrictions on SmartCard Related Issues

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

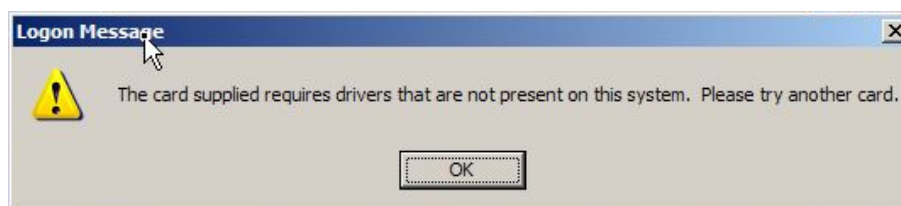


**Fig. 4-9: R&S DigIConf Installation > Logon message**

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

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

**1. "Logon Message" remains**

The system repeats the SmartCard error message and blocks the login. DisableCAD=1, i.e. the Windows security attention sequence (CTR-ALT-Del) for login is skipped. Windows tries to log in with the smart card and fails.

To terminate:

- a) Disconnect the R&S EX-IQ-BOX to enable login.
- b) Log in.
- c) Connect the R&S EX-IQ-BOX again.

**Note:** To solve this conflict for later operation, deactivate DisableCAD in the registry. The DisableCAD parameter determines whether you need to press CTRL+ALT+DEL keys to log in, or whether the login window directly appears after at startup or after locked desktop.

**2. "Logon Message" disappears**

The system forwards to the "Computer Locked" dialog box. In this case, DisableCAD=0, Windows requires users to press CTR-ALT-Del (security attention sequence) for login.

- a) Press CTRL+ALT+DEL to unlock the computer and log in as usual.  
The connection to the R&S EX-IQ-BOX may remain.

#### 4.4.4.1 How to avoid the SmartCard Conflict

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

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

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

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



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

#### 4.4.4.2 DisableCAD - Background Information

The DisableCAD parameter determines whether you must press the (**CTRL+ALT+DEL**) security attention sequence for windows login, or whether the login window directly appears after startup or after locked desktop.

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



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

The Windows dialog box opens, as shown below.

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



Fig. 4-11: Windows login dialog box

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

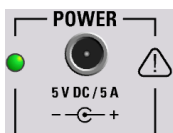
## 4.5 Connecting the R&S EX-IQ-BOX

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

### Connection

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

#### 1. Power supply



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

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

#### ► Connect the R&S EX-IQ-BOX to the AC supply.

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



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

## 2. USB Connection



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

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



## Device driver

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

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



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

## 3. Data signal connection

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



2. Establish the digital interface connection.

- a) Transmitter Mode

Connect the LVDS cable between the R&S EX-IQ-BOX (DIG I/Q IN/OUT 2) and the BASEBAND DIGITAL IN of the R&S instrument



- b) Receiver Mode

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

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

#### 4. Connection to the DUT

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



2. Establish the appropriate connection to the DUT.

## 4.6 Installing R&S EX-IQ-BOX Options

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

### Prerequisites

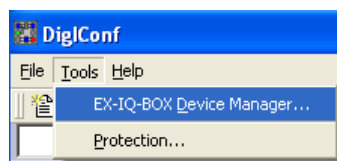
Before installing an option, make sure that the R&S EX-IQ-BOX is power supplied and an USB connection is established.

Keep the license key ready that is provided with the software option.

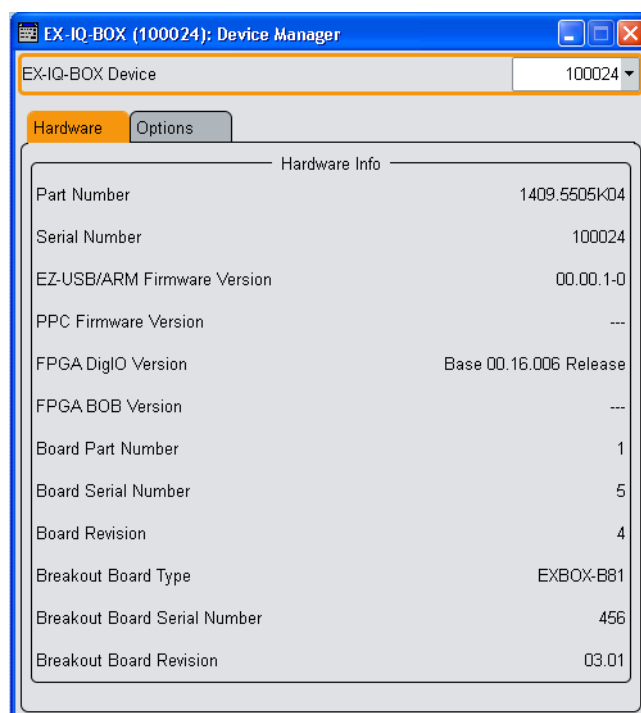
### Installation

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

1. Start R&S DiglConf.
2. In the "Tools" menu, select "Tools > EX-IQ-BOX Device Manager".



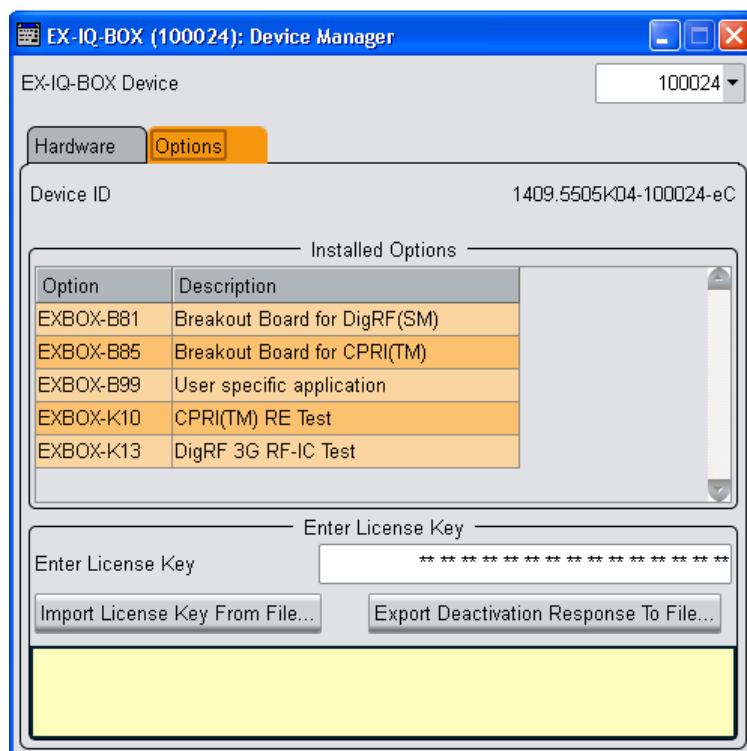
The "EX-IQ-BOX Device Manager" dialog opens.



The hardware tab indicates various information on a selected device, like part number, serial number, firmware version, and so on.

3. In the "Options" tab, select the appropriate "EX-IQ-BOX Device".

The list box lists each connected R&S EX-IQ-BOX.





For detailed description on this dialog refer to [chapter 6.1.6.1, "EX-IQ-BOX Device Manager"](#), on page 65 in the operating manual.

4. To enter the license key, perform one of the following:
  - in the "Enter License Key" text box, enter the license key code manually.
  - Select "Import License Key from File", and proceed accordingly.
5. Enter the license key provided with the option in the "Option-Key" field and confirm with "Enter".
6. Confirm with "OK".

R&S DigIConf immediately shows the newly enabled option in the table.



### Installing several options

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

---

### Checking for installed options

To check installed options proceed as follows:

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

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

## 5 Application Examples

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

### 5.1 Baseband Receiver Chip Test

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

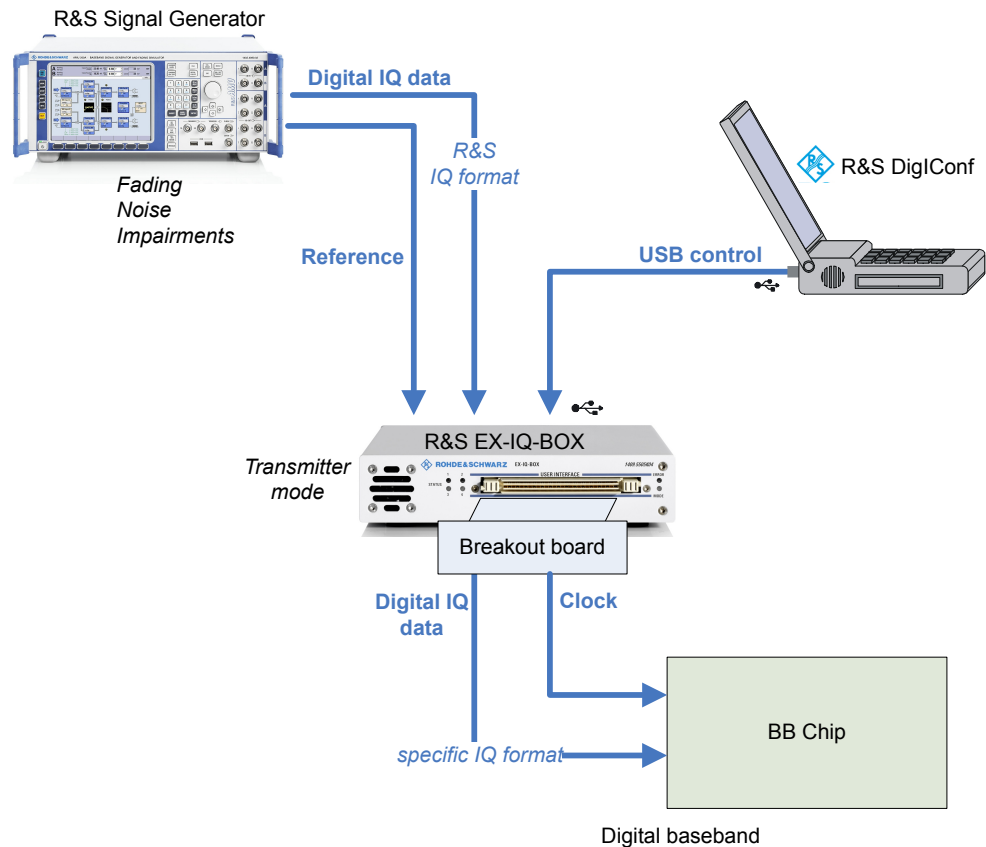


**Fig. 5-1: Application example of a baseband receiver chip test**

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

reproducibly. With the aid of bit and block error ratio measurements the quality of the receiver can be tested.

## 5.2 CPRI Test Setup

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

### 5.2.1 Typical CPRI RE Test Setup

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



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

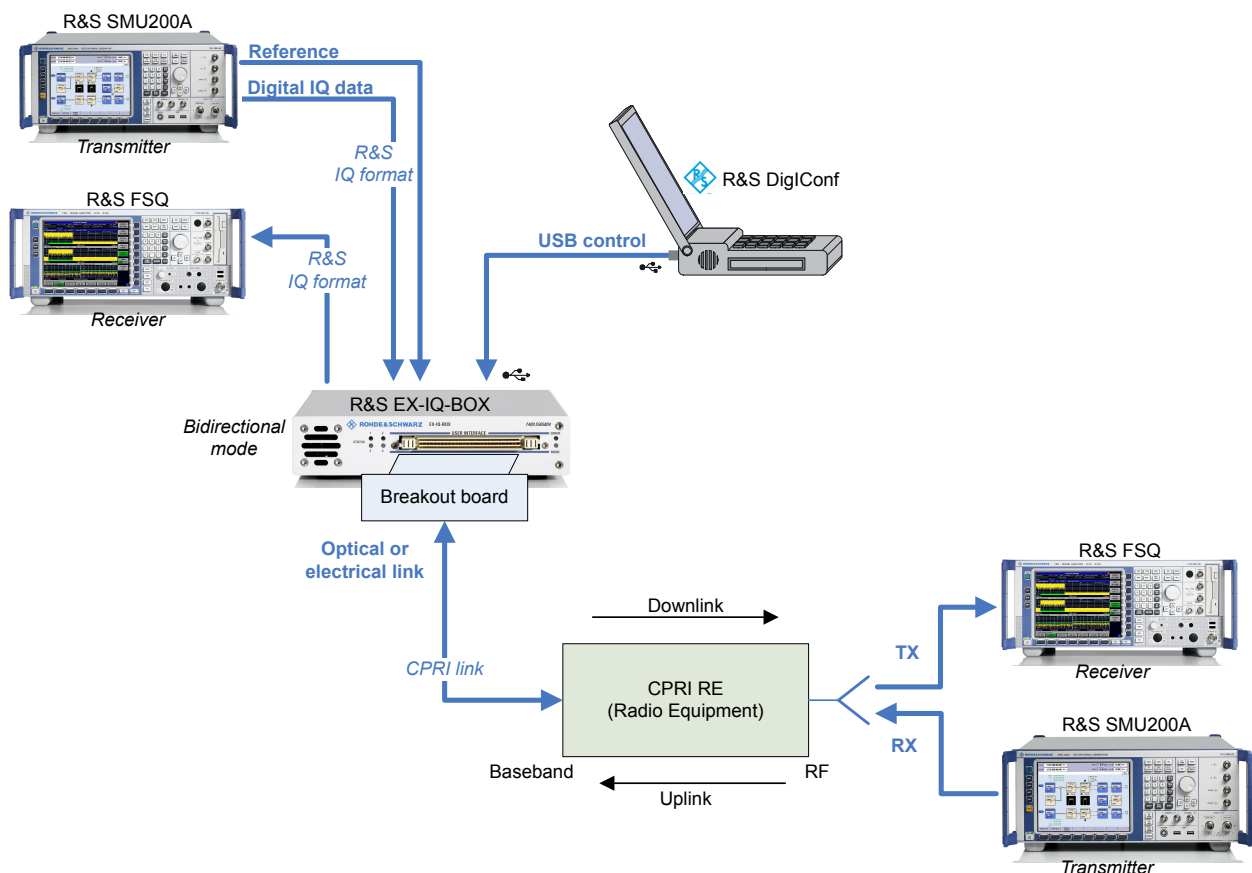


Fig. 5-2: Application example of a RE test setup with the digital interface protocol CPRI

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

#### 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** (Adjacent Channel Power) or **EVM** (Error Vector Magnitude) evaluation.

#### The uplink signal flow

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

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

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

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

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

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

### 5.2.2 Typical CPRI REC Test Setup

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



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

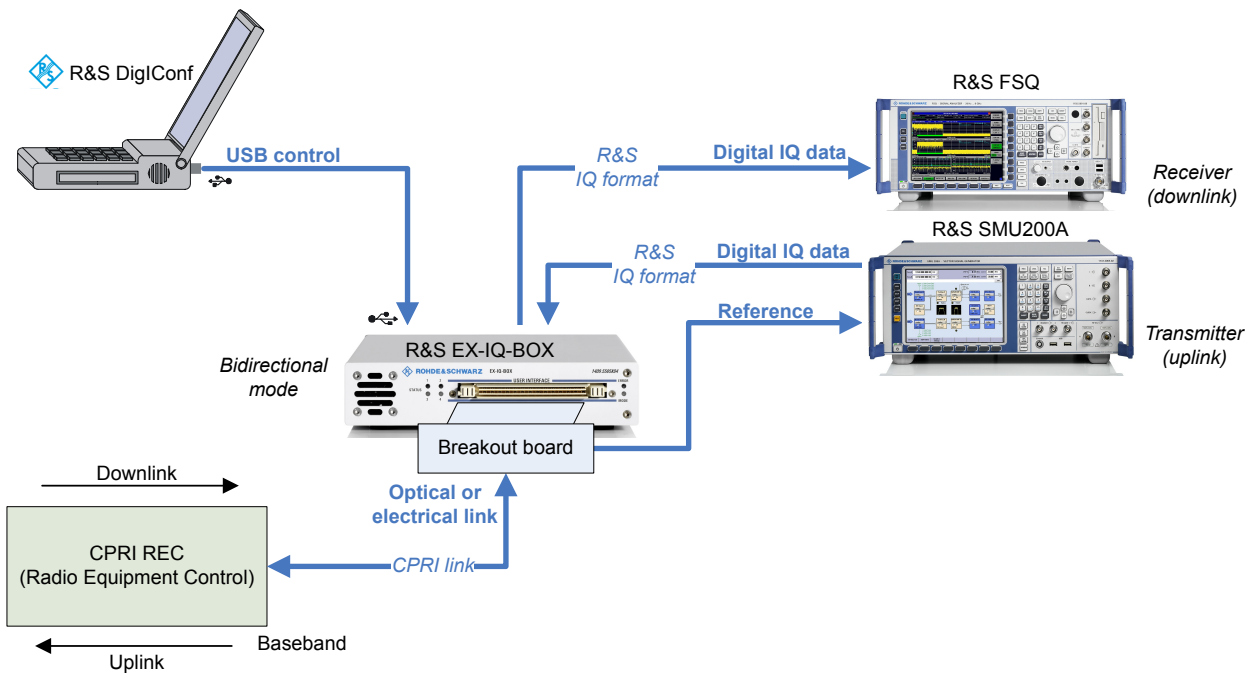


**Fig. 5-3: Application example of a REC test setup with the digital interface protocol CPRI**

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

### The downlink signal flow

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

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

The R&S signal analyzer features various measuring methods, as e.g. **ACP** (Adjacent Channel Power) or **EVM** (Error Vector Magnitude) evaluation. Use this measurement methods to examine the validity and quality of the digital baseband signal, or to evaluate the influence of numerical imperfections, e.g. quantization effects depending on the I/Q resolution.

### The uplink signal flow

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

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

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

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

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

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

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

## 5.3 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 DigiIConf.

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

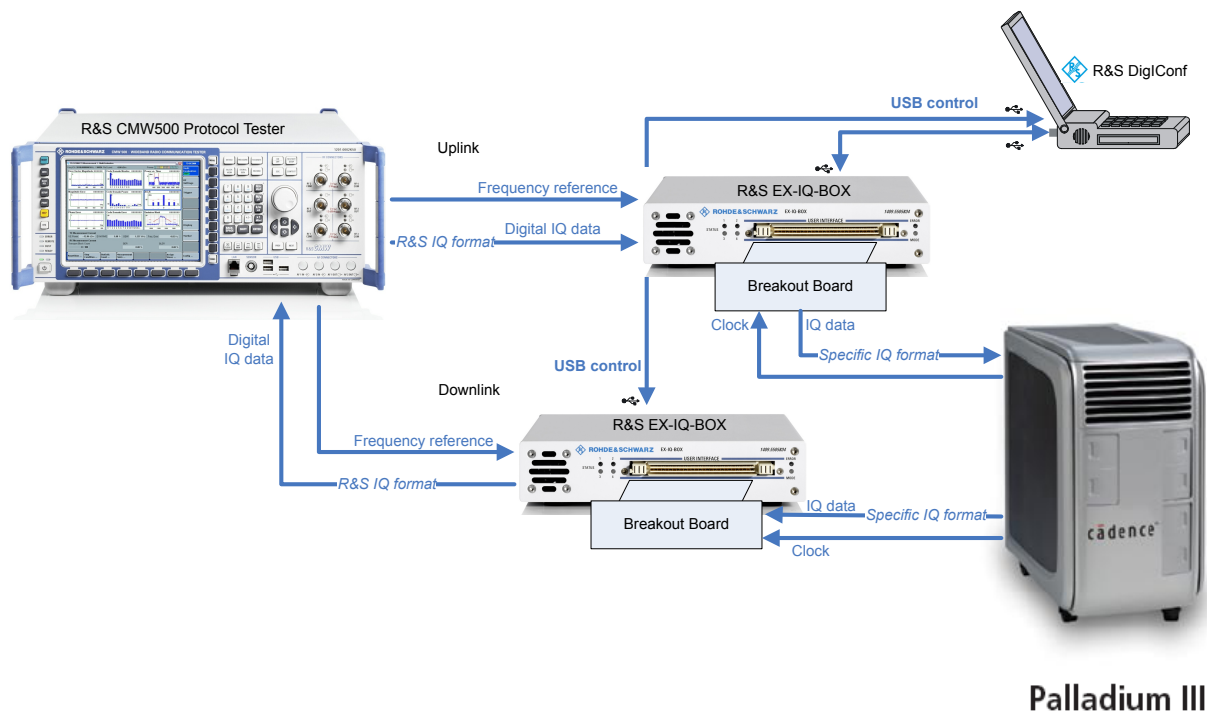


**Fig. 5-4: Application example of an in-circuit emulation of wireless designs**

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 DigiIConf. For detailed information on this application refer to the oper-

ating manual of the protocol tester, and the to <http://www.rohde-schwarz.com/appnote/1CM75> on the internet.

## 6 R&S EX-IQ-BOX Configuration

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

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



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

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

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

Separate chapters contain protocol settings of the specific operating modes:

- [chapter 7.1, "User Defined"](#), on page 95 covers the parameters and settings for serial or parallel transmission of I/Q signals, including clock modes, data rates and logical signal levels.
- [chapter 7.2, "CPRI"](#), on page 126 covers explanations and the description to this standardized protocol.

### 6.1 R&S DigIConf Configuration Software

This chapter describes the graphical user interface of R&S DigIConf, including the layout of the application window, the display, controls and how to operate the configuration software R&S DigIConf. Additionally the chapter contains information on special features



concerning the connection of the R&S EX-IQ-BOX to R&S instruments and the respective configuration dialogs.

### 6.1.1 Graphical User Interface - Overview

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

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

- a header with the name of the window and buttons for minimizing and closing
- a menubar with functions to file management, tools and access to the help system
- a toolbar with icons for saving ore restoring instrument settings
- a display with a block diagram and the infoline
- a taskbar with softkeys showing open dialogs that are minimized

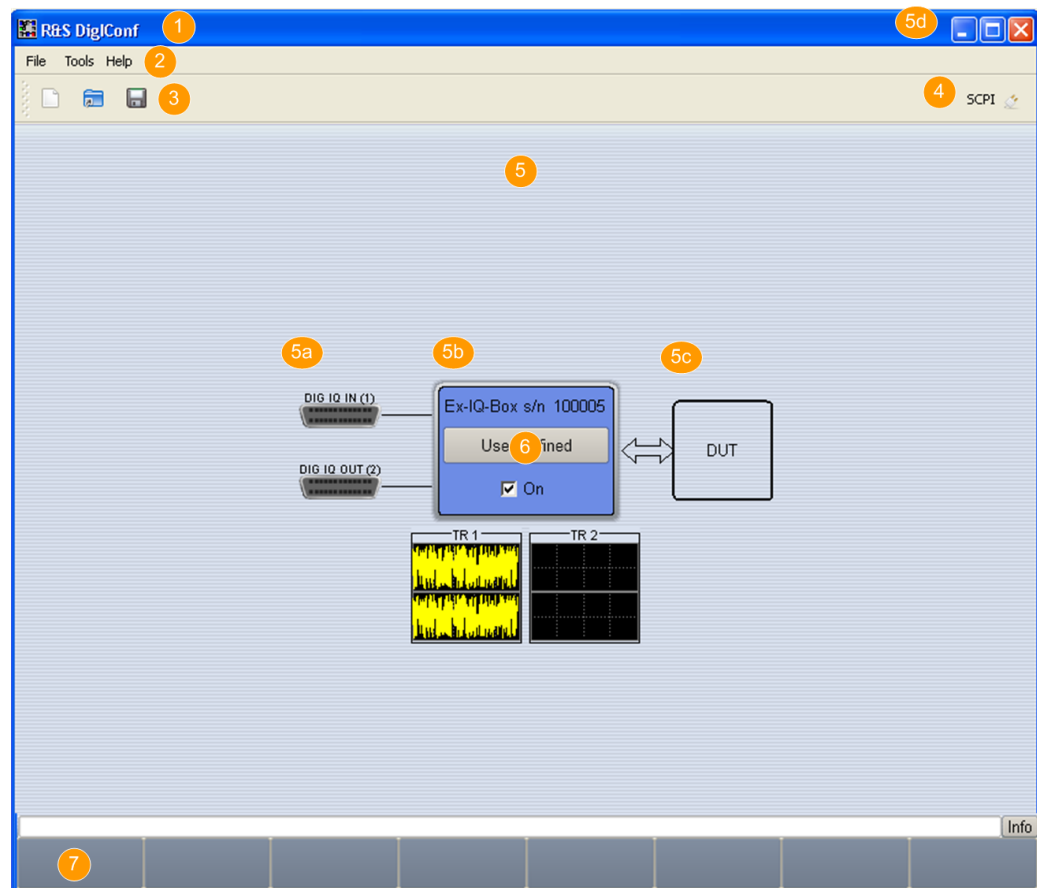


**Fig. 6-1: R&S DigIConf main application window**

- 1 = window header
- 2 = menu bar
- 3 = tool bar
- 4 = remote indicator
- 5 = block diagram
- 5a = connector symbol
- 5b = EX-IQ-BOX functional block

5c = DUT block  
 5d = graphical signal display  
 6 = info line  
 7 = task bar

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

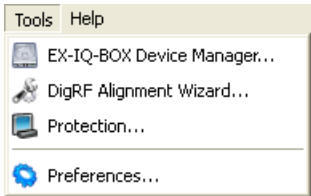
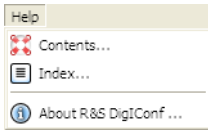
#### 6.1.1.1 Menu Bar

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

For an overview of functions with associated icons, refer to [chapter 6.1.1.2, "Toolbar"](#), on page 55.

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

**Table 6-1: Menu overview**

| Menu                                                                                | Function                                                                                                                                             | Find description under ...                                 |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
|   | The File menu contains all functions that belong to file management, e.g. creating, saving or recalling settings data.                               | <a href="#">chapter 6.1.2.1, "File Menu"</a> , on page 58  |
|  | Open dialogs for accessing information on R&S EX-IQ-BOX devices and to set protection levels for test and service purposes.                          | <a href="#">chapter 6.1.2.2, "Tools Menu"</a> , on page 59 |
|  | 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. | <a href="#">chapter 6.1.2.3, "Help Menu"</a> , on page 60  |

#### 6.1.1.2 Toolbar

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

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

**Table 6-2: Icons and the corresponding functions**

| Icon                                                                              | Function                                          | Corresponding Menu item |
|-----------------------------------------------------------------------------------|---------------------------------------------------|-------------------------|
|  | Preset                                            | File > New              |
|  | Load Settings                                     | File > Open             |
|  | Save Settings                                     | File > Save             |
|  | Indicates that R&S DigiConf is remotely operated. | ---                     |

File handling is described briefly in [chapter 6.1.2.1, "File Menu"](#), on page 58

### 6.1.1.3 Info

The info line reports and indicates the current state with status, error and warning messages. Detailed information on the messages is shown in the info window, called by the info button. For description in detail refer to [chapter 6.1.3, "Info Line and Window"](#), on page 60.

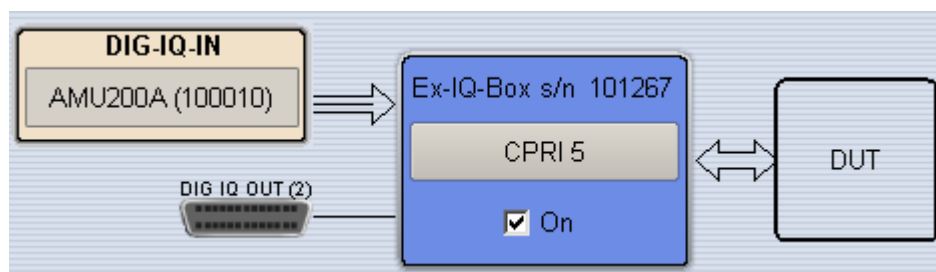
### 6.1.1.4 Block Diagram

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

#### Block Diagram

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

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



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

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

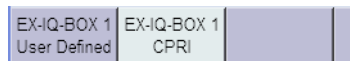
Input/Output symbols in the block diagram show the currently used inputs and outputs and the lines indicate the signal flow.

Remote command:

[ :SOURce<hw> ] :EBOX:COUNT on page 250

#### 6.1.1.5 Taskbar

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



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

#### 6.1.1.6 Dialogs

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

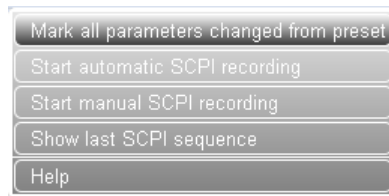
Each dialog consists of a window header and one or more sections with various fields for setting parameters. The header line contains the name of the dialog and the buttons for minimizing and closing the dialog. To operate the buttons, use the mouse. Several fields of associated but separately set parameters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

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

- Configuration dialogs are described in [chapter 6.1.6, "Configuration Dialogs"](#), on page 65.
- For settings dialogs of your specific application, comprising signal and interface parameters refer to the respective section under [chapter 7, "Protocol Settings"](#), on page 95.

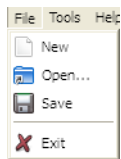
#### 6.1.1.7 Context-sensitive Menus

Within the entire screen display, including single parameters, you can access context-sensitive menus that provide some additional functions.



## 6.1.2 Menus

### 6.1.2.1 File Menu



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

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



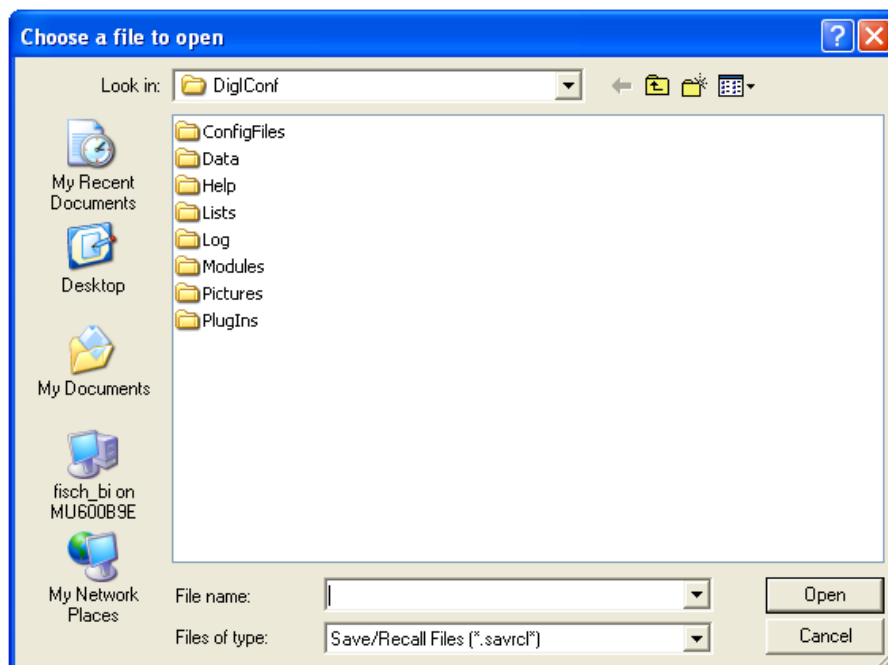
#### **File > New**

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



#### **File > Open...**

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



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



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



#### File > Save

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

#### File > Save as...

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



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

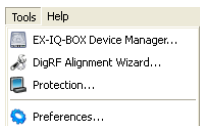


#### File > Exit

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.

### 6.1.2.2 Tools Menu



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



#### Tools > EX-IQ-BOX Device Manager

Displays information about the connected R&S EX-IQ-BOX devices, e.g. serial or part number and a list of installed options. Fields and parameters of this dialog are described in [chapter 6.1.6.1, "EX-IQ-BOX Device Manager"](#), on page 65.



For installing options refer to Installing [chapter 4.6, "Installing R&S EX-IQ-BOX Options"](#), on page 44.



#### Tools > Protection...

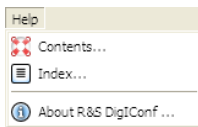
Opens the protection dialog, which is described under [chapter 6.1.6.2, "Protection"](#), on page 69.



#### Tools > Preferences...

Opens the preferences dialog, covering the default settings directory and displays the SCPI server port. See [chapter 6.1.6.3, "Preferences"](#), on page 69.

### 6.1.2.3 Help Menu



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



#### Help > Contents...

Opens the online help start page.

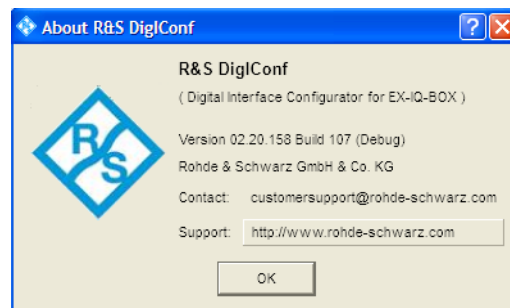


#### Help > Index...

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



#### Help > About R&S DigiIConf ...



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

## 6.1.3 Info Line and Window

### 6.1.3.1 Info Line

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

#### Status information

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

#### Messages

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

### Volatile messages

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

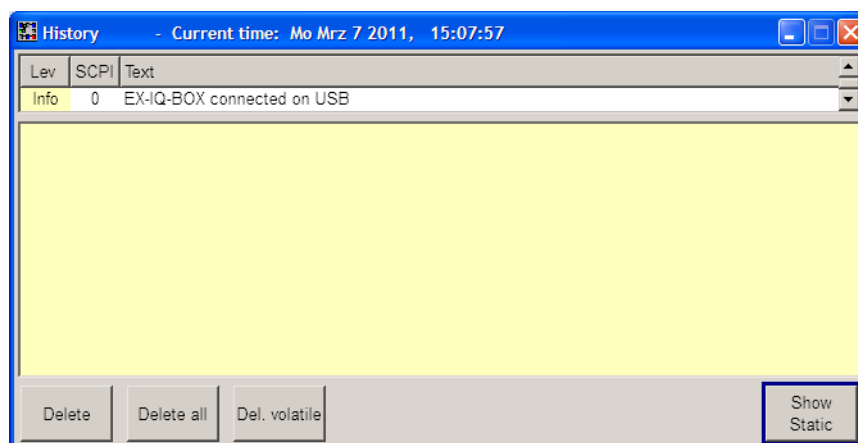
### Permanent messages

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

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

#### 6.1.3.2 Info Window

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



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

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

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

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



**Delete**

Clears the highlighted message.

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

**Delete all**

Clears all messages.

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

**Del. volatile**

Clears all volatile messages.

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

**Show History /Show Static**

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

## 6.1.4 Blocks

The block diagram shows the current configuration and signal flow and permits interactive operation via graphical elements. The diagram indicates a separate block for each connected R&S EX-IQ-BOX, and other R&S instruments.

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

### 6.1.4.1 R&S EX-IQ-BOX

An R&S EX-IQ-BOX function block provides access to the settings of the corresponding standard transmission protocol, determined by the connected breakout board.

R&S DigiConf may handle up to four connected R&S EX-IQ-BOXes, each displayed in a separate block. Each block automatically displays the essential information on the R&S EX-IQ-BOX and the transmission protocol.

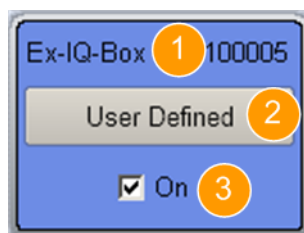


**Fig. 6-2: R&S DigiConf EX-IQ-BOX in the block diagram**

- 1 = block label
- 1 = config button
- 1 = On checkbox

In this block, a R&S EX-IQ-BOX is configured and activated.

The block label (1) represents the R&S EX-IQ-BOX, including the serial number of the connected instrument.

The label of the configure button (2) shows the used interface protocol, that means either "User Defined" or "CPRI". To access the settings dialogs, click the button.

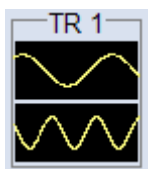


To access the settings dialog of a protocol requires that the associated option is installed and the respective breakout board is connected. Refer to [chapter 6.1.6.1, "EX-IQ-BOX Device Manager"](#), on page 65 for installed options.

The chapters [chapter 7.1, "User Defined"](#), on page 95 and [chapter 7.2, "CPRI"](#), on page 126 describe the parameters of the specific protocols.

The On checkbox (3) activates signal input or output of the assigned R&S EX-IQ-BOX.

#### 6.1.4.2 Smart Graphic Display

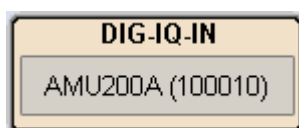


The signal can be graphically displayed in the block diagram, in form of a "smart graphic". A shown signal is actually recorded by one of the transient recorders. The display is activated in the settings dialog [chapter 6.1.6.5, "Transient Recorder"](#), on page 71, and can be used for checking purposes. R&S DigiConf provides two transient recorders pro R&S EX-IQ-BOX, which can both be activated for display.



To access the transient recorder dialog, click the smart graphic.

#### 6.1.4.3 Instrument



In the instrument block a connected R&S instrument is indicated. Click the button to get access to a dialog for configuring the network connection, described in [chapter 6.1.6.4, "Instrument on the R&S EX-IQ-BOX"](#), on page 70.

AMU200A (100010)

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

### 6.1.5 Help System

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

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

- Open a help page with the F1 function key.  
F1 opens a browser window with the description of the highlighted parameter. You can move from this context-sensitive page to any page of the help system.

**Note:**

The Help (\*.chm) file, included on the CD-ROM, also works in stand-alone mode.

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

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

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

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

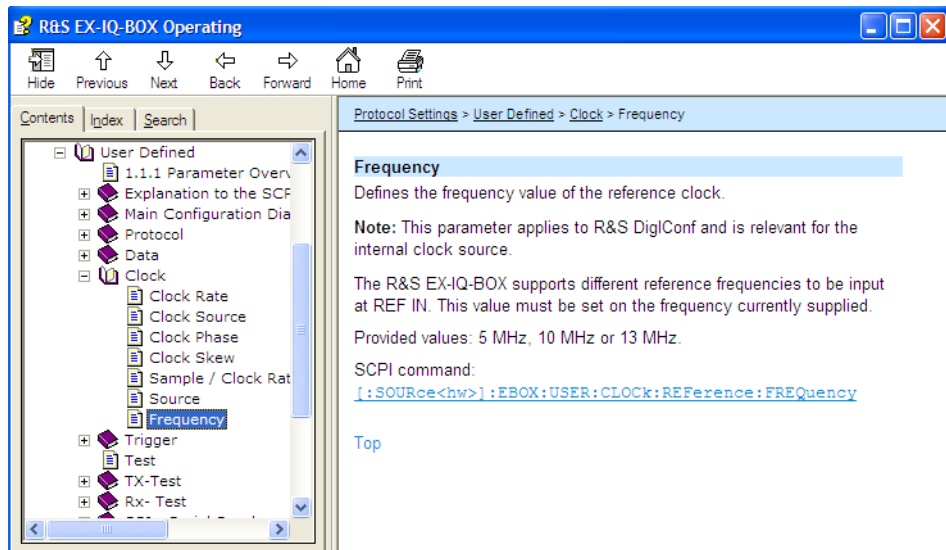


Fig. 6-3: R&S EX-IQ-BOX Configuration > help window

#### 6.1.5.1 Navigation panel

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

- "Hide" / "Show"  
Display or hide the contents panel.
- "Previous" / "Next"  
Scroll through the help pages. The sequence of the pages corresponds to their position in the dialogs.
- "Back" / "Forward"  
Switches to the previously opened help page and back again.
- Home

Opens the first page of the online help.

- **Print**  
Enables you to print the selected topic or all the topics in the selected heading.

#### 6.1.5.2 Contents panel

The contents panel is divided into three tabs:

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

#### 6.1.5.3 Text panel

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

### 6.1.6 Configuration Dialogs

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

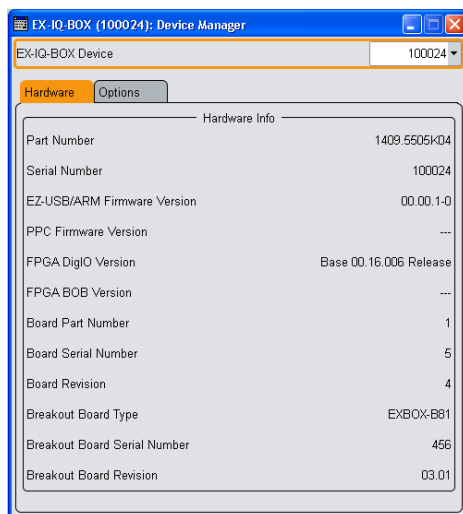
#### 6.1.6.1 EX-IQ-BOX Device Manager

This dialog displays instrument specific information on a connected R&S EX-IQ-BOX and the installed options. Installing new options is done in this dialog.

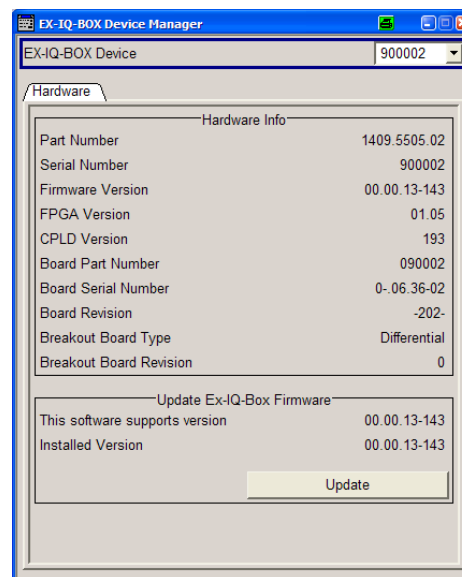


The enhanced functionalities like standardized protocols or waveform memories are supported only by the R&S EX-IQ-BOX variant **1409.5505K04**. Hence, the "EX-IQ-BOX Device Manager" dialog varies in dependence of the variant.

---



R&amp;S EX-IQ-BOX 1409.5505K04



R&amp;S EX-IQ-BOX 1409.5505.02

### EX-IQ-BOX Device

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

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

Remote command:

[ :SOURce<hw> ] :EBOX:DEvice:CATalog? on page 239

[ :SOURce<hw> ] :EBOX:DEvice:SElect on page 244

### Hardware Info

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

| Hardware component            | Information                                                       | Model-specific                       |
|-------------------------------|-------------------------------------------------------------------|--------------------------------------|
| "Part Number"                 | The part number of the R&S EX-IQ-BOX.                             | -                                    |
| "Serial Number"               | The serial number of the R&S EX-IQ-BOX.                           | -                                    |
| "EZ-USB/ARM Firmware Version" | The firmware version installed in the R&S EX-IQ-BOX.              | -                                    |
| "PPC Firmware Version"        | The version of the built-in power PC.                             | R&S EX-IQ-BOX<br><b>1409.5505K04</b> |
| "FPGA (Base) Version"         | The version of FPGA (Field Programmable Gate Array) basic design. | -                                    |
| "FPGA DigIO Version"          | The version of the digital interface standard.                    | R&S EX-IQ-BOX<br><b>1409.5505K04</b> |
| "FPGA BOB Version"            | The version of the connected breakout board.                      | -                                    |

| Hardware component             | Information                                                                                                                                                                                                                                                                                     | Model-specific                       |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| "CPLD Version"                 | The version of CPLD (Complex Programmable Logic Device).                                                                                                                                                                                                                                        | R&S EX-IQ-BOX<br><b>1409.5505.02</b> |
| "Board Part Number"            | The part number of the R&S EX-IQ-BOX's internal board.                                                                                                                                                                                                                                          | -                                    |
| "Board Serial Number"          | The serial number of the R&S EX-IQ-BOX's internal board.                                                                                                                                                                                                                                        | -                                    |
| "Board Revision"               | The revision number of the R&S EX-IQ-BOX's internal board.                                                                                                                                                                                                                                      | -                                    |
| "Breakout Board Type"          | The type of the connected breakout board.                                                                                                                                                                                                                                                       | -                                    |
| "Breakout Board Serial Number" | The serial number of the connected breakout board.                                                                                                                                                                                                                                              | R&S EX-IQ-BOX<br><b>1409.5505K04</b> |
| "Breakout Board Revision"      | The revision number of the connected breakout board.<br><br>The breakout board might be unplugged while the R&S EX-IQ-BOX is running. In this case, the R&S EX-IQ-BOX is deactivated, i.e. the protocol, if active, is also deactivated. The breakout board information is no longer indicated. | -                                    |

**Remote command:**

[\[:SOURCE<hw>\]:EBOX:DEVICE:PART](#) on page 241  
[\[:SOURCE<hw>\]:EBOX:DEVICE:CONTROLLER?](#) on page 240  
[\[:SOURCE<hw>\]:EBOX:DEVICE:SERIAL](#) on page 244  
[\[:SOURCE<hw>\]:EBOX:DEVICE:PPCVERSION?](#) on page 241  
[\[:SOURCE<hw>\]:EBOX:DEVICE:FPG:BASE?](#) on page 240  
[\[:SOURCE<hw>\]:EBOX:DEVICE:FPG:DIGIO?](#) on page 241  
[\[:SOURCE<hw>\]:EBOX:DEVICE:FPG:BOB?](#) on page 241  
[\[:SOURCE<hw>\]:EBOX:DEVICE:CPLD?](#) on page 240  
[\[:SOURCE<hw>\]:EBOX:DEVICE:BOARD:PART?](#) on page 242  
[\[:SOURCE<hw>\]:EBOX:DEVICE:BOARD:SERIAL?](#) on page 242  
[\[:SOURCE<hw>\]:EBOX:DEVICE:BOARD:REVISION?](#) on page 242  
[\[:SOURCE<hw>\]:EBOX:DEVICE:BOB:TYPE?](#) on page 243  
[\[:SOURCE<hw>\]:EBOX:DEVICE:BOB:SERIAL?](#) on page 243  
[\[:SOURCE<hw>\]:EBOX:DEVICE:BOB:REVISION?](#) on page 242

**Options**

Displays the installed hardware and software options of the R&S EX-IQ-BOX. In addition, you can enable options purchased at a later stage.

**Note:** An option is ready to operate after it is enabled by means of a license key code, supplied with the option. To obtain the license key code, you must specify the device ID of the R&S EX-IQ-BOX.

**Device ID ← Options**

Displays the R&S EX-IQ-BOX specific identification number. The device ID is a unique string with the following structure:

<part number>-<serial number>-<checksum>

Remote command:

[ :SOURce<hw> ] :EBOX:ID? on page 250

#### Installed Options ← Options

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

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

Remote command:

[ :SOURce<hw> ] :EBOX:OPT on page 250

#### Enter License Key ← Options

Type here the license key provided with the option.

For license key delivered as a file, use

For description on how to install a new option refer to [chapter 4.6, "Installing R&S EX-IQ-BOX Options"](#), on page 44.

#### Import License Key From File ← Options

Opens a file manager dialog for selecting the file with the license key.

#### Export Deactivation Response To File ← Options

Exports the generated deactivation response key to a file. A file management dialog opens for storing the file.

This key is required during the unregistration process.

**Note:** If you want to register an option at another R&S EX-IQ-BOX, you must request a new license key code for the instrument, see [Device ID](#).

#### Status Information ← Options

Displays status information about the license process.

#### Update EX-IQ-BOX Firmware

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

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

Remote command:

[ :SOURce<hw> ] :EBOX:DEVIce:FIRMWare:SUPPorted? on page 243

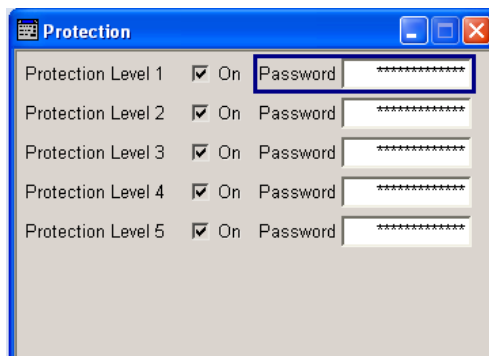
### Update

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

#### 6.1.6.2 Protection

### 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.

**Note:** Only personnel of R&S Service Departments are authorized to access level 2 and higher.

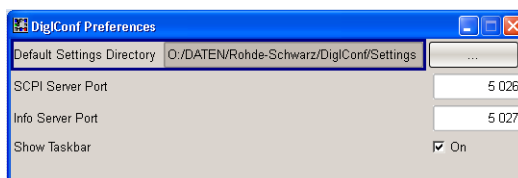
After Startup, all protection levels are activated.

Remote command:

n.a.

#### 6.1.6.3 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.

**Note:**



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

**SCPI Server Port**

Select the port address of the server for remote control.

**Info Server Port**

Sets the port address of the TCP/IP connection.

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

**Show Taskbar**

Activates the display of the taskbar in the block diagram. Changing the setting requires a restart of R&S DigIConf.

Remote command:  
n.a.

#### 6.1.6.4 Instrument on the R&S EX-IQ-BOX

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



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

---

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

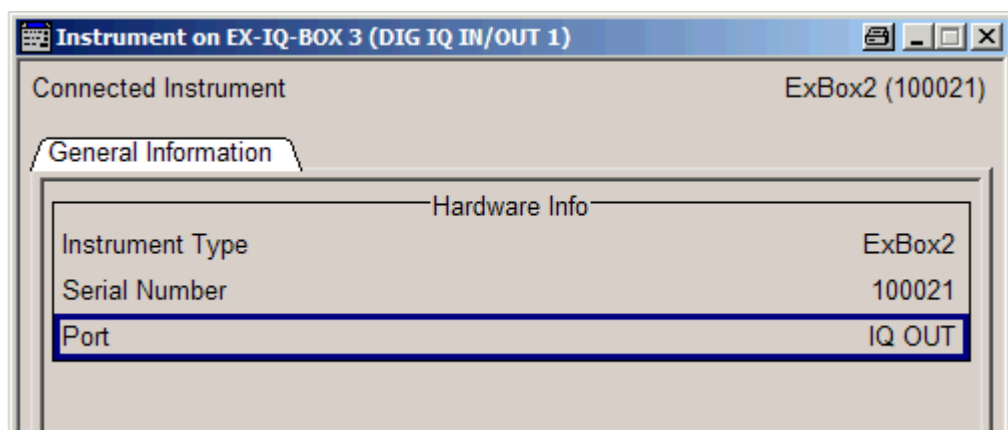


Refer to the operating manual of your R&S instrument for details to interfaces and programming for the remote control.

---

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

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



### 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.

Remote command:

`[ :SOURce<hw> ] :EBOX:INST<ch>:NAME?` on page 251

### Instrument Type

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

Remote command:

`[ :SOURce<hw> ] :EBOX:INST<ch>:TYPE?` on page 252

### Serial Number

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

Remote command:

`[ :SOURce<hw> ] :EBOX:INST<ch>:SERial?` on page 252

### Port

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

Remote command:

`[ :SOURce<hw> ] :EBOX:INST<ch>:PORT?` on page 252

#### 6.1.6.5 Transient Recorder

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

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

- To access an "Transient Recorder" settings dialog, click the smart graphic in the block diagram.

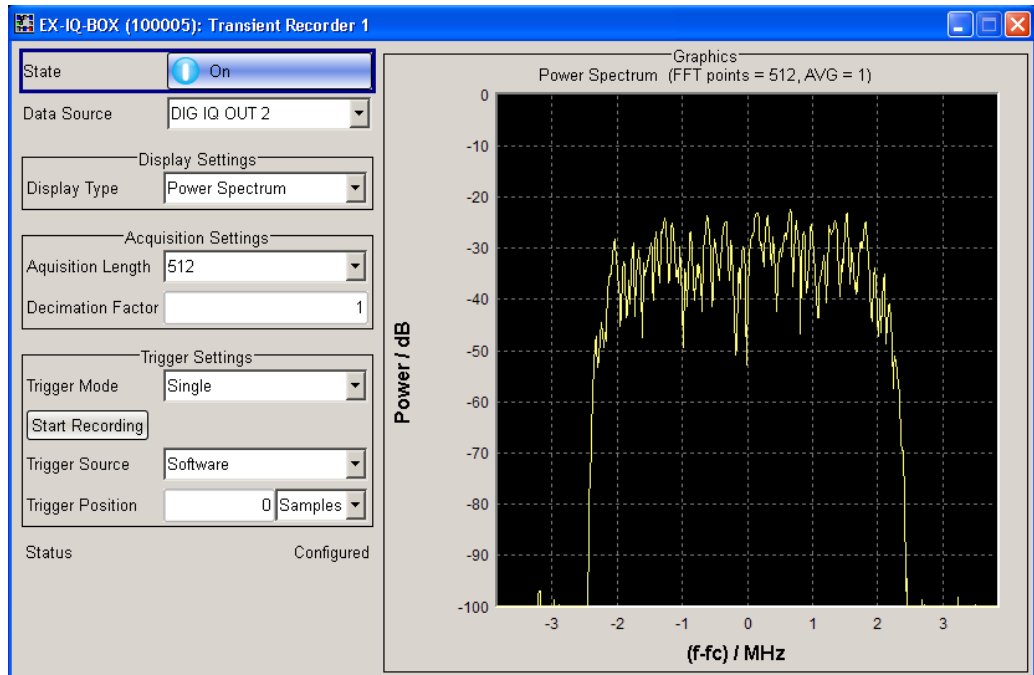
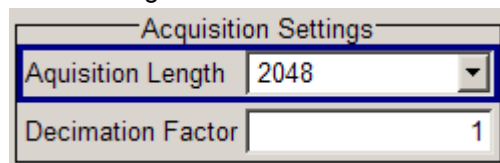


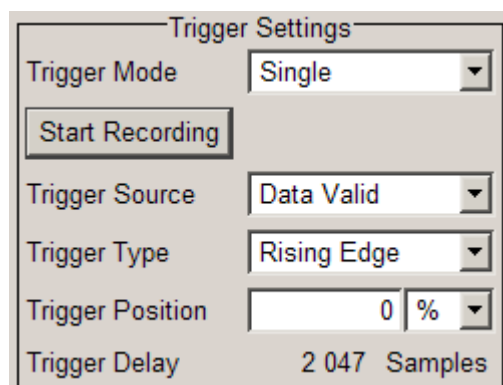
**Fig. 6-4: R&S DigiConf transient recorder**

This dialog contains all parameters required for recording, as:

- "State" for activating
- "Data Source" to select the signal
- "Display Settings" to determine the type of display
- "Acquisition Settings" for setting the capture length  
This section provides setting the length for recording or selecting a specific sample for recording.



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



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

### State

Activates the selected transient recorder.

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

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

### Data Source

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

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

"DIG IQ IN 1" Selects the signal fed in at the corresponding digital interface DIG I/Q IN/OUT 1.

"DIG IQ OUT 2" Selects the signal assigned at the corresponding digital interface DIG I/Q IN/OUT 2 output.

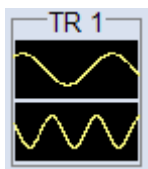
"ARB 1 ... 4" Records a signal played back from one of the waveform memories.

"USER INTERFACE"

Records the signal transmitted at the USER INTERFACE.

"Sine Testsignal"

Records the internally generated sine test signal.



### Smart Graphic

Activates the display of a smart graphic.

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

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

### Display Type

Select the graphical signal display. Available diagram types to display the recorded data are **I/Q**, **Vector**, **CCDF** and **Power Spectrum** diagrams. The individual diagram types are described in [chapter 6.1.6.6, "Graphical Signal Displays"](#), on page 75.

**Acquisition Length**

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

**Decimation Factor**

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

**Trigger Mode**

Select the mode for triggering.

"Continuous" Recording is automatically initiated and continues until the process is stopped manually. Recording is retriggered every 250ms.

**Note:** Deactivate the recorder while switching off status.

"Single" Records one signal flow until acquisition length is reached. Initiate a single trigger event by pressing the "Start Recording" button.

**Start Recording**

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

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

**Trigger Source**

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

**Note:** The control signals GP\_0 ... GP\_5 are part of the I/Q signal and transmitted via the digital I/Q interface of the R&S instrument.

"Software" R&S DigIConf initiates the trigger event for recording. Recording starts automatically either within specified intervals, in continuous mode or by defined user events in single mode.

"Data valid" The external control signal **Data Valid** initiates the recording of data.

"GP\_0" The "(Marker 0)" determines the beginning of recording.

"GP\_1 " (Reserve 0) triggers the recording.

"GP\_2 " (Trigger 0) triggers the recording.

"GP\_3 " (Trigger 1) triggers the recording.

"GP\_4 " (Marker 1) triggers the recording.

"GP\_5 " (Reserve 1) triggers the recording.

**Trigger Type**

Set the polarity of the signal to trigger data recording.

**Note:** "Trigger type" supports all hardware trigger sources like DATA VALID and GP\_0..5. Trigger source "Software" does not use this parameter.

"Rising Edge" The positive slope of the reference signal starts recording the I/Q data signal.

"Falling Edge" The negative slope of the reference signal triggers recording.

"Low Level" The low reference level of the signal triggers recording. Low level represents the logical 0.

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

**Trigger Position**

The trigger position determines the position of the trigger event on the time-scale. The value is set in samples while a positive number  $\langle n \rangle$  means the trigger event is at sample number  $\langle n \rangle$ , a negative value means the trigger event was before the first sample.

**Status**

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

**6.1.6.6 Graphical Signal Displays**

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

**I/Q Diagram**

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

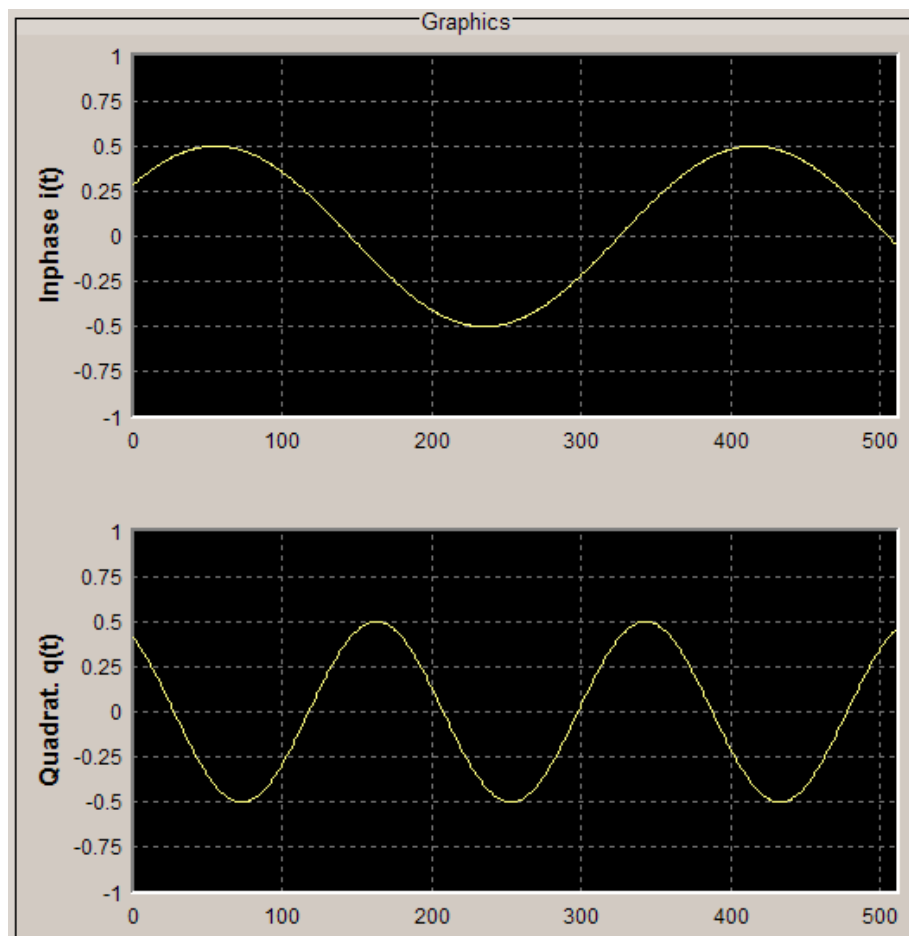


Fig. 6-5: R&S DigiConf signal graphics > I/Q diagram

### Vector Diagram

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

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

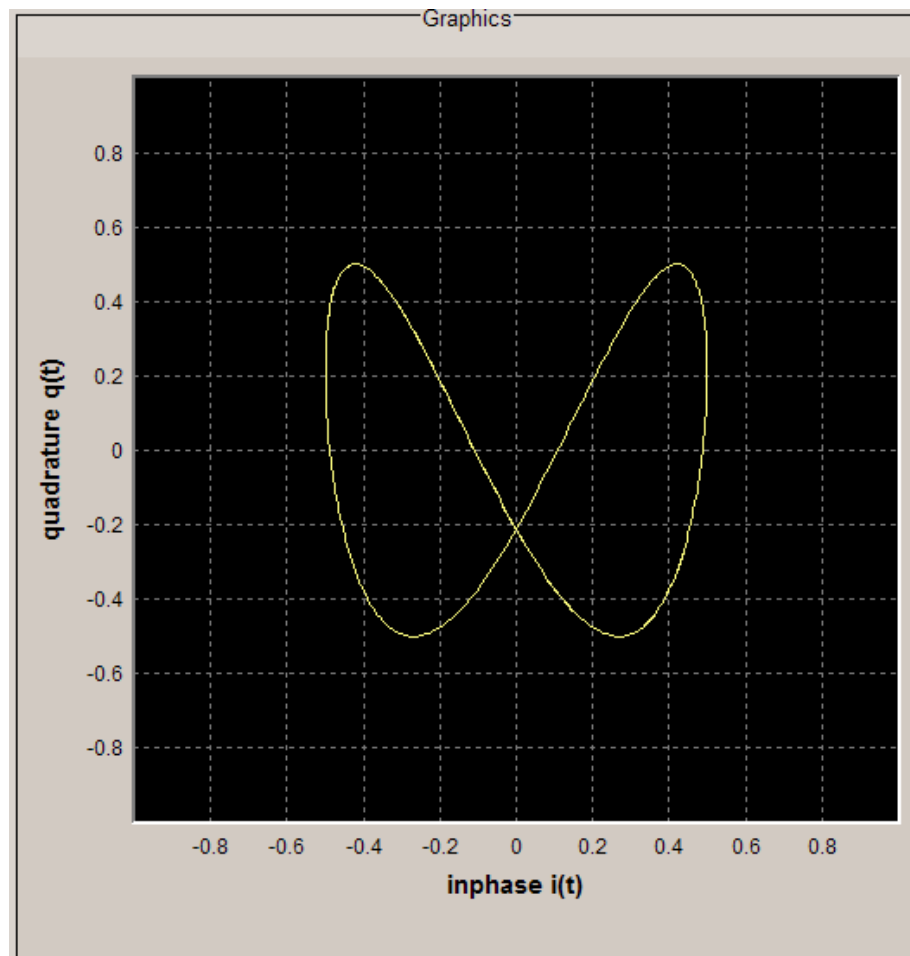


Fig. 6-6: R&S DigiConf signal graphics > Vector diagram

### CCDF Display

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

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



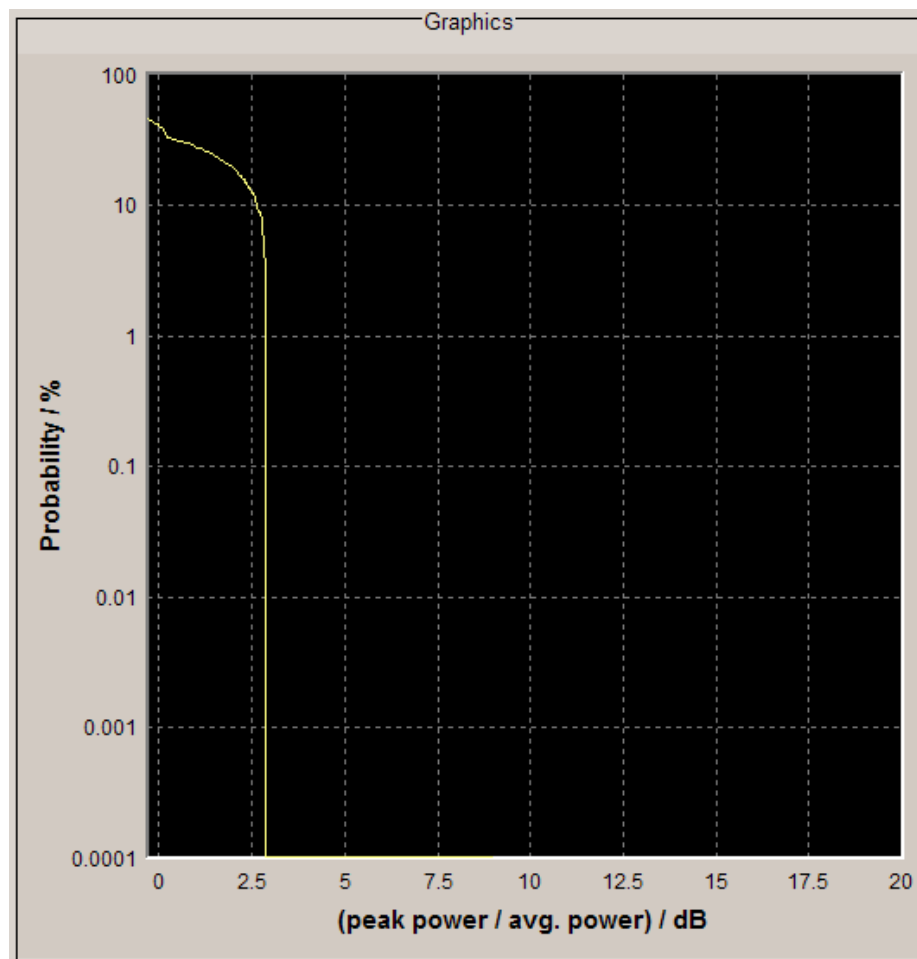


Fig. 6-7: R&S DigiConf signal graphics > CCDF display

### Power Spectrum (FFT)

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

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

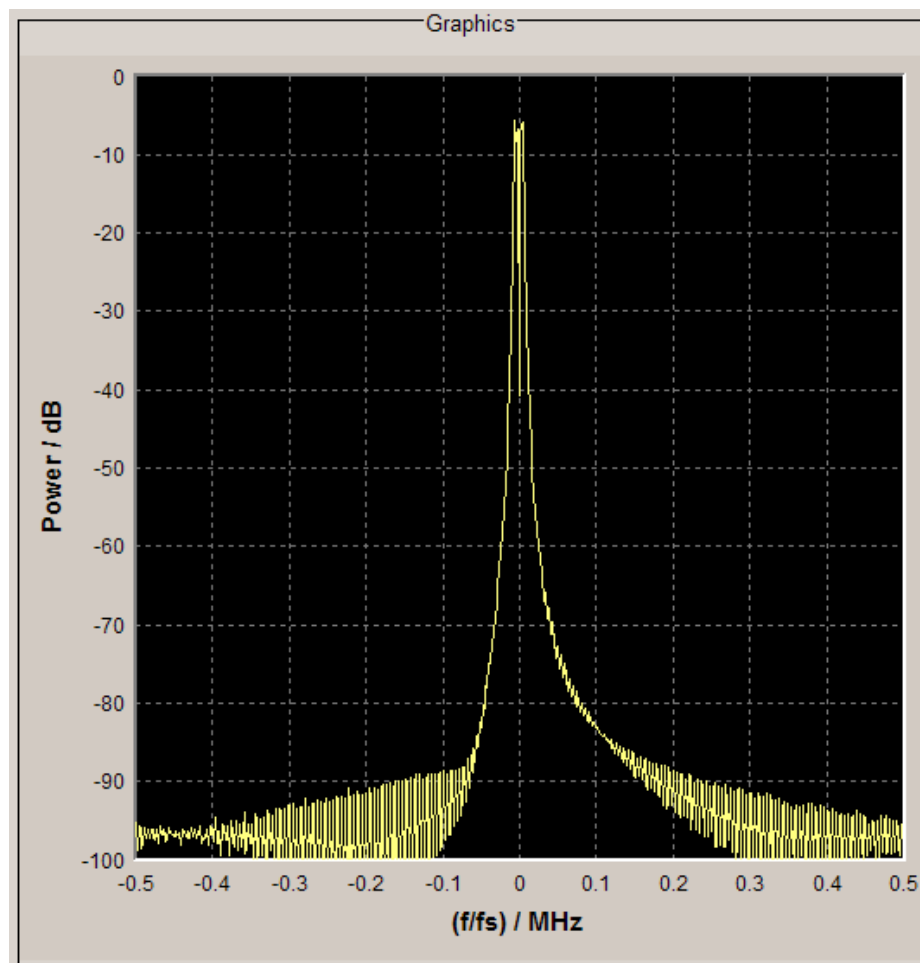


Fig. 6-8: R&S DigiConf signal graphics > Power spectrum

## 6.1.7 Connected R&S EX-IQ-BOX

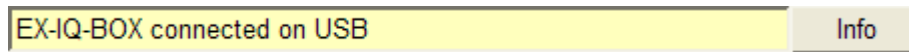
This section describes how a connected R&S EX-IQ-BOX is indicated in R&S DigiConf.

### 6.1.7.1 Connection

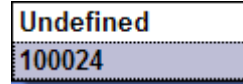
For controlling the R&S EX-IQ-BOX with R&S DigiConf, the R&S EX-IQ-BOX must be connected to the PC via USB. The connection of the R&S EX-IQ-BOX to the PC and the instrument is described in detail in [chapter 4.5, "Connecting the R&S EX-IQ-BOX"](#), on page 42.

### 6.1.7.2 Indicating the R&S EX-IQ-BOX in R&S DigiConf

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



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



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

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

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

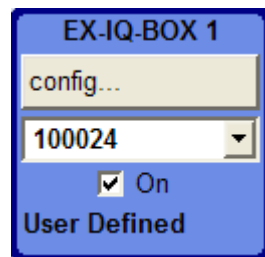


**Fig. 6-9: R&S DigIConf > serial number of the R&S DigIConf in the function block**

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

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

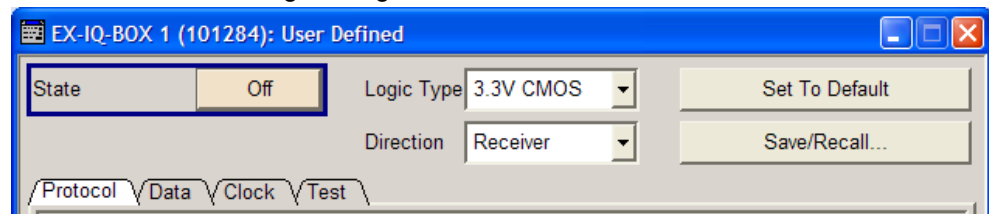


**Fig. 6-10: R&S EX-IQ-BOX serial number in the header of dialogs**

- the "EX-IQ-BOX Device Manager"

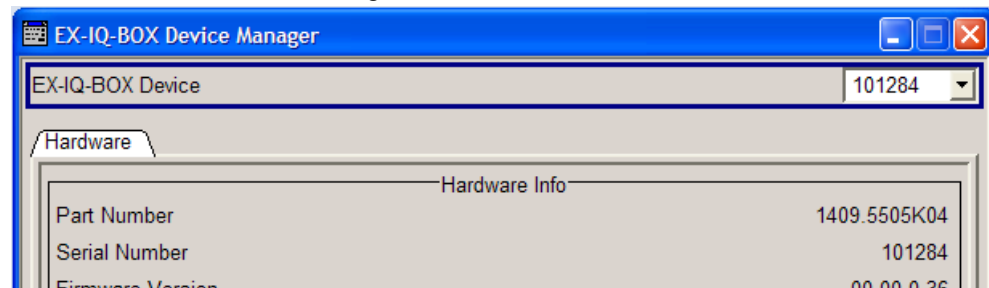


**Fig. 6-11: R&S EX-IQ-BOX hardware information in the device manager**

This dialog provides detailed information on the hard- and firmware, see [chapter 6.1.6.1, "EX-IQ-BOX Device Manager"](#), on page 65

### 6.1.7.3 Transmitting I/Q Data

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



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

## 6.1.8 Connected R&S Instruments

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

### 6.1.8.1 Connection

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



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

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

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

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

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

Device state changed on IQ IN Info

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

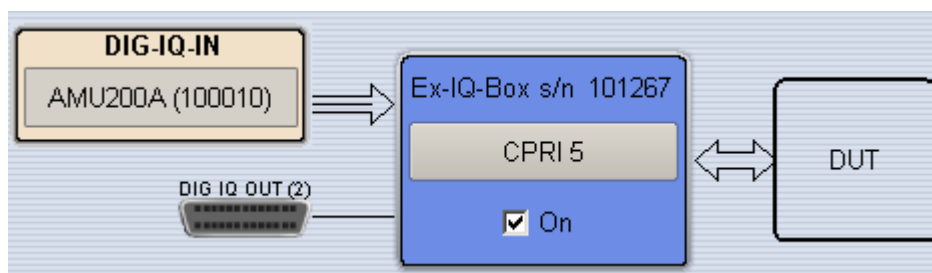


Fig. 6-12: R&S DigIConf > R&S instrument function block

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

- it shows an "Instrument" function block with a softkey, labeled with product name and device ID (serial number).
  - "Input/Output" symbols show the currently used inputs and outputs
  - "Arrows" indicate the signal flow.
- Click "<instrument>" to open the "Instrument on EX-IQ-BOX <n> (<connector>)" dialog box.

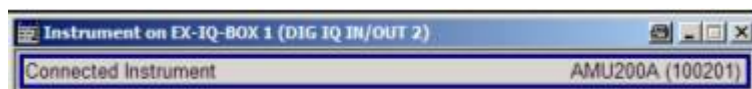


Fig. 6-13: R&S DigIConf > Instrument on EX-IQ-BOX... dialog box

R&S DigIConf displays the product name and device ID of the connected R&S instrument in the header of this dialog box, described in [chapter 6.1.6.4, "Instrument on the R&S EX-IQ-BOX"](#), on page 70.



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

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

### 6.1.9 Automation of R&S DigIConf

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

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

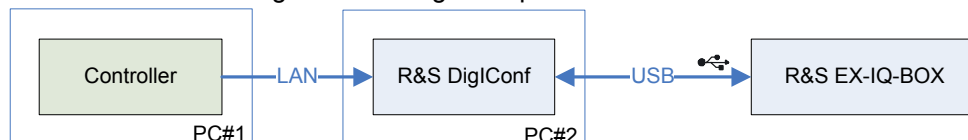
In remote mode, the software is remotely controlled by a controller. Each PC with the required remote control software installed can act as a controller. You only need a LAN connection to the PC with R&S DigIConf.

Possible remote control configurations are:

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



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



Refer to [chapter 8.1.3, "Starting a Remote Control Session"](#), on page 215 for information on how to get started and how to establish a remote control connection between the controller and the software.

The remote control mode controls R&S DigIConf with commands following the **SCPI** (Standard Commands for Programmable Instruments) standard.

Find a detailed description of the SCPI commands available for R&S DigIConf in [chapter 9, "Remote Control Commands"](#), on page 236. The remote control commands related to the transmission protocols are described in detail after each functional unit.

For background information on the SCPI command structure and basic information on operating the R&S DigIConf software via remote control, refer to [chapter 8, "Remote Control Basics"](#), on page 213.

## 6.2 Configuration via R&S Instruments

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

- [chapter 6.2.1, "R&S Signal Generators"](#), on page 84 contains general information on the connection and operation with the R&S signal generators, the block diagram and the configuration dialogs.
- [chapter 6.2.2, "R&S Signal Analyzers"](#), on page 89 contains general information on connection and operation with R&S signal analyzers and shows the display and configuration dialogs.
- [chapter 6.2.3, "R&S Protocol Tester"](#), on page 94 always control the R&S EX-IQ-BOX via R&S DigIConf. Therefore, this chapter contains references to the relevant information.



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

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

Some R&S instruments, as e.g. the R&S CMW500 may also directly control the R&S EX-IQ-BOX, but in this case, operation is only possible with R&S DigIConf. Check in the operating manual to see if your instrument supports this mode of operation. How to operate R&S DigIConf in general refer to [chapter 6.1, "R&S DigIConf Configuration Software"](#), on page 53.

The protocol settings are described in [chapter 7.1, "User Defined"](#), on page 95, where you also find links to the corresponding remote commands, described in [chapter 9.3, "User Defined - Remote Control Commands"](#), on page 257.

### 6.2.1 R&S Signal Generators

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



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

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

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

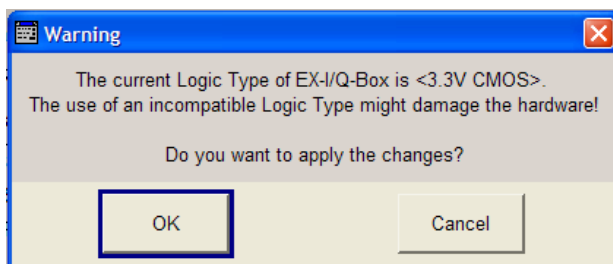
The configuration is performed in the signal generator's configuration dialogs. Accessing the dialogs is described in [chapter 6.2.1.3, "Dialogs"](#), on page 87 and the settings in [chapter 7.1, "User Defined"](#), on page 95.

**NOTICE****Risk of hardware damage**

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

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

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



- Check the voltage values of your test setup.
- Select "OK" if the correct logic type is selected.
- Select "Cancel" if an incompatible logic type is selected. Adjust your setup accordingly and set correct logic type in the main configuration dialog for User Defined protocols, see "[Logic Type](#)" on page 99 .

**6.2.1.1 Connection**

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

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

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



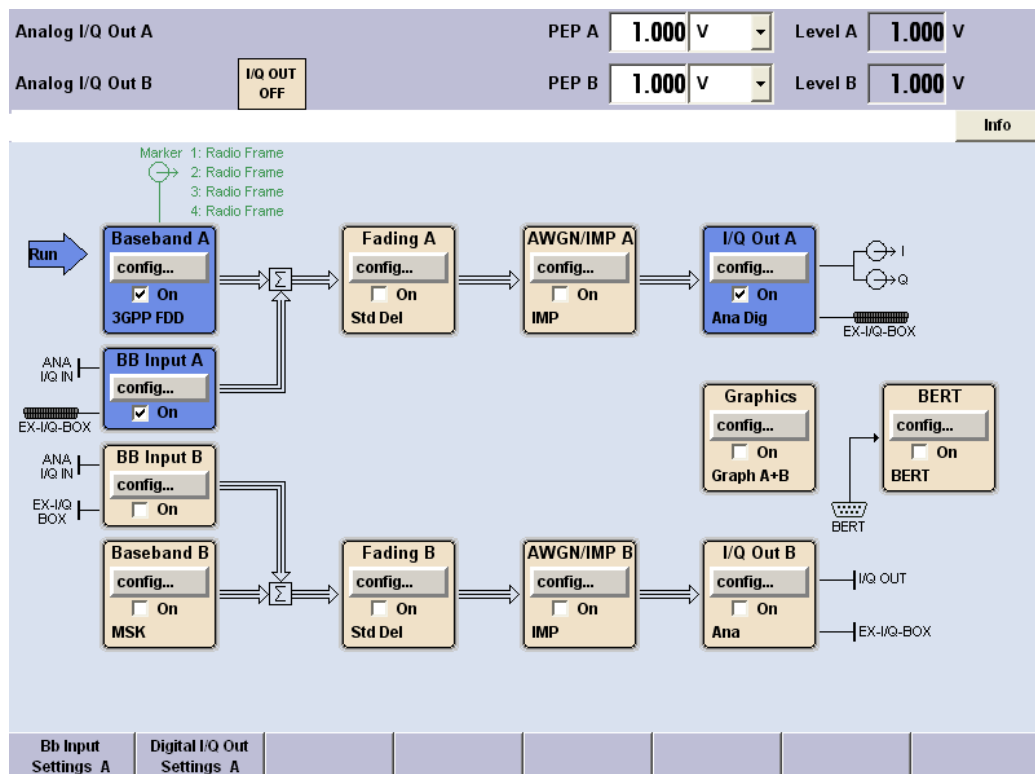


Fig. 6-14: Display of the R&S AMU 200A Baseband Signal Generator and Fading Simulator

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

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

- "Info Line"

The signal generator establishes the connection and reports it in the info line.



Fig. 6-15: R&S signal generator > establish R&S EX-IQ-BOX connection

- "Symbol in the block diagram"

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



Fig. 6-16: Indication of an R&S EX-IQ-BOX in a generator block diagram at the example of the R&S AMU200A

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

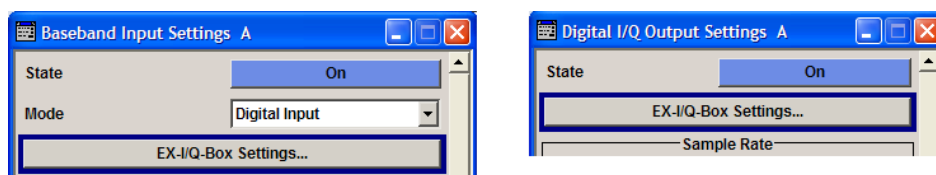
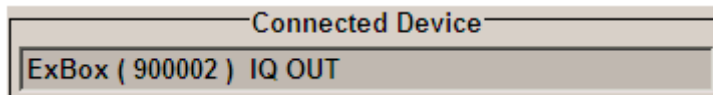


Fig. 6-17: R&S EX-IQ-BOX button in a signal generators digital input / output settings dialogs

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



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

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

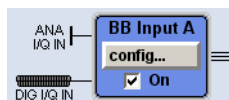


Fig. 6-18: R&S signal generator standard symbol of the digital interface.

### 6.2.1.3 Dialogs

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



- The setting parameters for the R&S EX-IQ-BOX are identical for baseband input and output, but there is a separate dialog for each direction, indicated in the header.
- In the remote control signal direction is determined in the command syntax.
- The parameters are described in [chapter 7.1, "User Defined"](#), on page 95 and the remote control commands in [chapter 9.3, "User Defined - Remote Control Commands"](#), on page 257 .

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

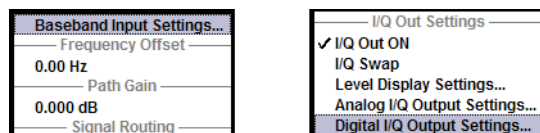


Fig. 6-19: Digital input / output menus of signal generators

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

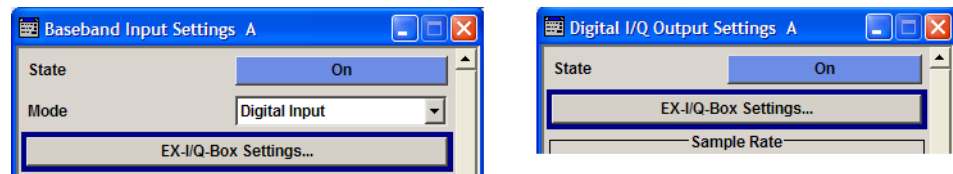


**Fig. 6-20: R&S EX-IQ-BOX button in a signal generators digital input / output settings dialogs**

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

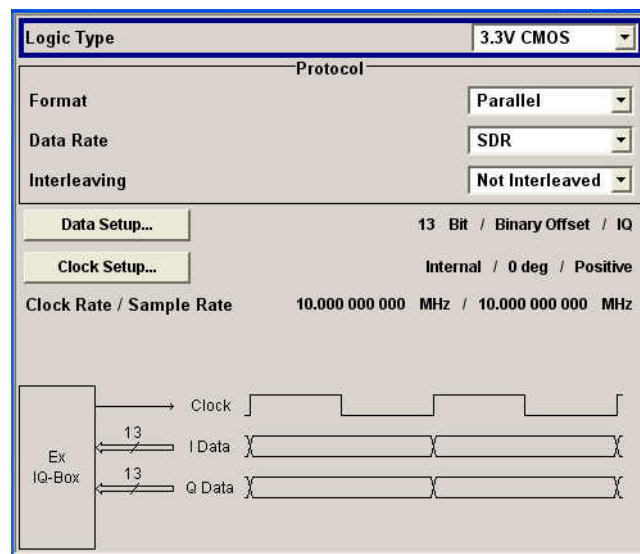


**Fig. 6-21: Main settings dialog of the R&S EX-IQ-BOX in R&S signal generators**

The main configuration dialog provides "Logic Type" and "Protocol" parameters. Corresponding to the current settings the I/Q data and clock signals are displayed graphically in the lower section of the dialog.

The buttons "Data Setup" and "Clock Setup" provide access to the respective sub-dialogs.

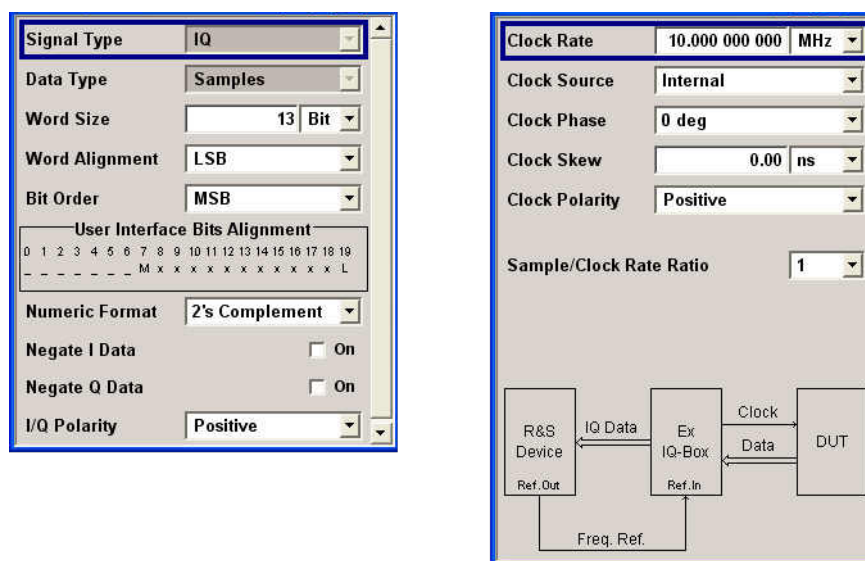


Fig. 6-22: R&S EX-IQ-BOX Data Setup and Clock Setup dialogs

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

The "Clock Setup" dialog contains all clock settings required for User Defined protocols. The lower area indicates clock and data signal direction in a block diagram

#### 6.2.1.4 I/Q Data Transmission

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

### 6.2.2 R&S Signal Analyzers

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



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

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

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

The configuration is performed in the signal analyzer's configuration dialogs. Accessing the dialogs is described in [chapter 6.2.2.3, "Dialogs"](#), on page 92 and the settings in [chapter 7.1, "User Defined"](#), on page 95.

**NOTICE****Risk of hardware damage**

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

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

**6.2.2.1 Connection**

- Establish the USB and LVDS connection between the R&S EX-IQ-BOX and the R&S signal analyzer, as described in [chapter 4.5, "Connecting the R&S EX-IQ-BOX"](#), on page 42.

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

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

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

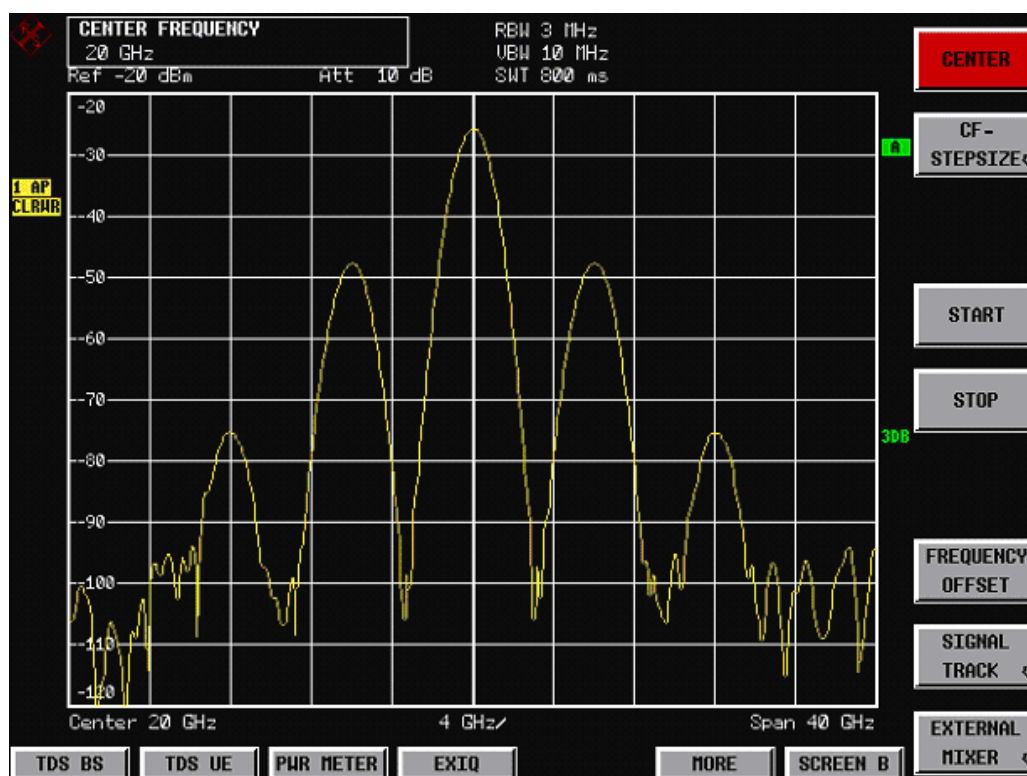


Fig. 6-23: Display of the R&S FSQ Signal Analyzer with R&S FSQ-B17 option

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

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

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

Fig. 6-24: ExBox Status information in an R&S signal analyzer

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

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

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

**Fig. 6-25: ExBox Status > Not connected**



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

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

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

### 6.2.2.3 Dialogs

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

The configuration dialog "ExIQ-Box Settings" opens.



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

The parameters are described in [chapter 7.1, "User Defined"](#), on page 95 and the remote control commands in [chapter 9.3, "User Defined - Remote Control Commands"](#), on page 257 .

| ExIQ-Box Settings                                                                                                                                                                                                                                  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>Select Type</b><br>Type: Transmitter                                                                                                                                                                                                            |  |
| <b>Logic Type</b><br>Logic Type: 3.3V CMOS                                                                                                                                                                                                         |  |
| <b>Base Settings</b><br>Format: Parallel<br>Data Rate: SDR (single data rate)<br>Interleaving: Not Interleaved                                                                                                                                     |  |
| <b>Data Settings</b><br>Signal Type: IQ<br>Word Size: 16<br>Word Alignment: MSB<br>Bit Order: LSB<br>Numeric Format: 2's Complement<br>Negate I Data: <input type="checkbox"/><br>Negate Q Data: <input type="checkbox"/><br>IQ Polarity: Positive |  |
| <b>ExBox Status</b><br>Serial Number: ---<br>Version: ---<br>FPGA Data: ---<br>Setup State: Not Configured<br>Connection State: Not Connected                                                                                                      |  |
| <b>Clock Settings</b><br>Clock Source: Internal<br>Reference Clock: 10.000MHz<br>Clock Rate: 10 MHz<br>Clock Phase: 0 deg<br>Clock Skew: 0 s<br>Clock Polarity: Positive<br>Sample/Clock Rate Ratio: 1                                             |  |
| <b>Strobe Settings</b><br>Strobe Polarity: Positive<br>Strobe Position: 0                                                                                                                                                                          |  |

Fig. 6-26: Settings dialog of the R&S EX-IQ-BOX in R&S signal analyzers

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

### Select Type

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

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

### Exit

Press the "EXIT" to leave the configuration dialog.

### Store

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

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





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

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

Fig. 6-27: ExBox Status > configuring box ...

It also indicates if the configuration is completed.

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

Fig. 6-28: ExBox Status > box is configured

#### 6.2.2.4 I/Q Data Transmission

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

##### Send to

Start signal transmission. The direction path of signal transmission is determined in the "Select Type" field in [chapter 6.2.2.3, "Dialogs"](#), on page 92.

Remote command:

`[ :SOURce ] :RECeiver :SENDto` on page 260

`SOURce :TRANSmitter :SENDto` on page 260

#### 6.2.3 R&S Protocol Tester

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

Some R&S instruments, as e.g. the R&S CMW500 may have installed the configuration software directly. Check in the operating manual to see if your instrument supports this mode of operation. How to operate R&S DigIConf refer to [chapter 6.1, "R&S DigIConf Configuration Software"](#), on page 53. The parameters are described in [chapter 7, "Protocol Settings"](#), on page 95.

## 7 Protocol Settings

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

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



### Important note to the command syntax in User defined applications

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

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

If you run an R&S EX-IQ-BOX, model 1409.5505.02 directly with an R&S instrument, you can find the appropriate command syntax by following the link of the SCPI command. See also [chapter 9.3.1, "Explanation to the Device Specific SCPI Syntax"](#), on page 257 for more details.

"Protocol Settings" contains:

- [chapter 7.1, "User Defined"](#), on page 95 describes the parameters of user defined applications, i.e. settings for serial or parallel transmission of I/Q signals to a DUT, including variable clock modes, various data rates as well as different logical signal levels. This section applies to applications using the breakout boards included in delivery.
- [chapter 7.2, "CPRI"](#), on page 126 contains a general overview of the standard interface and explains the configuration dialogs and parameters, performed with the configuration software R&S DiglConf. Besides the "Downlink" / **Uplink** settings, CPRI additionally enables you to set "Control&Management" parameters, "Vendor Data" management, "Waveform Playback" and "Recording" memory.

### 7.1 User Defined

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

But also without any additional option, the R&S EX-IQ-BOX covers a large number of different digital I/Q interfaces by using user-specific breakout boards. This general oper-

ating mode is called **User Defined** and provides a maximum of flexibility and configuration possibilities.

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

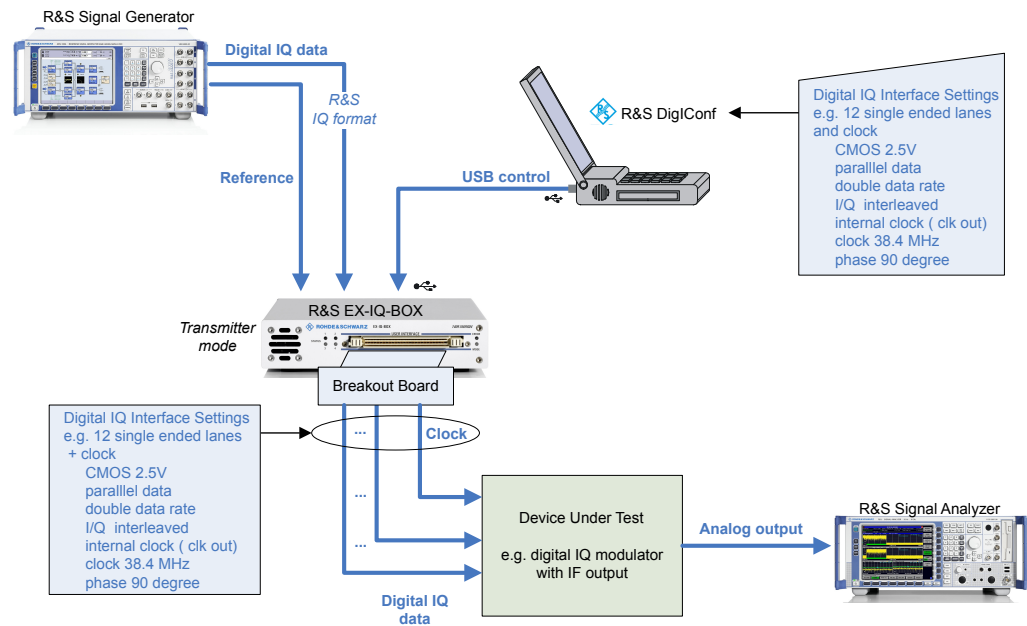


Fig. 7-1: Test scenario of a User Defined application

### 7.1.1 Parameter Overview

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

| Parameter Group | Purpose                                 | Examples                                                      |
|-----------------|-----------------------------------------|---------------------------------------------------------------|
| Protocol        | Fundamental protocol type settings      | Parallel/serial interface, double data rate, I/Q interleaving |
| Data            | Data representation                     | Resolution, alignment, bit order, numeric format              |
| Clock           | Interface clock settings                | Clock rate, phase shift, skew, frequency reference            |
| Trigger         | Synchronization                         | Trigger source, delay                                         |
| Test            | Diagnostics on the interface to the DUT | TX Test, RX Test, Test signal sources                         |

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

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

### 7.1.2 Main Configuration Dialog

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

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

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

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



#### Device-specific dialog representation as well as command syntax

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

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

---

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

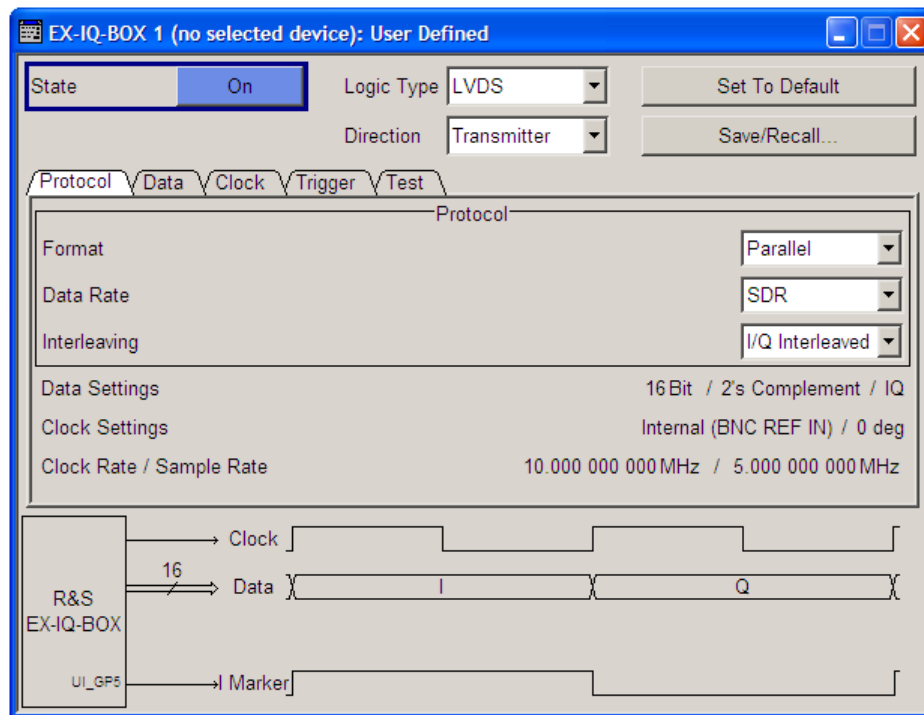


Fig. 7-2: R&S DiglConf > User Defined dialog

## NOTICE

### Risk of hardware damage

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

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

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

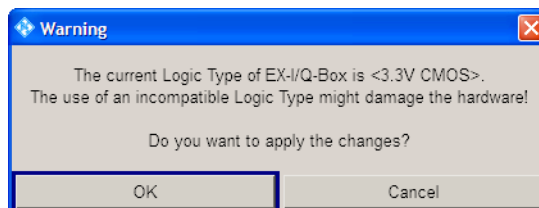


Fig. 7-3: User > Logic type warning

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

**State**

Activate signal transmission.

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

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

Remote command:

[ :SOURce<hw> ] :EBOX:USER:STATe on page 261

**Logic Type**

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

**Note: SCPI notation varies**

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

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

|              |                                                                                                                                                                                          |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "LVDS"       | The signal is transmitted by using the signaling system LVDS ( <b>L</b> ow <b>V</b> oltage <b>D</b> ifferential <b>S</b> ignaling).                                                      |
| "LVTTL"      | The signal is transmitted by using LVTTL technology ( <b>L</b> ow <b>V</b> oltage <b>T</b> ransistor <b>T</b> ransistor <b>L</b> ogic) with a voltage level of 3.3 V.                    |
| "x.x V CMOS" | The signal is transmitted by using the CMOS Technology ( <b>C</b> omplementary <b>M</b> etal <b>O</b> xid <b>S</b> emiconductor). x.x represents the voltage level provided in the list. |
| "x.x V SSI"  | The signal is transmitted by using the SSI Technology ( <b>S</b> erial <b>S</b> ynch- <b>r</b> onous <b>I</b> nterface). Voltage levels are 1.5 V and 1.8 V.                             |

Remote command:

[ :SOURce<hw> ] :EBOX:USER:LOGic [ :TYPE ] on page 259

**Direction**

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

**Note:**

Setting the transmission path and starting depend on the activating device

- **R&S DiglConf**  
Signal direction is selected in the "Direction" field of the R&S EX-IQ-BOX "User Defined" settings dialog. Select "Transmitter/Receiver" in the drop down list. The transmission is activated by switching On the "State" button.
- **R&S signal analyzers**  
Signal direction is selected in the "Select Type" field of the "EXIQ-Box Settings" dialog. Select "Transmitter/Receiver" in the drop down list, as described in [chapter 6.1.1.6, "Dialogs"](#), on page 57.  
To toggle between the different types, press the "TX SETTINGS" or "RX SETTINGS" softkey to select the type from the combo box.
- **R&S signal generators**  
The direction of signal transmission is distinguished as input and output settings dialogs "EX-IQ-BOX BBIN" and "EX-IQ-BOX BBOUT". Therefore, "Direction" is not required in control by for R&S signal generators.

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

- |               |                                                                                                                                                                                                                                                                                                 |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "Transmitter" | The connected R&S EX-IQ-BOX receives data from an R&S instrument and transmits this data to the DUT.<br>In conjunction with analyzers the setup of the box must be initiated by the user. To do this the user must press "SEND TO" hotkey or send the following remote command to the analyzer: |
| "Receiver"    | The connected R&S EX-IQ-BOX receives data from the DUT and transmits this data to an R&S instrument.                                                                                                                                                                                            |

Remote command:

R&S DigIConf, R&S signal generators:

`[ :SOURce<hw> ] :EBOX:USER:DIRection` on page 258

R&S signal analyzers:

`SOURCE:TRANsmitter:SENDto` on page 260

`[ :SOURce ] :RECeiver:SENDto` on page 260

### Set To Default

Executes a default application setup.

The function, provided by R&S DigIConf presets all parameters and switching states, also those of inactive operating modes. The default application settings provide a reproducible initial basis for all other settings.

Remote command:

`[ :SOURce<hw> ] :EBOX:USER:PRESet` on page 260

### Save/Recall

Store the current application settings in the specified path, or load the selected file. Save provides to store the current application settings of R&S DigIConf in a file. Recall opens previously stored settings files.

**Note:** A settings file is always stored, or loaded with the extension `*.iqbox`. This file type cannot be changed.

Remote command:

`[ :SOURce<hw> ] :EBOX:USER:SETTing:STORe` on page 262

`[ :SOURce<hw> ] :EBOX:USER:SETTing:LOAD` on page 262

## 7.1.3 Protocol

The "Protocol" tab contains the interface parameters for signal transmission from the DUT to the R&S EX-IQ-BOX and vice versa. To the overview R&S DigIConf also shows the "Clock" and "Data" settings and the signal flow in a diagram.

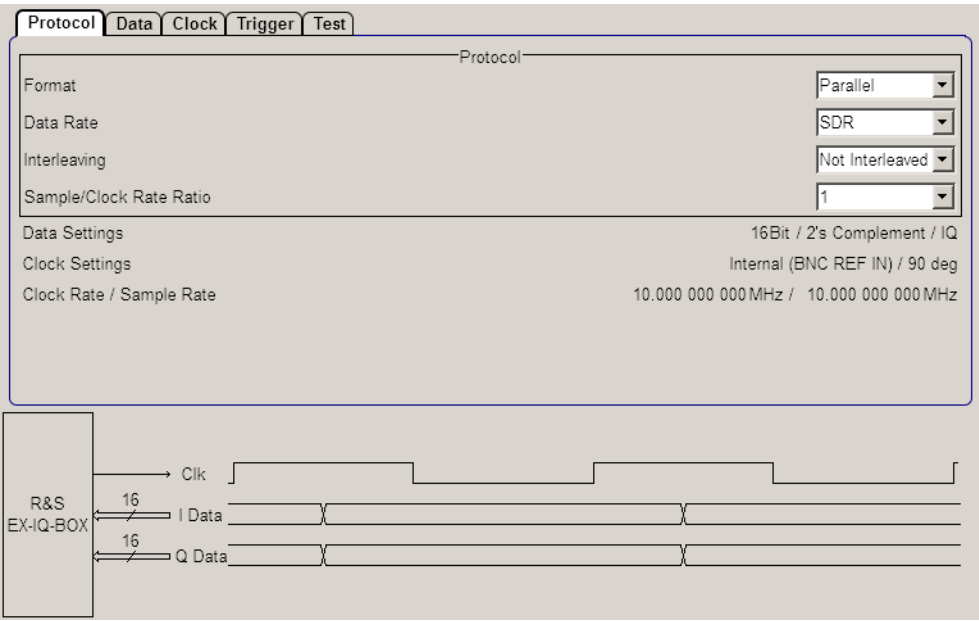


Fig. 7-4: User defined > Protocol dialog

**Format**

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

"Serial" Transmits each sample serially, i.e. bitwise from the DUT to the R&S EX-IQ-BOX or vice versa.

**Example:**

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

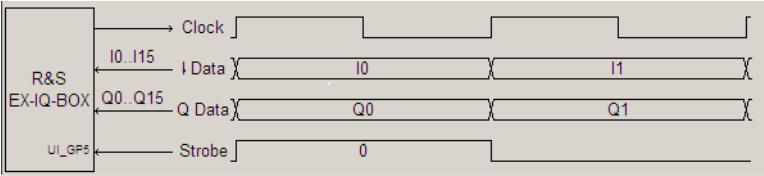


Fig. 7-5: User defined > I/Q IN serial signal flow

Direction = Receiver  
Format = Serial

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



"Parallel" Transmits each sample parallel, i.e. wordwise from the DUT to the R&S EX-IQ-BOX or vice versa.

**Example:**

Parallel signal output to the DUT

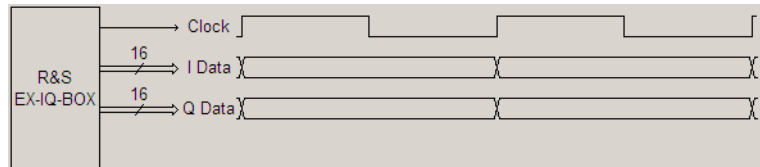


**Fig. 7-6: User defined > I/Q OUT parallel signal flow**

Direction = Transmitter  
Format = Parallel

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

Remote command:

[ :SOURce<hw> ] :EBOX:USER:FORMat on page 264

**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"

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

**Example:**

- Parallel signal output in single data rate

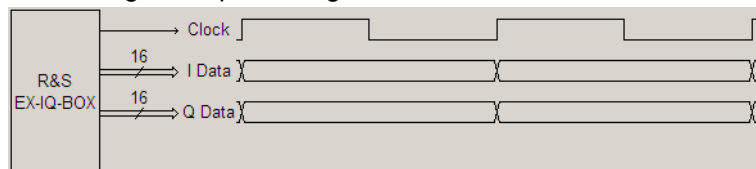


**Fig. 7-7: User defined > Signal flow: I/Q OUT parallel, single data rate**

Direction = Transmitter

Format = Parallel

Data Rate = SDR

- Serial signal input in single data rate:

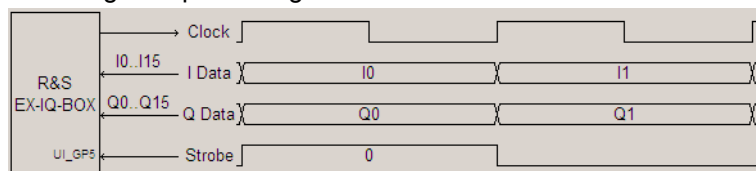


**Fig. 7-8: User defined > Signal flow: I/Q OUT serial, single data rate**

Direction = Receiver

Format = Serial

Data Rate = SDR

"DDR"

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

The signal transmission is also shown in the graph.

#### Example:

- Parallel signal input in double data rate:

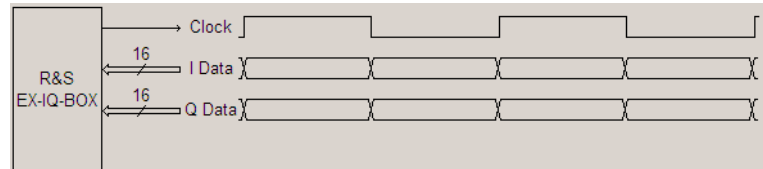


**Fig. 7-9: User defined > Signal flow: I/Q IN parallel, double data rate**

Direction = Receiver

Format = Parallel

Data Rate = DDR

- Serial signal input in double data rate:

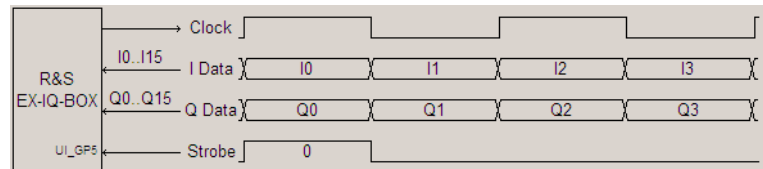


**Fig. 7-10: User defined > Signal flow: I/Q IN serial, double data rate**

Direction = Receiver

Format = Serial

Data Rate = DDR

Remote command:

[ :SOURce<hw> ] :EBOX:USER:DRATe on page 263

#### Interleaving

Activates interleaving and selects the interleaving mode.

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

"Not Inter-  
leaved"

Transmits the baseband signal on the I and Q data lines as indicated in the graph below.

**Example:**

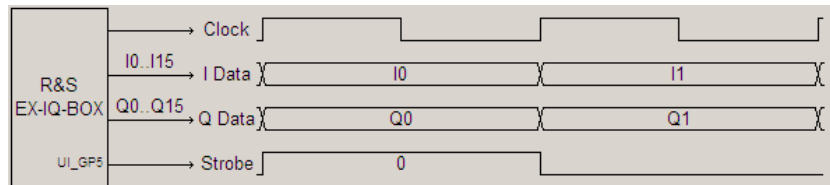


**Fig. 7-11: User defined > Signal flow: I/Q OUT serial, not interleaved**

Direction = Transmitter  
 Format = Serial  
 Data Rate = DDR  
 Interleaving = Not interleaved

"I/Q Inter-  
leaved"

Transmits the baseband signal on the I data line starting with I data.

#### Example:

- Serial signal output in single data rate.

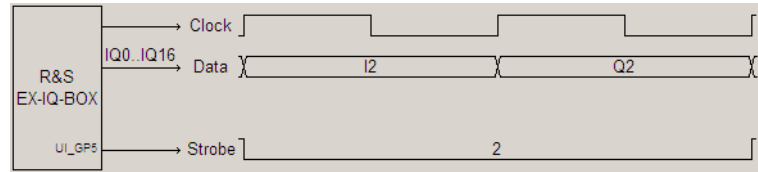


**Fig. 7-12: User defined > Signal flow: I/Q OUT serial, single data rate, I/Q interleaved**

Direction = Transmitter  
Format = Serial  
Data Rate = SDR  
Interleaving = I/Q interleaved

The strobe signal (UI\_GP5) takes 2 clock cycles. The first clock cycle triggers the I data, and the second cycle triggers the Q data.

- Serial signal output in double data rate.

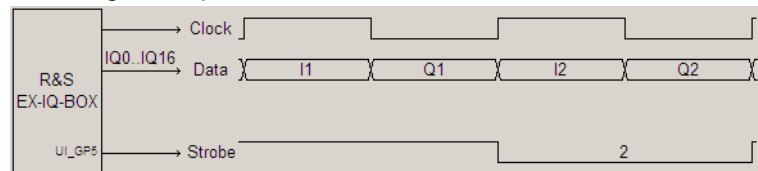


**Fig. 7-13: User defined > Signal flow: I/Q OUT serial, double data rate, I/Q interleaved**

Direction = Transmitter  
Format = Serial  
Data Rate = DDR  
Interleaving = I/Q interleaved

The strobe signal UI\_GP5 lasts 1 clock cycle. The rising edge triggers the I data, the falling edge the Q data.

- Parallel signal output in single data rate.



**Fig. 7-14: User defined > Signal flow: I/Q OUT parallel, single data rate, I/Q interleaved**

Direction = Transmitter  
Format = Parallel  
Data Rate = SDR  
Interleaving = I/Q interleaved

The I marker output at the Reserved1 pin UI\_GP5 of the user interface marks the I data.

- Parallel signal output in double data rate.

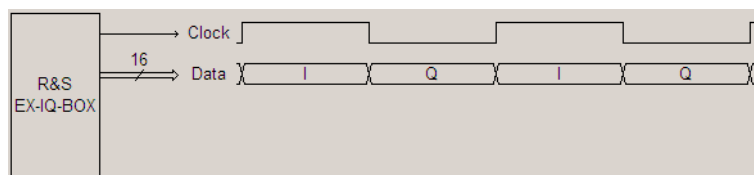


**Fig. 7-15: User defined > Signal flow: I/Q OUT parallel, double data rate, I/Q interleaved**

Direction = Transmitter  
 Format = Parallel  
 Data Rate = DDR  
 Interleaving = I/Q interleaved

The rising edge of the clock signal triggers the I data, the falling edge the Q data.

"Q/I Interleaved" Transmit the baseband signal on the I data line starting with Q data. With interchanged order of the I and Q data the I/Q signal is transferred similarly as described above.

Remote command:

`[ :SOURce<hw> ] :EBOX:USER:ILEaving` on page 265

### Sample / Clock Rate Ratio

Sets the sample to clock rate ratio in parallel signal transmission mode. This parameter characterizes the ratio of the sample rate to the clock rate depending on the parameter settings for "Word Size", "Interleaving" and "Data Rate". See also "Clock Rate" on page 115.

#### Note:

#### SCPI notation varies

- In the remote control, determine the clock rate ratio value for the R&S DigIConf and R&S signal generators with `SCRxDy`.  $x$  represents the value,  $D$  substitutes the decimal point, and  $y$  is the decimal place.
- In contrast, just enter the value  $x.y$  when using an R&S signal analyzer.

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

"SCR" 1, 4/5, 2/5, 1/5, 1/10, 1/20

"SCR < 1:" Dummy samples are added.  
 The signal output SCR\_VALID at the UI\_GP\_P1 pin of the user interface marks the validity of the data.

Remote command:

`[ :SOURce<hw> ] :EBOX:USER:SCRatio` on page 271

### Data Settings

Displays the data parameters "Word Size", "Numeric Format" and "Signal Type". For the description of these parameters, see [chapter 7.1.4, "Data"](#), on page 108, including "Word Size" on page 109, "Numeric Format" on page 112, and "Signal Type" on page 108.

### Clock Settings

Indicates the current values of the Clock Source and the Clock Phase. For the description of these settings in detail, see "Clock Source" on page 116 and "Clock Phase" on page 118.

### Clock Rate / Sample Rate

Displays the clock parameters "Clock Rate" and the calculated "Sample Rate". "Clock Rate" on page 115 explains these parameters in detail.

## 7.1.4 Data

The "Data" tab contains the parameters for data transmission. In parallel data transmission, R&S DigIConf shows the bits alignment at the user interface graphically, corresponding to the settings. If you transmit serially, you can additionally configure the serial strobe. In the lower pane, the signal flow is displayed as in all views.

Analyzers do not indicate data transmission graphically.

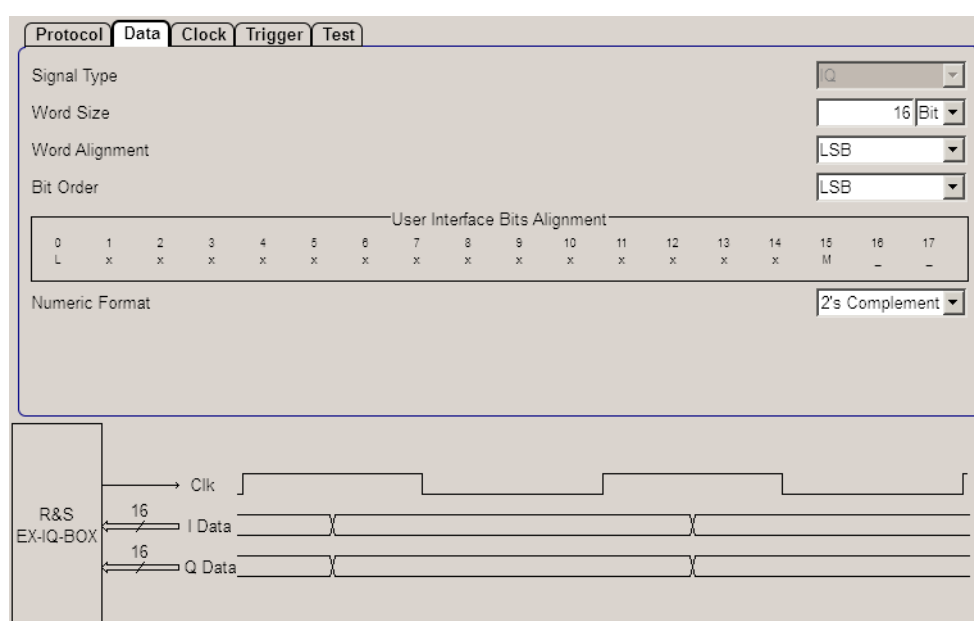


Fig. 7-16: User defined > Data dialog of parallel transmission

### Signal Type

Selects the signal mode of the transmission. The digital I and Q signals are either transmitted separately or the I and Q samples are assembled to a carrier signal and shifted to an intermediate frequency (IF).

**Note:** Currently the signal type is firmly set to "IQ" and read only. IQ transmits the digital I and Q signal components separately. Signal type "IF" is intended for future use.

"IQ" Transmits the digital I and Q signals separately.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:DATA:STYPe on page 276

**Word Size**

Sets the word size resolution of a sample. If the word size is set to a value  $n$ , the I word and the Q word use these  $n$  bits. The R&S EX-IQ-BOX supports word sizes from 4 to 18 bits.

Remote command:

`[ :SOURce<hw> ] :EBOX:USER:DATA:SIZE` on page 275

**Word Alignment**

Sets the alignment of the data bits on the data lines. Either the MSB or the LSB is mapped firmly to one data line. Depending on the word size the equivalent bit moves to the appropriate data line.

**Note:**

- This parameter applies to parallel data transmission.
- Graphics in the dialog of the generators and in R&S DigIConf show the presently set word alignment in the "User Interface Bits Alignment" section.

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

**Example:**

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

**Fig. 7-17: User defined > Word alignment MSB: I/Q parallel transmission, 5 bit, bit order MSB**

word size = 5  
word alignment = MSB  
bit order = MSB

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

**Fig. 7-18: User defined > Word alignment: I/Q parallel transmission, 9 bit, bit order MSB**

word size = 9  
word alignment = MSB  
bit order = MSB



"LSB" The LSB (Last Significant Bit) is mapped firmly to the same data line and the data line of the MSB varies in dependency of the word size.

Example:

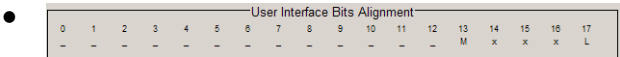


Fig. 7-19: User defined > Word alignment LSB: I/Q parallel transmission, 5 bit, bit order MSB

word size = 5  
word alignment = LSB  
bit order = MSB

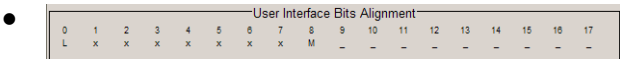


Fig. 7-20: User defined > Word alignment LSB: I/Q parallel transmission, 9 bit, bit order LSB

word size = 9  
word alignment = LSB  
bit order = LSB

Remote command:  
`[ :SOURce<hw> ] :EBOX:USER:DATA:ALIGNment` on page 272

Bit Order

Sets the order of the data bits. In "Parallel mode", either the LSB or the MSB is transmitted on the first used data line. In "Serial mode" either the LSB or the MSB is transmitted as first bit.

"MSB"

Transmits the MSB (**M**ost **S**ignificant **B**it) first.**Parallel transmission**

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

**Note:** Graphics in the dialog of the generators and in R&S DigiConf shows the presently set bit sequence.

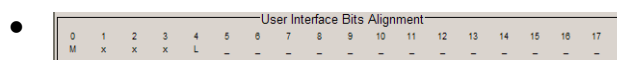
**Example:**

**Fig. 7-21: User defined > Bit order MSB: I/Q parallel transmission, alignment MSB, 5 bit**

word size = 5  
word alignment = MSB  
bit order = MSB

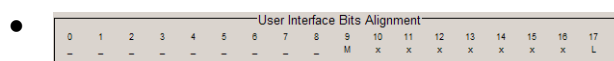


**Fig. 7-22: User defined > Bit order MSB: I/Q parallel transmission, alignment LSB, 9 bit**

word size = 9  
word alignment = LSB  
bit order = MSB

**Serial transmission:**

The MSB is transmitted first.

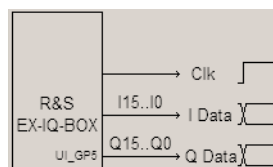
**Example:**

**Fig. 7-23: User defined > Bit order MSB: I/Q serial transmission, 16 bit**

word size = 16 Bit  
bit order = MSB

"LSB"

Transmits the LSB (Last Significant Bit) first.

**Parallel transmission:**

The LSB is transmitted on the first data line.

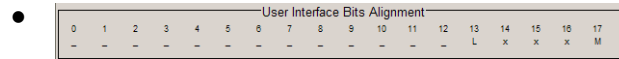
**Example:**

**Fig. 7-24: User defined > Bit order LSB: I/Q parallel transmission, alignment MSB, 5 bit**

word size = 5  
word alignment = MSB  
bit order = LSB

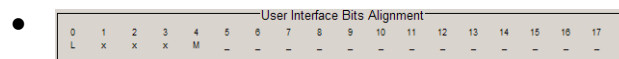


**Fig. 7-25: User defined > Bit order LSB: I/Q parallel transmission, alignment LSB, 9 bit**

word size = 9  
word alignment = LSB  
bit order = LSB

**Serial transmission:**

The LSB is transmitted first.

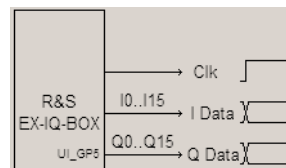
**Example:**

**Fig. 7-26: User defined > Bit order LSB: I/Q serial transmission, 16 bit**

word size = 16 Bit  
bit order = LSB

Remote command:

[ :SOURce<hw> ] :EBOX:USER:DATA:BORDER on page 273

**Numeric Format**

Select a numeric representation for data transmission.

Allowed number range for word size n Bit:

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

**Table 7-1: User defined > Numeric format coding**

| z  | 2's Complement |   |   |   |  | Binary Offset |   |   |   |
|----|----------------|---|---|---|--|---------------|---|---|---|
| -8 | 1              | 0 | 0 | 0 |  | 0             | 0 | 0 | 0 |
| -7 | 1              | 0 | 0 | 1 |  | 0             | 0 | 0 | 1 |
| -6 | 1              | 0 | 1 | 0 |  | 0             | 0 | 1 | 0 |
| -5 | 1              | 0 | 1 | 1 |  | 0             | 0 | 1 | 1 |

| z  | 2's Complement |   |   |   | Binary Offset |   |   |   |
|----|----------------|---|---|---|---------------|---|---|---|
| -4 | 1              | 1 | 0 | 0 | 0             | 1 | 0 | 0 |
| -3 | 1              | 1 | 0 | 1 | 0             | 1 | 0 | 1 |
| -2 | 1              | 1 | 1 | 0 | 0             | 1 | 1 | 0 |
| -1 | 1              | 1 | 1 | 1 | 0             | 1 | 1 | 1 |
| 0  | 0              | 0 | 0 | 0 | 1             | 0 | 0 | 0 |
| 1  | 0              | 0 | 0 | 1 | 1             | 0 | 0 | 1 |
| 2  | 0              | 0 | 1 | 0 | 1             | 0 | 1 | 0 |
| 3  | 0              | 0 | 1 | 1 | 1             | 0 | 1 | 1 |
| 4  | 0              | 1 | 0 | 0 | 1             | 1 | 0 | 0 |
| 5  | 0              | 1 | 0 | 1 | 1             | 1 | 0 | 1 |
| 6  | 0              | 1 | 1 | 0 | 1             | 1 | 1 | 0 |
| 7  | 0              | 1 | 1 | 1 | 1             | 1 | 1 | 1 |

"2's Complement"

The value of the transmitted data is formatted in two's-complement. The most significant bit has a value of  $-2^{n-1}$ , the bits of lesser significance follow as:  
 $+2^{n-2} \dots +2^0$

"Binary Offset"

The value of the transmitted data is formatted in binary offset. A binary offset of  $-2^{n-1}$  is added such that the final values are always positive.

#### Example:

$$n = 4 \rightarrow -8 \leq z < 8$$

Remote command:

[\[:SOURce<hw>\]:EBOX:USER:DATA:NFORmat](#) on page 273

#### Strobe Polarity

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

The strobe marker is output at the UI\_GP5 of the user interface.

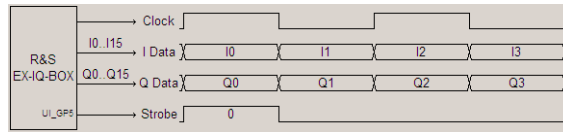
**Note:** This parameter applies to serial data transmission.

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

"Positive"

**Example:**

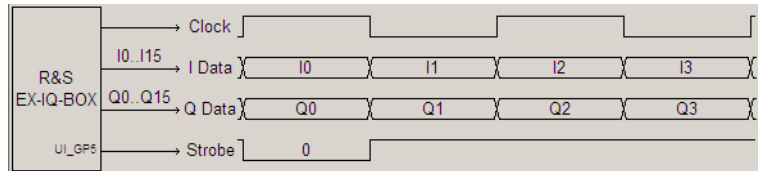
Sets the strobe polarity to high level.

**Fig. 7-27: User defined > Strobe polarity positive: I/Q OUT serial**

word size = 4  
 bit order = LSB  
 numeric format = 2's complement  
 strobe polarity = positive

"Negative"

Sets the strobe polarity to low level.

**Example:****Fig. 7-28: User defined > Strobe polarity negative: I/Q OUT serial**

word size = 4  
 bit order = LSB  
 numeric format = 2's complement  
 strobe polarity = negative

Remote command:

[:SOURce&lt;hw&gt;]:EBOX:USER:DATA:SPOLarity on page 275

**Strobe Position**

Sets the sample position of the strobe marker output.

**Note:**

- This parameter applies to serial data transmission.
- Value range: 0 to word size -1.
- The graphic in the clock dialog of the generators and in R&S DigIConf shows the presently set sample position.
- The strobe marker is output at the UI\_GP5 of the user interface.

**Example:**

Strobe Position = 2, Strobe Polarity = Positive.

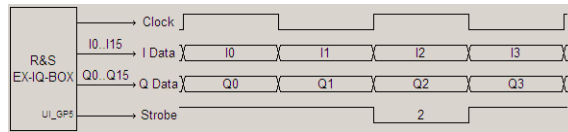


**Fig. 7-29: User defined > Strobe position 2: I/Q OUT serial, negative polarity**

word size = 16  
 bit order = LSB  
 strobe polarity = negative  
 strobe position = 2

Remote command:

`[ :SOURCE<hw> ] :EBOX:USER:DATA:SPOSITION` on page 276

## 7.1.5 Clock

The "Clock" tab provides the frequency settings for synchronizing the test setup with either external or internal clock source.

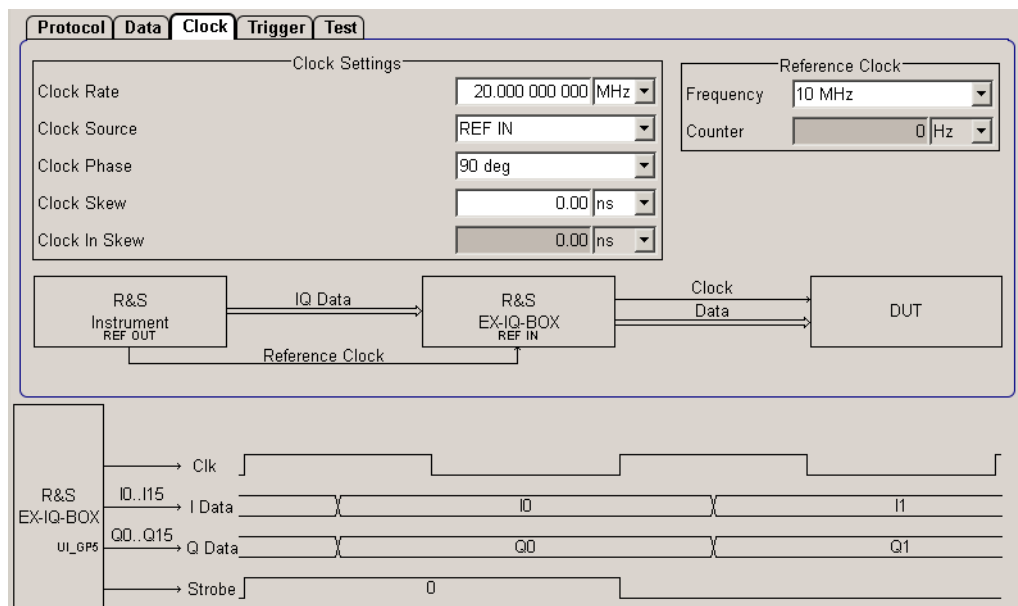


**Fig. 7-30: User defined > Clock dialog**

The graphic in the clock dialog of the generators and in R&S DigIConf indicates the data flow, the clock signal and the reference frequency signal. A signal diagram displays schematically the current type of data transmission.

### Clock Rate

Sets the clock rate (frequency) for signal transmission between the R&S EX-IQ-BOX and the external device (DUT). Depending on the logic type and the clock source the clock rate range varies, as shown below.

$$f_{CLK} = \frac{f_s \cdot WS \cdot INT}{DDR \cdot SCR}$$

**Fig. 7-31: User defined > Clock rate**

$f_{clk}$  = clock rate  
 $f_s$  = sample rate  
 WS = Word size  
 INT = Interleaving mode  
 DDR = double data rate  
 SCR = sample/clock rate ratio

**Table 7-2: User defined > Value range of  $f_{CLK}$**

|                                                                                                                                                                          | Value Range                          |                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------------------|
| f <sub>s</sub>                                                                                                                                                           | 1 kHz ... 100 MHz                    |                                     |
| f <sub>CLK</sub>                                                                                                                                                         | <b>LVTTL:</b> 1 (25) kHz - 100 MHz*) | <b>LVDS:</b> 1 (25) kHz - 400 MHz*) |
| WS                                                                                                                                                                       | 4 ... 18 (serial mode)               | 1 (parallel mode)                   |
| INT                                                                                                                                                                      | 1 (non interleaved)                  | 2 (I/Q and Q/I interleaved)         |
| DDR                                                                                                                                                                      | 1 (SDR)                              | 2 (DDR)                             |
| SCR                                                                                                                                                                      | 1, 4/5, 2/5, 1/5, 1/10, 1/20         |                                     |
| *)1 kHz applies to the REF IN clock source, i. the reference signal is fed in from the R&S instrument, 25 kHz applies to the external reference from the user interface. |                                      |                                     |

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

Remote command:

[ :SOURce<hw> ] :EBOX:USER:CLOCK:RATE on page 268

### Clock Source

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

The following clock scenarios are possible:

- Signal "input" synchronized by an "external" clock source.  
Data and data clock are fed by the DUT.

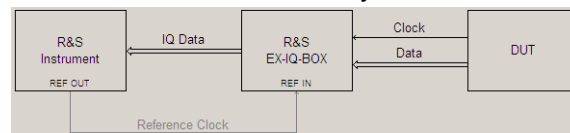


**Fig. 7-32: User defined > I/Q IN synchronized by external clock**

clock source = External (user interface)

- Signal "input" synchronized by the "internal" reference clock signal.  
The R&S EX-IQ-BOX receives the clock signal from the R&S instrument and forwards it to the DUT in order to synchronize the incoming data from the DUT.

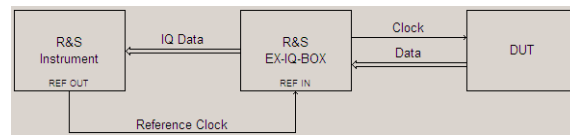


**Fig. 7-33: User defined > I/Q IN synchronized by internal clock**

clock source = Internal (BNC REF IN)

- Signal "output" synchronized by an "external" reference clock signal. The R&S EX-IQ-BOX receives the I/Q data from the R&S instrument and forwards it to the DUT, synchronized by the reference frequency of the DUT.

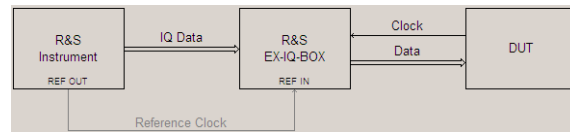


**Fig. 7-34: User defined > I/Q OUT synchronized by external clock**

clock source = External (User Interface)

- Signal "output" synchronized by the "internal" reference clock signal. The R&S instrument provides the I/Q data and the reference clock passed to the DUT by the R&S EX-IQ-BOX.

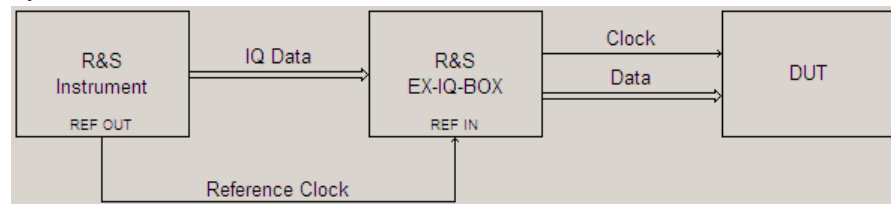


**Fig. 7-35: User defined > I/Q OUT synchronized by internal clock**

clock source = Internal (BNC REF IN)

- "REF IN" To synchronize data transmission, the R&S EX-IQ-BOX obtains the reference frequency from a connected R&S instrument, i.e. a signal generator or signal analyzer. The R&S instrument supplies the clock at the REF IN (BNC) connector. Select the supplied reference frequency in [Frequency](#).
- Note:** When using the reference frequency of an R&S instrument, the reference output of the R&S instrument must be connected to the REF IN of the R&S EX-IQ-BOX (see [chapter 4.3.2, "Rear Panel View"](#), on page 32). The connection can be kept during the entire operation even if an external clock reference is used.
- "Internal" The R&S EX-IQ-BOX synchronizes data transmission with a internally generated reference frequency of 10 MHz. The frequency is indicated [Frequency](#).



"User Interface" The R&S EX-IQ-BOX receives an external reference signal from the DUT via the user interface.

Remote command:

[\[:SOURce<hw>\]:EBOX:USER:CLOCK:SOURce](#) on page 270

### Clock Phase

Sets a phase shift of the active clock edge in 90° steps related to the data bits.

The phase shift is graphically displayed in main settings dialog.

Adjustable values: 0° | 90° | 180° | 270°

### Example:

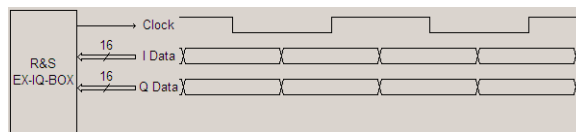


**Fig. 7-36: User defined > Clock phase**

Clock source = internal

clock phase = 90°

### Note: SCPI notation varies

In the remote control you determine the clock phase value for the R&S signal analyzers with `Pxx`. In contrast, just enter the value `xx` without `P` when using R&S EX-IQ-BOX or an R&S signal generator. `xx` represents the value in degree.

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

Remote command:

[\[:SOURce<hw>\]:EBOX:USER:CLOCK:PHASe](#) on page 267

### 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.

Remote command:

[\[:SOURce<hw>\]:EBOX:USER:CLOCK:SKEW:OUT](#) on page 270

### Clock In Skew

Sets a time shift of the active clock edge related to the data bits. This feature is used to compensate an internal clock skew which is caused by differences of the clock and data line lengths.

Remote command:

[\[:SOURce<hw>\]:EBOX:USER:CLOCK:SKEW:IN](#) on page 269

### Frequency

Sets / indicates the reference frequency.

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

The parameter is grayed out, when an external, or the internal reference clock of the R&S EX-IQ-BOX is used.

"5 | 10 | 13"      Provided reference frequencies in MHz.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:CLOCK:REFERENCE:FREQuency on page 269

### Freq. Counter

The function counts and indicates the actually reference frequency, fed by an R&S instrument, or the DUT.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:CLOCK:REFERENCE:VALue? on page 269

## 7.1.6 Trigger

In the "Trigger" tab you can configure and activate a trigger signal, when the R&S EX-IQ-BOX is working in transmitter mode.

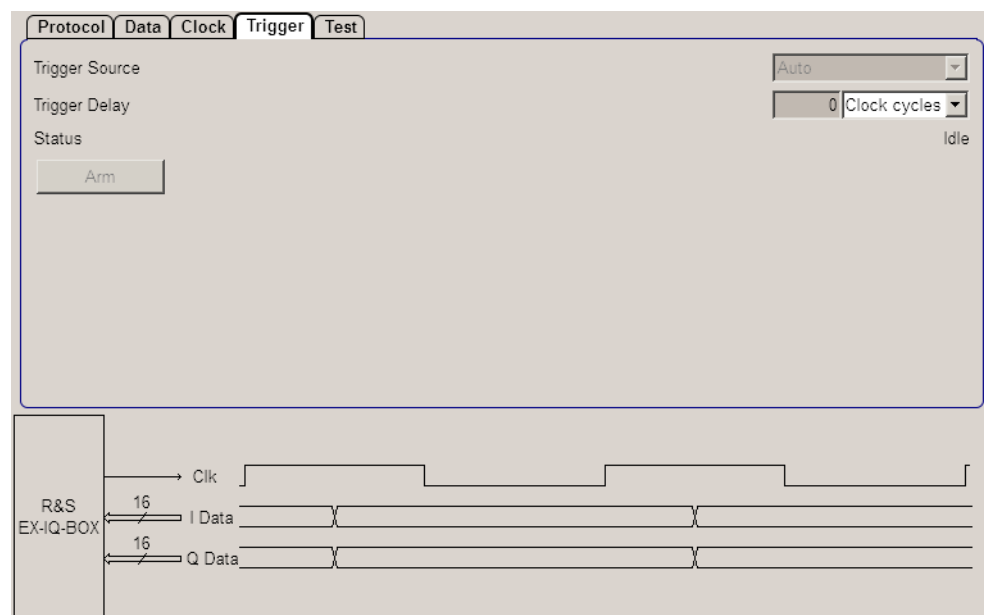


Fig. 7-37: User defined > Trigger dialog

### Trigger Source

Select the trigger source. The trigger signal starts the signal output at the user interface.

"Auto"      Outputs the signal immediately.

"Sync"      Synchronizes signal output with an incoming trigger signal, i.e. the DUT triggers data output to the R&S EX-IQ-BOX. The trigger signal is applied at the SYNC IN pin of the user interface.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:TRIGger:SOURce on page 282

**Trigger Delay**

Specify a time delay after the trigger event. Trigger delay is defined clock cycles.

Remote command:

[\[:SOURce<hw>\]:EBOX:USER:TRIGger:DElay](#) on page 282

**Status**

Indicates the current trigger status.

Remote command:

[\[:SOURce<hw>\]:EBOX:USER:TRIGger:STATe?](#) on page 283

**Arm**

Stops the current signal output. It continues either automatically or synchronized, according to the used trigger source.

Remote command:

[\[:SOURce<hw>\]:EBOX:USER:TRIGger:ARM](#) on page 281

## 7.1.7 Test

The "Test" tab provides functions for testing the user interface between the R&S EX-IQ-BOX and the DUT.



Prior to any measurement of an I/Q signal, we recommend that you to check the function of the data interface.

The R&S EX-IQ-BOX provides both, a test signal generator and a measurement receiver that supports BER measurement.

The test dialog changes depending on the transmission path. If the R&S EX-IQ-BOX is working as transmitter, the test dialog shows the control elements for the test signal generator. In receiver mode, the dialog provides the control elements for the test receiver. Refer for description to [chapter 7.1.8, "TX-Test"](#), on page 120, and to [chapter 7.1.9, "Rx-Test"](#), on page 123, respectively.

## 7.1.8 TX-Test

This section describes the parameters for testing in transmitter mode.

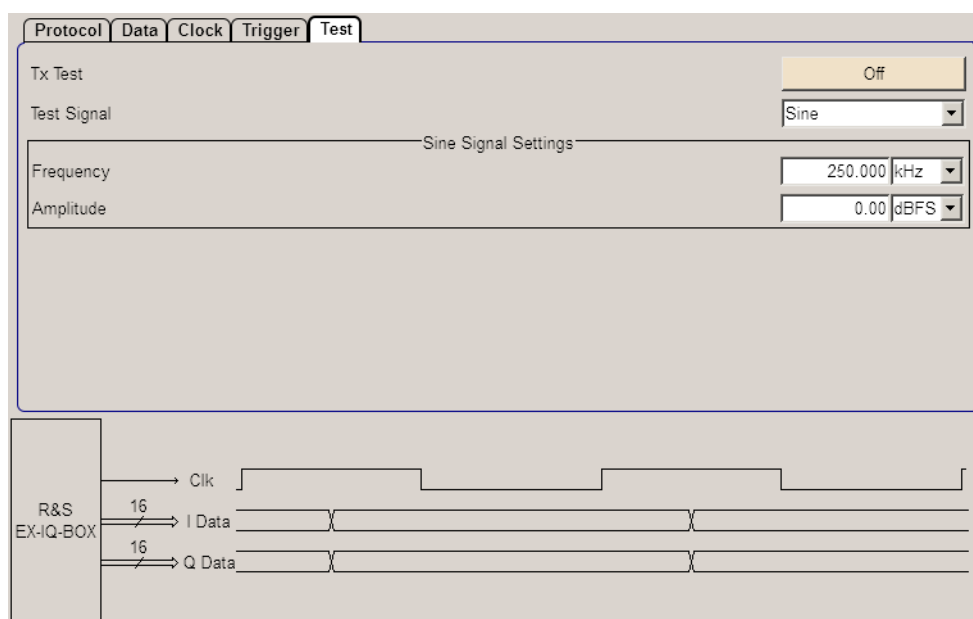


**Fig. 7-38: User defined > Test dialog of transmitter mode**

### Tx Test

Switches the test generator on or off.

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

Remote command:

[\[:SOURce<hw>\]:EBOX:USER:TEST:TX:STATe](#) on page 281

### Test Signal

Selects a test signal of the test generator. The R&S EX-IQ-BOX provides three different signals for testing.

**"PRBS"**

Generates a PRBS 16 (**P**seudo **R**andom **B**inary **S**equences) sequence. The output of this sequence complies to the "Protocol", "Data" and "Clock" settings of the R&S EX-IQ-BOX.

E.g. if the word size of the I / Q sample is 7 bits, the R&S EX-IQ-BOX sends the PRBS 16 sequence in 7-bit parts.

The I and Q values always contain the same copy of one test sample. The PRBS 16 sequence is defined by the generator polynomial  $G(x) = 1 + x^2 + x^3 + x^5 + x^{16}$ .

**Example:**

The functional implementation of this PRBS generator is also defined by the following linear feedback shift register (LFSR):

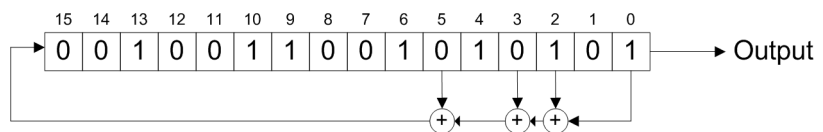


**Fig. 7-39: User defined > Test PRBS linear feedback shift register (LFSR)**

**"Counter"**

Generates a counter test signal. The counter size is based on the word size, set in the "Data" tab. Each output sample increases the counter by 1.

**"Sine"**

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

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

**Fig. 7-40: User defined > sine signal formula**

$n$  = discrete time index

$f$  = frequency of the test sine signal

$f_s$  = sampling frequency, based on the "protocol", "data" and "clock" settings.

with the real component,

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

**Fig. 7-41: User defined > sine signal I component formula (real)**

and the imaginary component:

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

**Fig. 7-42: User defined > sine signal Q component formula (imaginary)**

Remote command:

`[ :SOURce<hw> ] :EBOX:USER:TEST:TX:SIGNal` on page 279

**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.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:TEST:TX:SINE:FREQuency on page 281

**Amplitude**

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

Remote command:

[ :SOURce<hw> ] :EBOX:USER:TEST:TX:SINE:AMPLitude on page 280

**7.1.9 Rx- Test**

This section provides the parameters for testing in receiver mode.

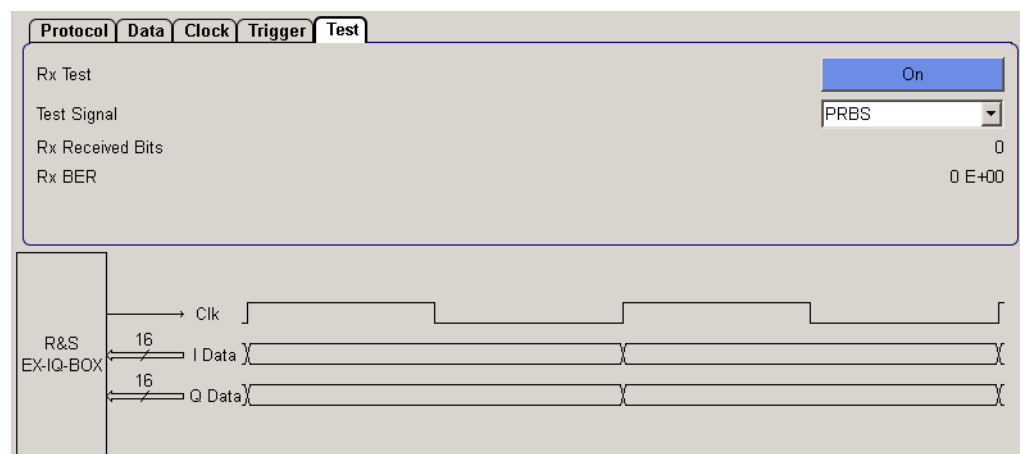


Fig. 7-43: User defined > Test dialog of receiver mode

**Rx Test**

Activates the test receiver.

The R&S EX-IQ-BOX expects a test signal at the user interface. First, the test receiver synchronizes to the last received data word, and then generates a test sequence and compares each generated sample with the corresponding received sample.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:TEST:RX:STATe on page 278

**Test Signal**

Selects the incoming test signal to be analyzed. The test receiver analyzes both PRBS 16 or counter test signals.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:TEST:RX:SIGNal on page 278

**Rx Received Bits**

Indicates the number of received bits. This functions consecutively counts the number of received bits, compares them with the sent data and determines the error rate.

Remote command:

`[ :SOURCE<hw> ] :EBOX:USER:TEST:RX:WORDS?` on page 279

**Rx BER**

Indicates the bit error rate. The function consecutively counts the number of discrepancies that occur during the test. The BER result is the ratio, which is calculated by dividing the number of error bits by the total number of bits.

Remote command:

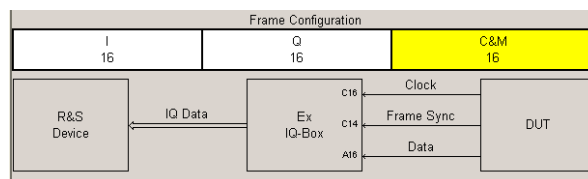
`[ :SOURCE<hw> ] :EBOX:USER:TEST:RX:BER?` on page 277

**7.1.10 SSI - Serial Synchronous Interface**

The "SSI General" panel contains parameters for data transmission of SSI (Serial Synchronous Interface) signals.



The graphic in the clock dialog of the signal generators and in R&S DigIConf indicates the frame configuration, data flow and the control signals Clock, Frame Synchronization and Data.



Settings of the SSI logic types currently provide special applications and should not be changed. Extensions for future applications are intended.

**Word Size**

Defines the size in bits of an I or Q data word. The size is defined from 4 up to 24 bits.

Remote command:

`[ :SOURCE<hw> ] :EBOX:USER:SSI:SIZE` on page 284

**C&M Size**

Defines the number of the Control & Management Bits which follows the I/Q data word. The size is defined from 0 up to 32 bits.

Remote command:

`[ :SOURCE<hw> ] :EBOX:USER:SSI:CMSize` on page 284

**C&M Data**

Defines the number of the Control & Management bit word as defined in the C&M Size parameter. This setting can be specified in transmitter mode, in receiver mode it is read-only.

**Note:** For this setting, the SCPI notation lightly differs between the command for the R&S signal generators, R&S DigIConf and the command for the R&S analyzers.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:CMDData:RX|TX on page 283

**Late Frame Sync**

Defines if the sync signal appears at the first period of a data bit (parameter set to On) or if the sync signals appears one period before (parameter is Off).

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:LFSYnc on page 284

**Gain File**

Defines a binary file containing a gain table. For the format of the gain table, refer to the appropriate generator section.

**Note:** A gain file can be selected in input / receiver mode and for "C&M" >=8 !

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:GAIN:FSElect on page 284

**Enable Automatic Gain**

Activates the automatic gain handling.

**Note:** A gain file can be used in input / receiver mode and for "C&M" >=8 !

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:GAIN:STATe on page 284

**7.1.11 SPI Setup**

The "SPI Setup" panel contains clock parameters for data transmission of SSI (Serial Synchronuos Interface) signals.

**Clock Frequency**

Sets a system clock frequency. Available frequencies are 1 MHz, 2.5 MHz, 5 MHz, 8.333 MHz, 12.5 MHz or 25 MHz.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:SPI:CLOCK:FREQuency on page 285

**Clock Phase**

Selects 0 or 180 degree clock phase.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:SPI:CLOCK:PHASe on page 285



**Chip Select**

Activates using the SSI-SPI chip.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:SPI:CSElect on page 285

**Write Byte (hex)**

Writes the SSI:SPI byte in hexadecimal format.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:SPI:WBYTe on page 286

**Read Byte (hex)**

Indicates the SSI:SPI byte in hexadecimal format.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:SPI:RBYTe? on page 286

**Select File**

Selects a SSI:SPI file.

Remote command:

[ :SOURce<hw> ] :EBOX:USER:SSI:SPI:FSElect on page 285

**Send**

Send all parameters of the configuration dialog to the R&S EX-IQ-BOX.

## 7.2 CPRI

This CPRI documentation contains a general overview of the standard interface. The main part explains the configuration dialogs and parameters in detail, provided by the configuration software R&S DigIConf. Find the appropriate information in [chapter 7.2.6, "Main Configuration Dialog"](#), on page 150, [chapter 7.2.7, "Hardware"](#), on page 153, [chapter 7.2.8, "L1 Analysis"](#), on page 163, [chapter 7.2.9, "Downlink and Uplink"](#), on page 170, [chapter 7.2.10, "Control & Management"](#), on page 193, [chapter 7.2.11, "Vendor Data"](#), on page 200, and [chapter 7.2.12, "Diagnostics"](#), on page 203.

You also find a panel [chapter 7.2.13, "ARB"](#), on page 205 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 (Radio Equipment) test application exemplifies the necessary equipment, test construction and essential settings. Refer to [chapter 7.2.5, "Start with CPRI - Setup Example"](#), on page 143 for information on this application example.

CPRI parameter settings are set by means of the configurator software R&S DigIConf. See [chapter 6.1, "R&S DigIConf Configuration Software"](#), on page 53 for description of R&S DigIConf in detail.



The CPRI transmission protocol option, as well as the options for waveform memory, multi waveform playback and recording memory require the R&S EX-IQ-BOX **1409.5505K04** and the configuration software R&S DigiConf. The R&S EX-IQ-BOX **1409.5502.02** provides only **User Defined** protocols.

## 7.2.1 Introduction

CPRI™ (Common Public Radio Interface) 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 (Radio Equipment Control) in the standard, to local or remote radio units, known as RE (Radio Equipment). For further information on CPRI Interface Specification refer to <http://www.cpri.info/spec.html>.

In the figure below, the REC and RE are shown for clarification. When connecting a REC and a RE with one or several CPRI interfaces, the resulting entity is a Node B in a Radio Access Network.

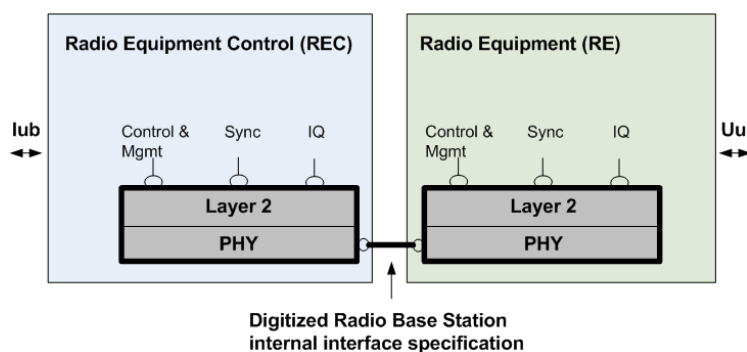


**Fig. 7-44: CPRI internal interface specification**

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



The associated option is available under R&S part number 1409.7208.02 (supporting line rates up to 3072 MBit/s) and 1409.7208.04 (supporting line rates up to 9830 MBit/s), including a breakout board and an option key code for authentication. For information on how to install the option refer to [chapter 4.6, "Installing R&S EX-IQ-BOX Options"](#), on page 44.

The enclosed CPRI breakout board is directly connected to the R&S EX-IQ-BOX at the Z-Dok user interface. The connection to the device under test (DUT) is done from the breakout board, which supports small form factor pluggable (SFP) modules for the optical CPRI link. The interface is configured by the configuration software R&S DigiConf.

For information on connection of a test setup example, refer to [chapter 7.2.5, "Start with CPRI - Setup Example"](#), on page 143.

With the option R&S EXBOX-B85 you can perform tests directly in the CPRI interface between the baseband module and the RF module of a base station, i.e. between the

REC and the RE. While one of the modules is simulated, the other, either the REC or the RE can be tested independently.

All state-of-the-art standards such as 3GPP FDD, incl. HSDPA, HSUPA and HSPA+, LTE, WiMAX and CDMA2000 are supported. The test solution covers individual uplink or downlink operation as well as full duplex operation. Depending on the configuration, up to 24 signal streams with settable sample rates can be processed; line bit rates of up to 3072.0 Mbps are achieved. Control and management information can be inserted, even in real-time.

In combination with R&S signal generators and R&S spectrum analyzers, the R&S EX-IQ-BOX utilizes the enhanced functions of the signal generators, like e.g. generation of digital communication signals, fading and AWGN simulation, and the signal analysis features of the spectrum analyzers, like e.g. EVM measurements for digital standards, or ACP measurement in the RF section.

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

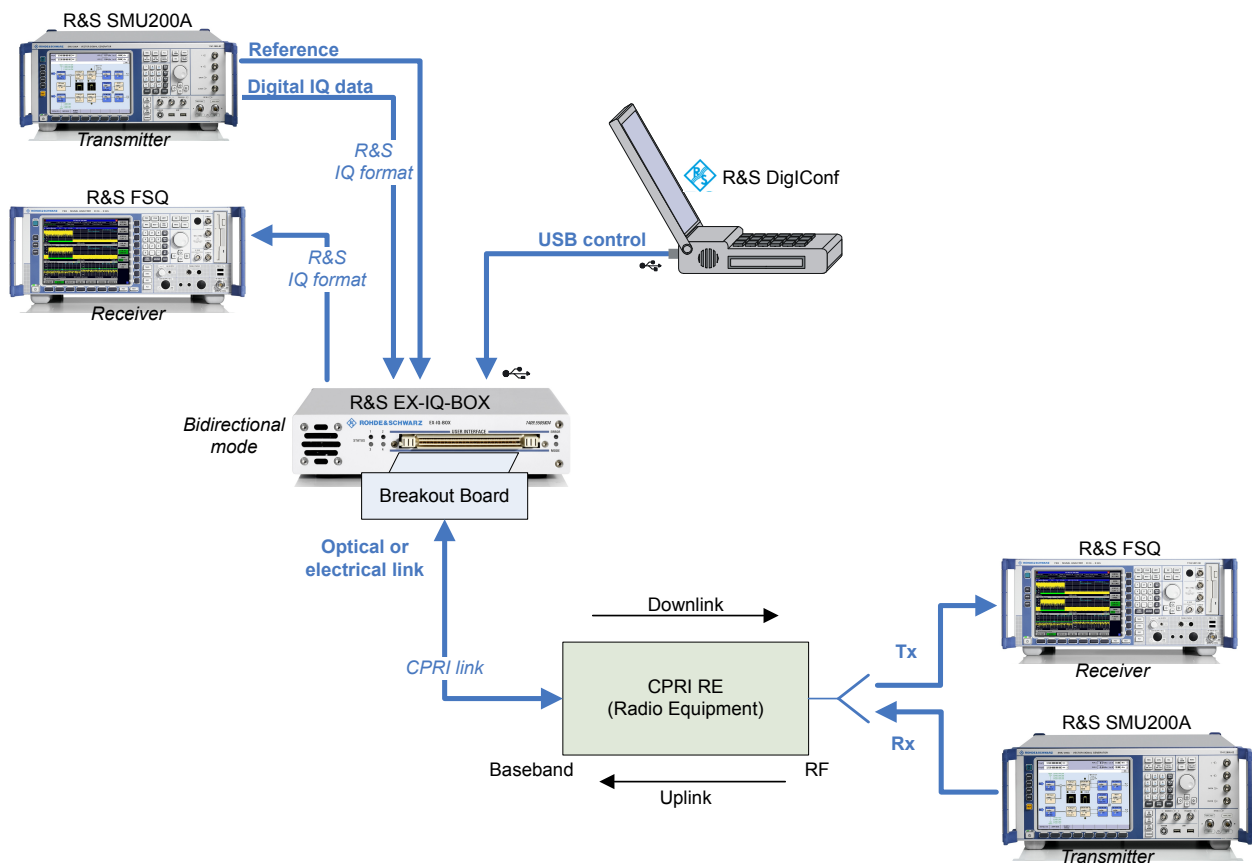


Fig. 7-45: CPRI RE test scenario, with the R&S EX-IQ-BOX emulating the baseband module REC

The test setup comprises the downlink and the uplink. Both directions can be tested either simultaneously, i.e. full duplex, or only uplink or downlink individually.

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

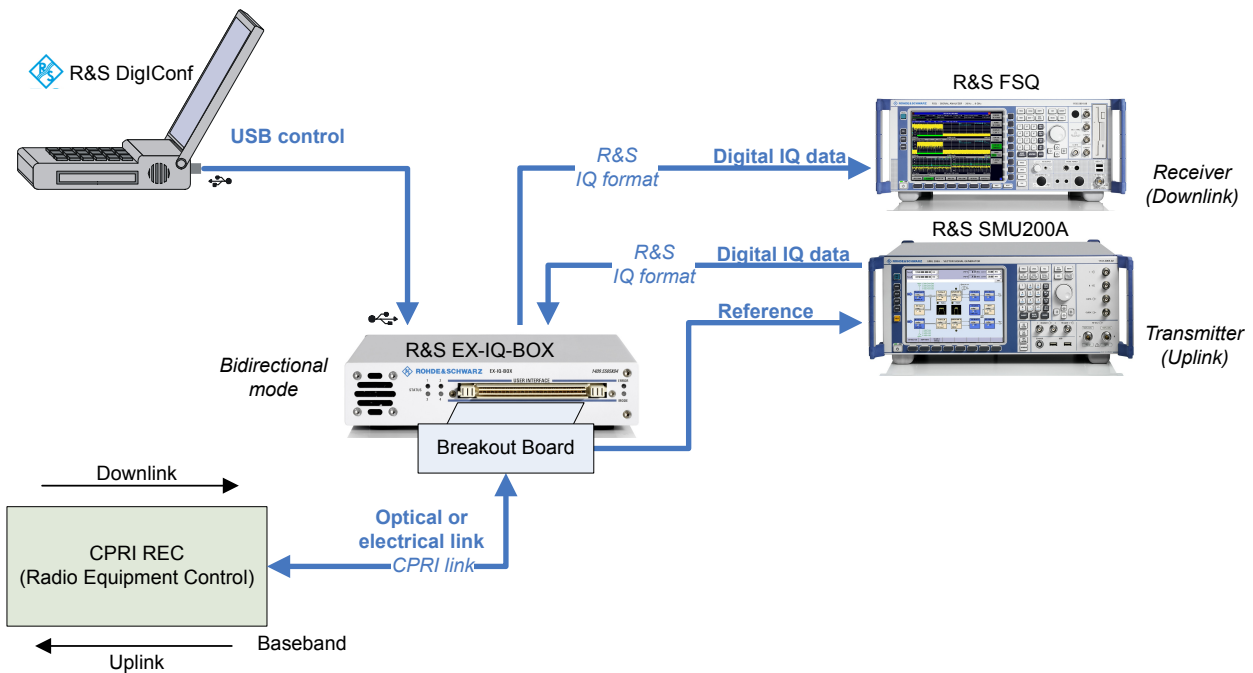


**Fig. 7-46: CPRI REC test scenario, with the R&S EX-IQ-BOX emulating the RF module RE**

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

## 7.2.2 CPRI Transmission Protocol - Overview

In the digital link, the I/Q baseband data and control information are transmitted together in one link. The I/Q data and controlling data are embedded in the transmission protocol with the aid of the multiplex procedure. The overview shows, how the protocol is built up.

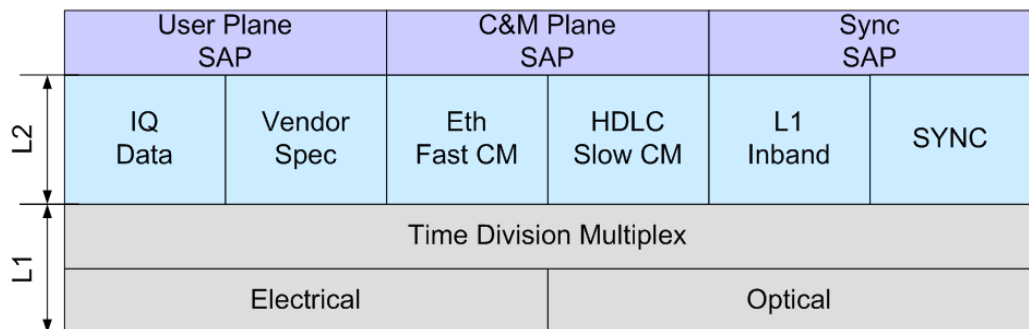


**Fig. 7-47: CPRI protocol overview**

CPRI defines the layer 1 and layer 2 protocols for the transfer of user plane data, control & management plane data as well as synchronization information between a REC and a RE as well as between two REs.

The interface supports the following types of information flows:

- I/Q Data

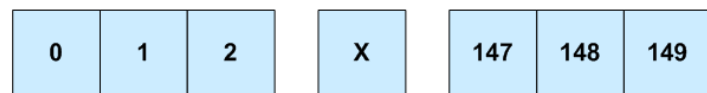
User plane information in the form of in-phase and quadrature modulation data (digital baseband signals).

- **Vendor Specific Information**  
This information flow is reserved for vendor specific information.
- **C&M Data**  
Control and management information exchanged between the control and management entities within the REC and the RE. This information flow is given to the higher protocol layers. The CPRI protocol offers two separate channels for the transmission of C&M data. A slow C&M channel using HDLC as the transport layer protocol as well as a fast C&M channel using Ethernet as the high level protocol.
- **L1 Inband Protocol**  
Signalling information that is related to the link and is directly transported by the physical layer. This information is required for system start-up, layer 1 link maintenance and the transfer of time critical information that has a direct time relationship to layer 1 user data.
- **Synchronization**  
Synchronization data used for frame and time alignment.

### Frame Structure

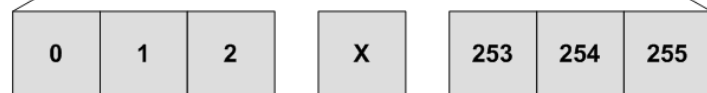
#### Node B Frame

150\*Th



#### Hyper Frame

Th=256\*Tb



#### Basic Frame

Tb=1/3.84MHz



**Fig. 7-48: CPRI hierarchical frame structure**

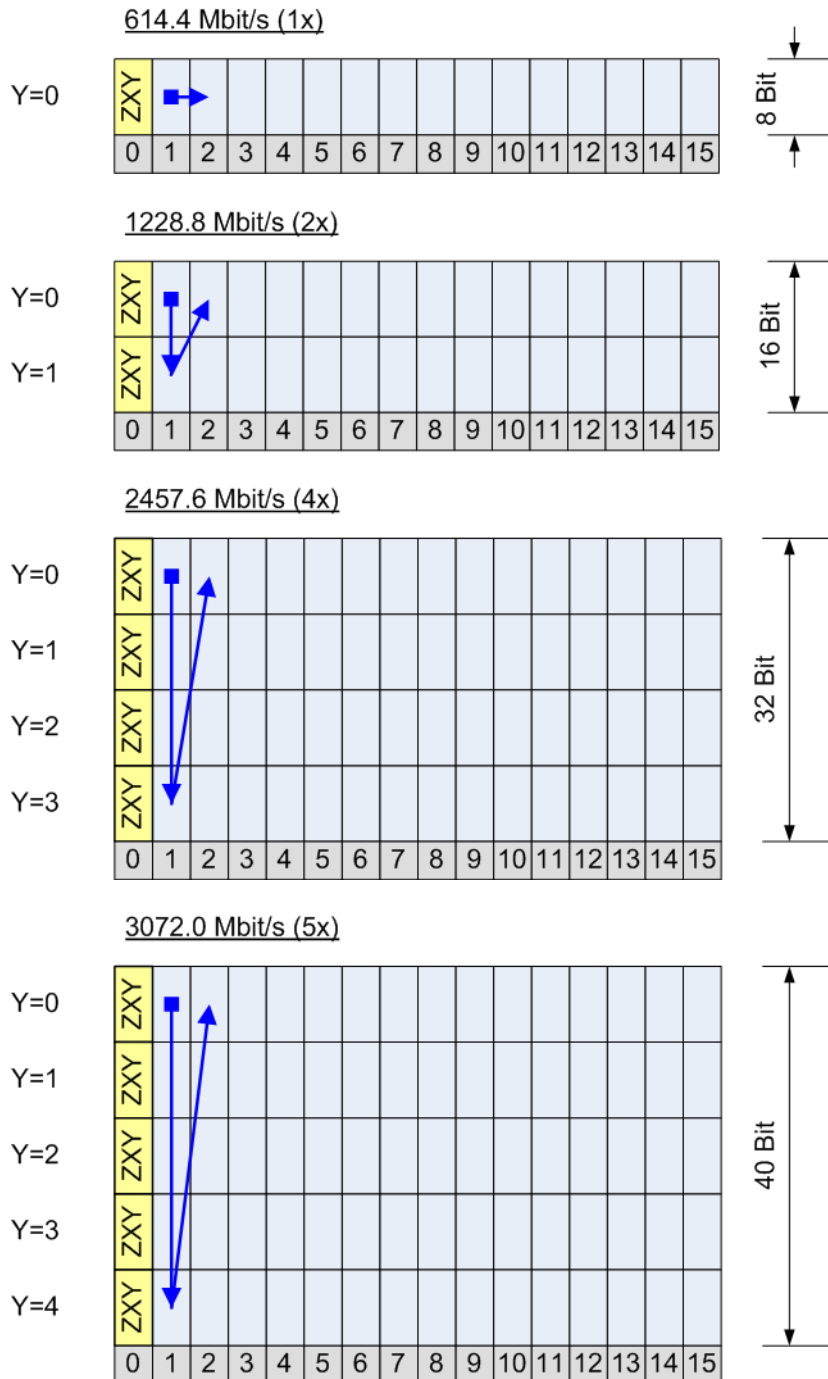
Data is transported via time division multiplex inside, so called **Basic Frames** consisting of 16 words of variable length (depending on the CPRI line rate). The Basic Frame rate is always 3.84 MHz.

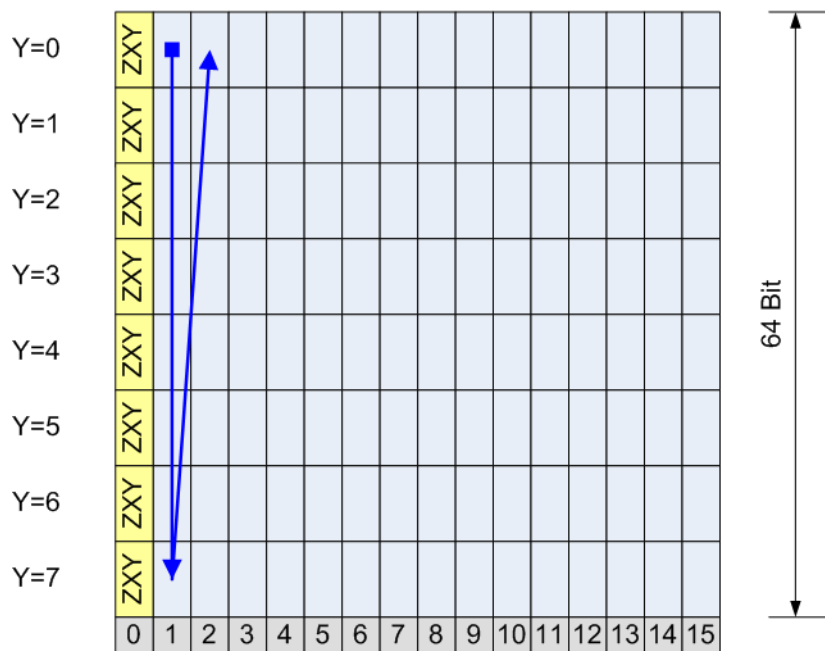
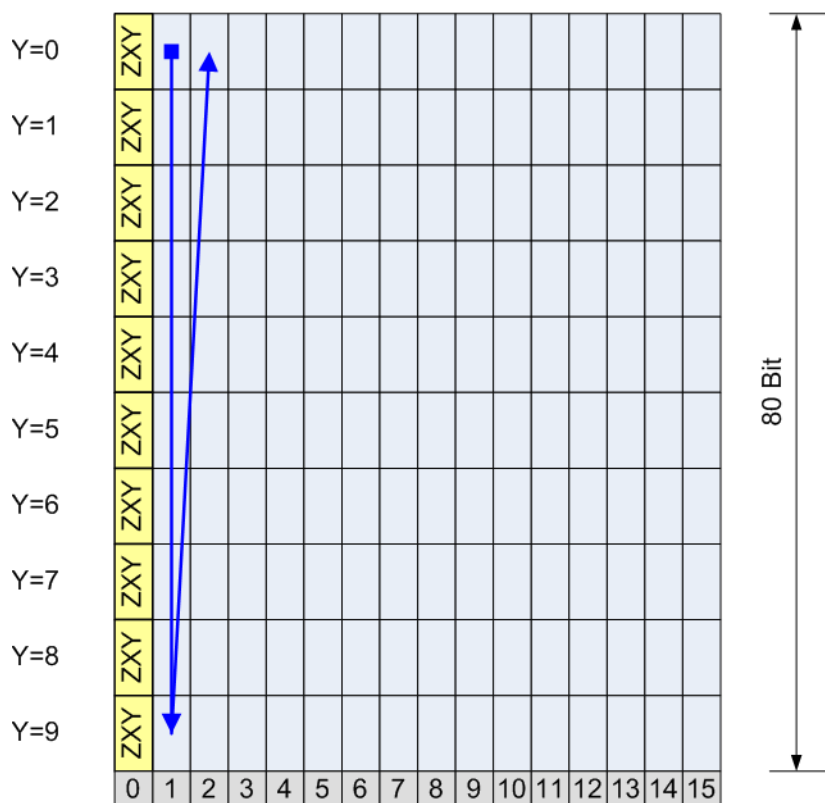
The first word of every basic frame is always a control word while the other 15 contain I/Q data. Inside the control words the other data streams like vendor specific data, C&M data as well as L1 inband protocol and sync information are transmitted.

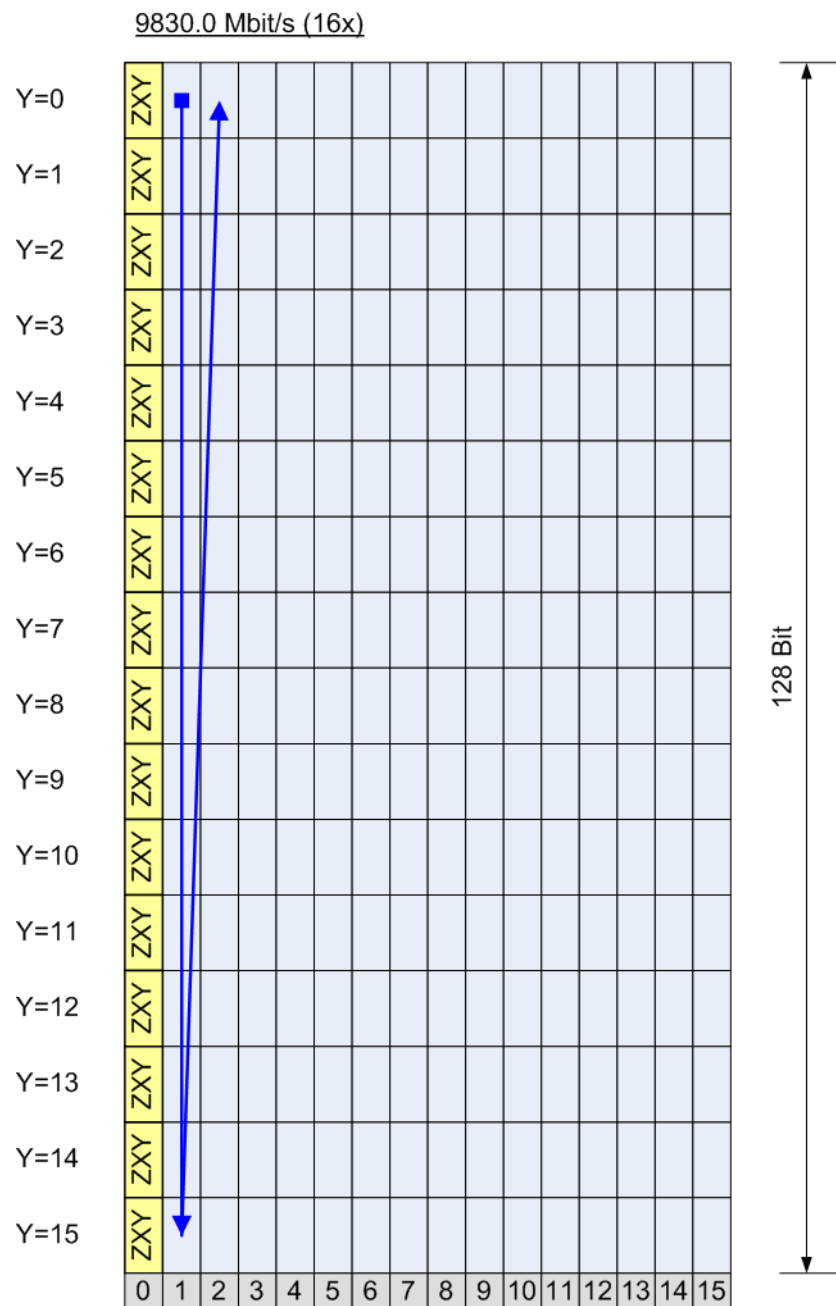
256 of these Basic Frames form a Hyper Frame and its 256 control words form a complete control block.

On the highest hierarchy level, a Node B Frame (or CPRI 10ms Frame) consists of 150 Hyperframes.

Depend on the CPRI line rate, the wordlength of the basic frames varies:



4915.2 Mbit/s (8x)6144.0 Mbit/s (10x)



### 7.2.2.1 Description of the CPRI Control Data

The 256 control words of a hyperframe are organized into 64 subchannels of 4 control words each. One subchannel contains 4 control words per hyperframe.

The index  $N_s$  of the subchannel ranges from 0 to 63. The index  $X_s$  of a control word within a subchannel has four possible values, namely 0, 1, 2 and 3. The index  $X$  of the control word within a hyperframe is given by:

$$X = N_s + 64 \cdot X_s.$$



| Ns | Xs=0 | Xs=1 | Xs=2 | Xs=3 |                    |
|----|------|------|------|------|--------------------|
| 0  | 0    | 64   | 128  | 192  | Sync & Timing      |
| 1  | 1    | 65   | 129  | 193  | Slow C&M Link      |
| 2  | 2    | 66   | 130  | 194  | L1 Inband Protocol |
| 3  | 3    | 67   | 131  | 195  | Reserved           |
| 4  |      |      |      |      | Vendor Spec        |
| 5  |      |      |      |      | Fast C&M Link      |
| 6  |      |      |      |      |                    |
| 7  |      |      |      |      |                    |
| 8  |      |      |      |      |                    |
| 9  |      |      |      |      |                    |
| 10 |      |      |      |      |                    |
| 11 |      |      |      |      |                    |
| 12 |      |      |      |      |                    |
| 13 |      |      |      |      |                    |
| 14 |      |      |      |      |                    |
| 15 | 15   | 79   | 143  | 207  |                    |
| 16 | 16   | 80   | 144  | 208  |                    |
| 17 | 17   |      |      |      |                    |
| 18 | 18   | 82   | 146  | 210  |                    |

|   |     |      |       |       |
|---|-----|------|-------|-------|
|   | P-1 | P+63 | P+127 | P+191 |
| P | P   | P+64 | P+128 | P+192 |

|    |    |     |     |     |
|----|----|-----|-----|-----|
| 61 | 61 |     |     |     |
| 62 | 62 | 126 | 190 | 254 |
| 63 | 63 | 127 | 191 | 255 |

Fig. 7-49: CPRI subchannels

The graph shows that the subchannels can carry various data streams, as explained in the following sections.

### Sync. & Timing

The data transmitted inside subchannel 0 is used for synchronization. The first byte marks the start of a hyperframe while bytes 2, 3 and 4 indicate the actual Node B Frame number and Hyperframe Number.

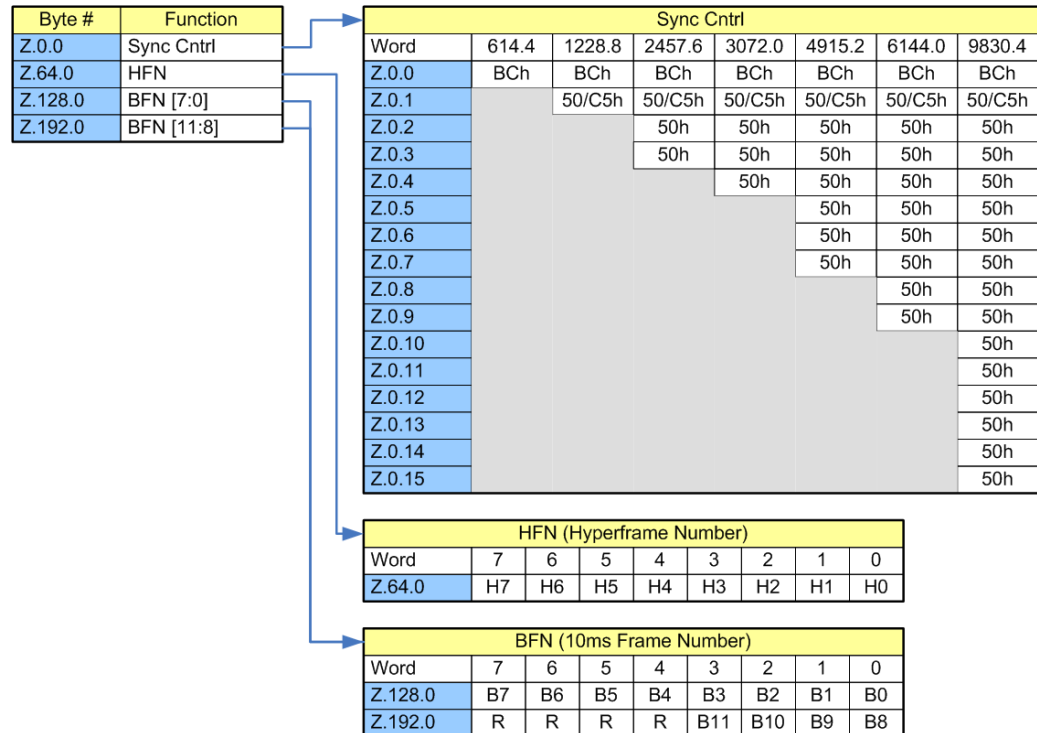


Fig. 7-50: CPRI synchronization and timing

### L1 Inband Protocol

Subchannel 2 is used for the transmission of link parameters between the devices. The L1 Inband protocol indicates status flags and defines Slow & Fast C&M link properties.

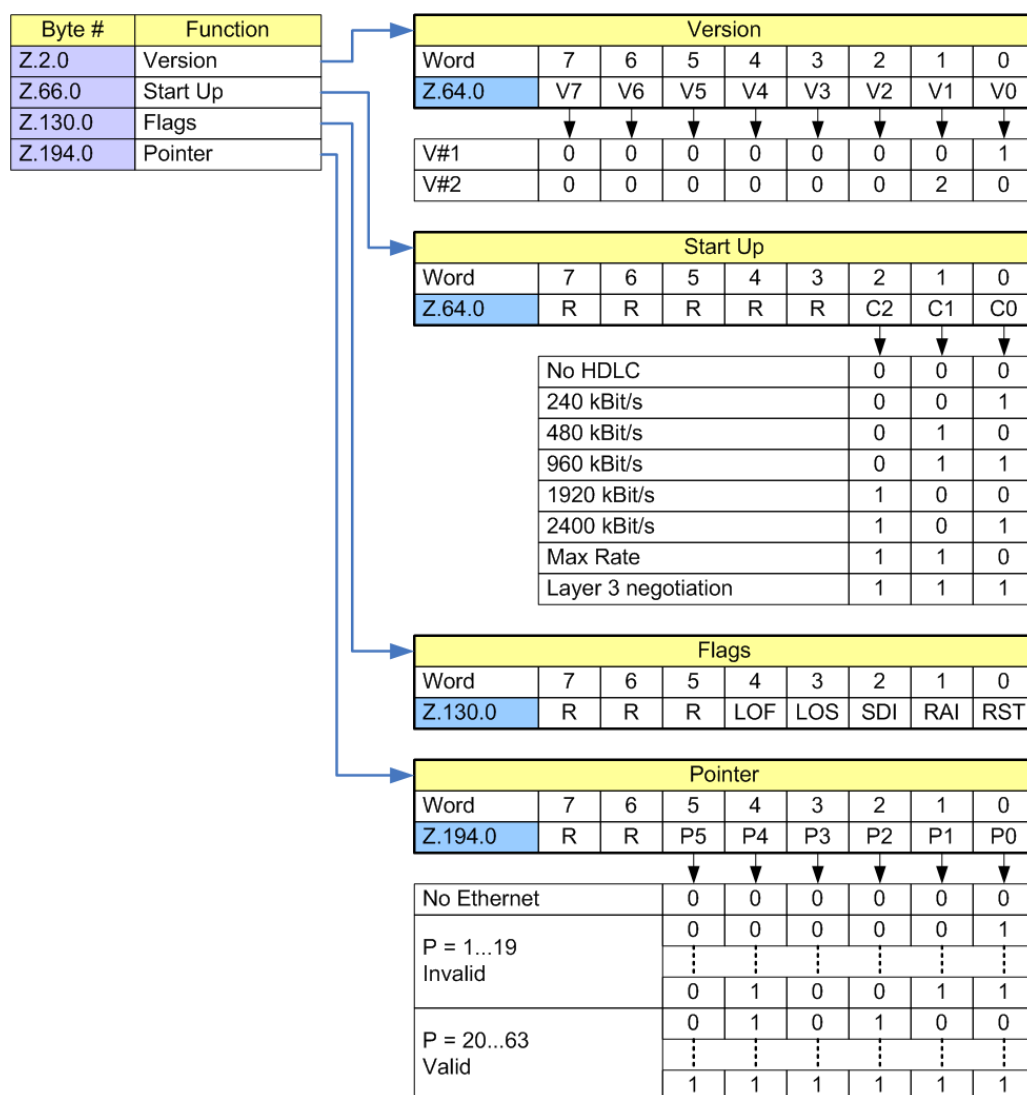


Fig. 7-51: CPRI L1 inband protocol

### Slow C&M Link

One option of transmitting C&M plane data is using subchannel 1 which bytes are reserved for the transmission of management data via HDLC.

Depending on the CPRI line rate the capacity of the slow C&M link varies.

### Fast C&M Link

Starting from a subchannel number P defined by the L1 inband parameter "Pointer" till subchannel index 63 the fast C&M channel can be used for transmitting C&M plane data using the ethernet protocol.

Depending on the CPRI line rate and the pointer index P, the capacity of the fast C&M link varies.

The following table defines the transmission speed of a CPRI connection for control and I/Q data:

**Table 7-3: Bit Rates**

| Line Rate R<br>[Mbit/s] | Netto Rate R <sub>n</sub><br>[Mbit/s] | I/Q Rate R <sub>iq</sub><br>[Mbit/s] | C&M Rate R <sub>c</sub><br>[Mbit/s] | Slow CM (max)<br>R <sub>scm</sub><br>[Mbit/s] | Fast CM (max)<br>R <sub>fc</sub><br>[Mbit/s] |
|-------------------------|---------------------------------------|--------------------------------------|-------------------------------------|-----------------------------------------------|----------------------------------------------|
| 614.4                   | 491.52                                | 460.8                                | 30.72                               | 480.0                                         | 21.12                                        |
| 1228.8                  | 983.04                                | 921.6                                | 61.44                               | 960.0                                         | 42.24                                        |
| 2457.6                  | 1966.08                               | 1843.2                               | 122.88                              | 1920.0                                        | 84.48                                        |
| 3072.0                  | 2457.60                               | 2304.0                               | 153.60                              | 2400.0                                        | 105.60                                       |
| 4915.2                  | 3932.16                               | 3686.4                               | 245.76                              | 3840.0                                        | 168.96                                       |
| 6144.0                  | 4915.20                               | 4608.0                               | 307.20                              | 4800.0                                        | 211.20                                       |
| 9830.4                  | 7864.32                               | 7372.8                               | 491.52                              | 7680.0                                        | 337.92                                       |

The bit rates are calculated as:

$$\text{Line Rate: } R = W \cdot 16 \cdot 3.84 \cdot \frac{10}{8}$$

$$\text{Netto Rate: } R_n = W \cdot 16 \cdot 3.84 = R \cdot \frac{8}{10}$$

$$\text{I/Q Rate: } R_{iq} = W \cdot 15 \cdot 3.84 = R \cdot \frac{3}{4}$$

$$\text{C\&M Rate } R_c = W \cdot 3.84 = R \cdot \frac{1}{20}$$

$$\text{Slow CM (max): } R_{scm} = W \cdot 4 \cdot \frac{3.84}{256} = \frac{R_c}{64} = \frac{R}{1280}$$

$$\text{Fast CM (max): } R_{fc} = W \cdot 4 \cdot 44 \cdot \frac{3.84}{256} = \frac{44}{64} \cdot R_c = \frac{44}{64} \cdot R \cdot \frac{1}{20}$$

$$\text{Fast CM (var): } R_{fcv} = W \cdot 4 \cdot (64 - P) \cdot \frac{3.84}{256} = \frac{64 - P}{64} \cdot R_c = \frac{64 - P}{64} \cdot R \cdot \frac{1}{20}$$

### Vendor Data

Starting from subchannel index 16 up to the start of the fast C&M channel defined by the pointer position P, vendor specific data can be transmitted.

### 7.2.3 Parameter Overview

Beside the main controls, like switching on the CPRI signal transmission, mode and save/recall of settings, the interface is controlled by various parameters, which are grouped by function:

| Parameter Group      | Purpose                                                                                                                                                 | Examples                                                                                                                                                                 |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hardware             | Hardware information on the R&S EX-IQ-BOX and the CPRI breakout board, the status of signal transmission and hardware link settings.                    | Hardware versions, CPRI mode, Reference Clock, timing measurements, line bit rate, input and outputs, GPIO settings.                                                     |
| L1 Analysis          | Link status information                                                                                                                                 | L1 inband protocol, status, local and remote alarms, layer events.                                                                                                       |
| 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, low level BER test and start conditions. |
| 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.<br>Fast C&M: Ethernet pointer, bit rate, host, port and login data.<br>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.                                                                             |
| Diagnostics          | Diagnostics on the link interfaces and Tx / Rx test possibilities.                                                                                      | Identifier, vendor, connector type, transceiver type, module temperature, warnings.<br>Rx alarms, SFP module alarms.                                                     |
| ARB                  | Table with information on the currently loaded waveform files.                                                                                          | File name, option, sample rate, samples, state and status display.                                                                                                       |
| Recorder             | Settings for recording an I/Q signal and storing the data in a waveform file.                                                                           | Data source, recording length, trigger, status display and file management                                                                                               |

### 7.2.4 Control Elements and Connectors

This section explains the control elements and connectors of the breakout board for CPRI applications, i.e. the R&S EX-IQ-BOX option EXBOX-B85. With the help of the following schematic view, the control elements and the connectors are briefly described, including references to the chapters with detailed information.

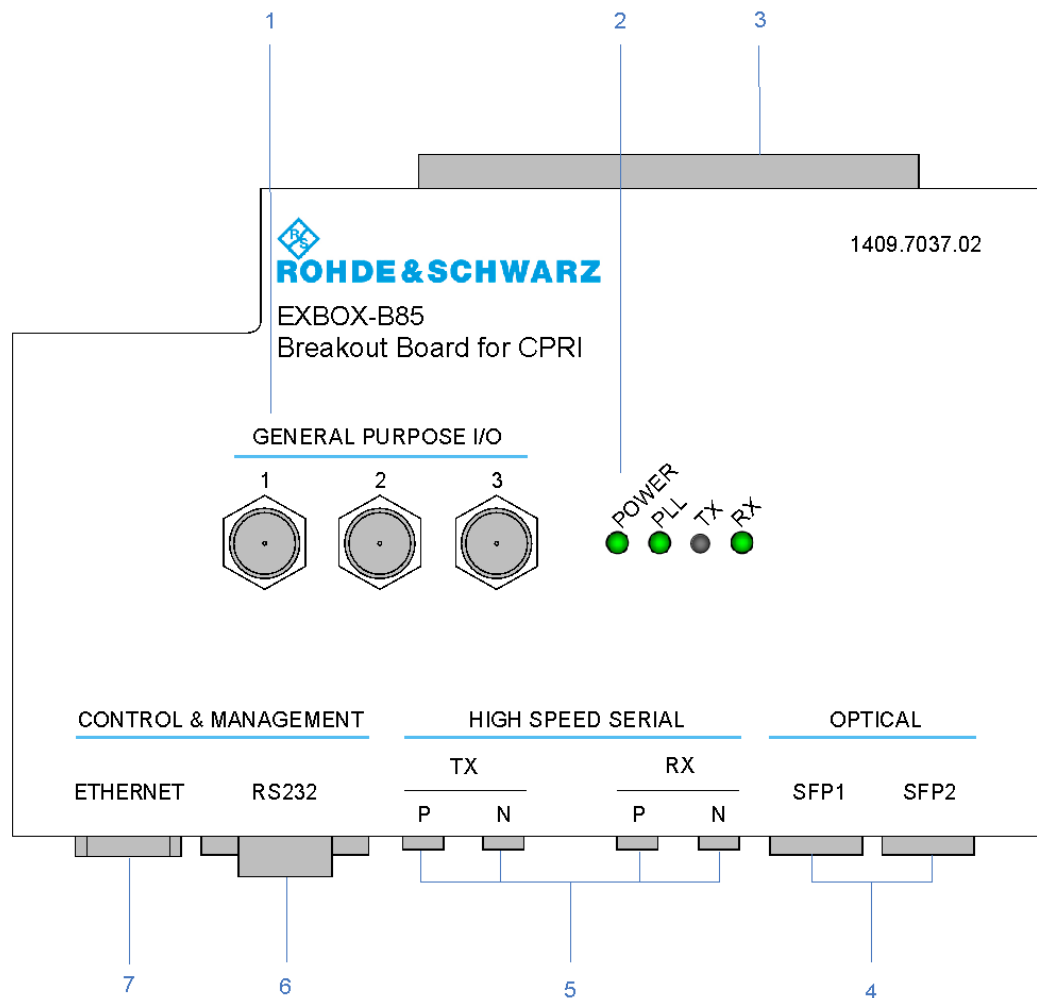


**Fig. 7-52: Schematic view of the CPRI breakout board, option R&S EXBOX-B85 (1409.7208.02)**

- 1 = GENERAL PURPOSE I/O - Marker signals input / output
- 2 = Status LEDs
- 3 = User Interface
- 4 = SFP1/SFP2 - Modules
- 5 = RX/TX P/N - High Speed Serial Connectors
- 6 = RS-232-C - Slow C&M Interface
- 7 = ETHERNET- Fast C&M Interface

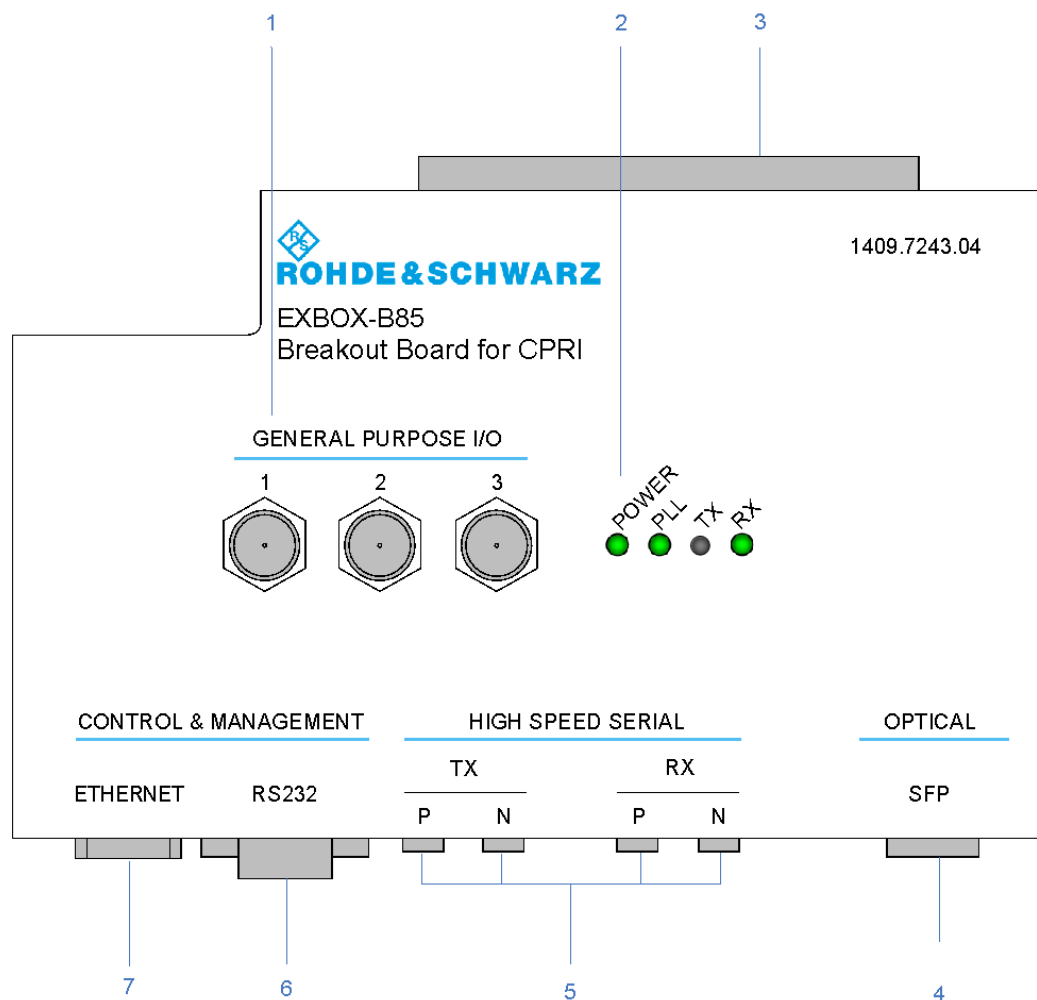


**Fig. 7-53: Schematic view of the CPRI breakout board, option R&S EXBOX-B85 (1409.7208.04)**

- 1 = GENERAL PURPOSE I/O - Marker signals input / output
- 2 = Status LEDs
- 3 = User Interface
- 4 = SFP - Module
- 5 = RX/TX P/N - High Speed Serial Connectors
- 6 = RS-232-C - Slow C&M Interface
- 7 = ETHERNET- Fast C&M Interface

#### 7.2.4.1 Top View

On the top of the case, the CPRI breakout board is equipped with three BNC connectors for general purpose signals, and four status LEDs which visually indicate the status of the CPRI communication link.



##### **GENERAL PURPOSE I/O - Marker signals input / output**

BNC connectors for GPIO (**General Purpose Input/Output**) to interface with the DUT, e.g. the RRH (Remote Radio Head) of a base station.

The interfaces act bidirectional, i.e. as input, to read signals from the DUT, or as output, to control the DUT. The connectors are configurable for user-specific purposes, e.g. marker or clock signals can be used as trigger signals.

The input and output voltage levels are LVTTTL.



### Status LEDs

The status LEDs Power, PLL (**P**hase **L**ocked **L**oop) and **TX** / **RX** visually indicate the status of the CPRI CL (**C**ommunication **L**ink ) as shown in the table.

|  | Power            | PLL      | Tx (downlink) / Rx (uplink)                                     |
|--|------------------|----------|-----------------------------------------------------------------|
|  | CL is active     | locked   | The CPRI frame is active, synchronized and DL and UL are active |
|  | -                | -        | The CPRI frame is synchronized                                  |
|  | -                | unlocked | not synchronized                                                |
|  | CL is not active | -        | -                                                               |

**Note:** The TX/RX LEDs refer either to the SFP or to the SMA connection, depending on the settings of the high speed serial switch in the hardware section.

#### 7.2.4.2 Rear View

The rear panel of the CPRI breakout board contains the user interface for connection with the R&S EX-IQ-BOX. Data transmission between the R&S devices is executed via this interface.

### User Interface

TYCO Z-Dok adapter board connector at the rear of the CPRI breakout board. At this interface, the breakout board is connected directly to the R&S EX-IQ-BOX by a 168 pin connector, type TYCO Z-Dok (56 differential pairs).

see [chapter 10.1.1, "Z-DOK-Adapter Board Connector"](#), on page 355

#### 7.2.4.3 Front View

On the front panel, the CPRI breakout board provides the interfaces to the DUT. The breakout board supports the optical CPRI link with two SFP modules, and contains a differential electrical interface, realized by four SMA connectors. In addition, the interfaces Ethernet and RS-232-C provide the input or output for C&M (**C**ontrol and **M**anagement) data. The connectors are labeled on the top on the case.



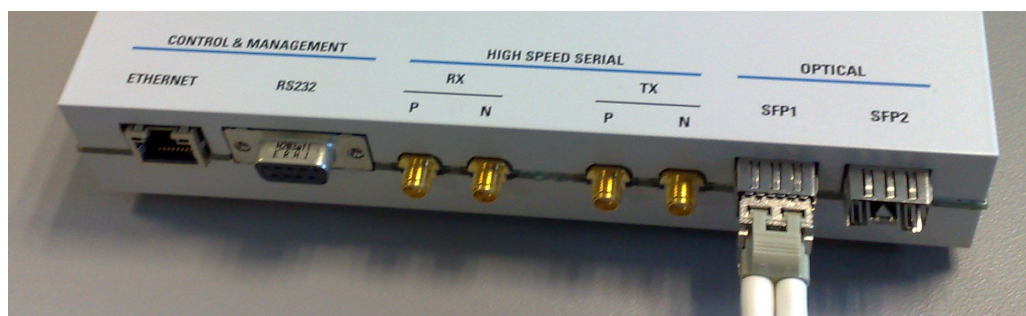


Fig. 7-54: Front panel view (1409.7208.02)



The CPRI breakout board (1409.7208.02) covers two SFP cages, that means sockets to insert an SFP module, while the variant (1409.7208.04) has a single SFP cage.

#### SFP1/SFP2 - Modules (1409.7208.02) / SFP -Module (1409.7208.04)

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 (1409.7208.02) covers two cages, that means sockets to insert an SFP module, that are standardized according to MSA (**M**ulti-**S**ource **A**greement of September the 14th, 2000), while the variant (1409.7208.04) has a single SFP cage.

SFP transceivers are available for several communications standards. They support high data rates in electro optical networks and also in fiber optic networks.

#### RX/TX P/N - High Speed Serial Connectors

Two SMA (**S**ub**M**iniature version **A**) connectors for differential data transmission. These SMA connectors are coaxial connectors with a differential impedance of 100 Ohm, and the logic type CML (**C**urrent **M**ode **L**ogic), a differential digital logic family for high speed data transmission. CML follows the to XAUI (**X** **A**ttachment **U**nit **I**nterface) standard, while X stands for 10 Gigabit.

**Note:** CPRI primarily uses the optical link via the SFP interfaces. Additionally, the breakout board delivers the signals at these interfaces, e.g., to execute a concurrent monitoring of the signals. See [chapter 7.2.7.5, "SMA Settings"](#), on page 158 to activate the interface and to set the corresponding parameters.

#### RS-232-C - Slow C&M Interface

RS-232-C interface for slow transmission of control and management data between the PC and the CPRI breakout board.

The interface supports bidirectional data transmission of C&M data from a customized software.

**Note:** For transmission of control signals by means of R&S DigiConf, use the USB connection between the control PC and the R&S EX-IQ-BOX.

Set the corresponding data source in the Slow C&M (HDLC) panel of R&S DigiConf according to your setup.

Select the bit rate Slow C&M (HDLC) panel of R&S DigiConf.

See also [chapter 7.2.10.1, "Slow C&M \(HDLC\)"](#), on page 193.

### ETHERNET - Fast C&M Interface

Ethernet IEEE 802.3u interface for fast transmission of control and management data between the controlling PC and the CPRI breakout board. The interface supports bidirectional data transmission of C&M data either from a customized software, or from R&S DigiConf.

The PC is connected to the CPRI breakout board with the aid of a commercial RJ-45 CAT7 crossover cable.

**Note:** Depending on the line rate and the position of the Ethernet pointer, the data transfer rate varies. For information in detail, refer to [chapter 7.2.10.2, "Fast C&M \(Ethernet\)"](#), on page 197.

## 7.2.5 Start with CPRI - Setup Example

This section describes a **RE (Radio Equipment)** test setup for testing **RRH (Remote Radio Head)** with the CPRI transmission protocol in downlink mode.

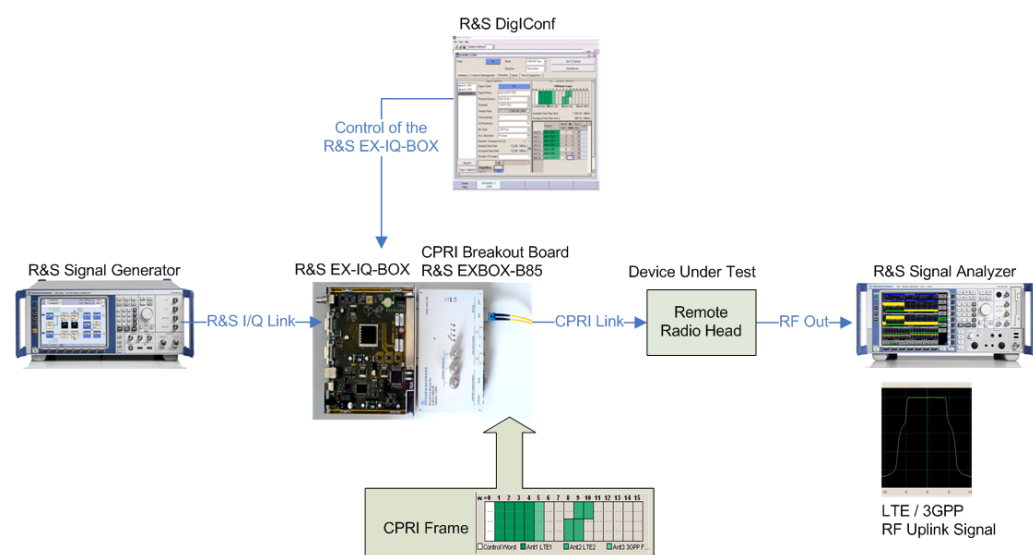


This description refers to an example of a CPRI application and shows the configuration of this test setup. Therefore it cannot be applied directly to other test setups. For information on how to set up your CPRI application refer to the characteristics of your DUT.

For connection in general refer to [chapter 4.5, "Connecting the R&S EX-IQ-BOX"](#), on page 42.

**Note:** You find a detailed explanation of the CPRI parameter settings under [chapter 7.2.6, "Main Configuration Dialog"](#), on page 150, and the following chapters.

### 7.2.5.1 Overview



The signal generator feeds the baseband signal digitally to the R&S EX-IQ-BOX, i.e. in the R&S specific I/Q format. The R&S EX-IQ-BOX converts the signal format into the CPRI transmission protocol with the aid of the breakout board. The CPRI link transmits the I/Q baseband signal and also control & management information to the RRH, i.e. the CPRI RE Device.

The RRH device extracts the baseband signal from the CPRI link and executes an I/Q modulation to a certain carrier frequency. The resulting RF signal is sent to the R&S signal analyzer, to perform various performance measurements.

#### 7.2.5.2 Used Devices and Cables

##### Devices:

- R&S EX-IQ-BOX V04 including external power supply
- R&S EXBOX-B85 CPRI breakout board
- an SFP module for the SFP1 cage of the CPRI breakout board
- an R&S signal generator, e.g. R&S SMU200A, or R&S AMU200A, equipped with digital baseband output, option B18
- an R&S signal analyzer, e.g. an R&S FSQ, or an equivalent instrument, which can demodulate 3GPP W-CDMA, LTE, WiMAX signals
- a DUT, e.g. a Remote Radio Head, with power supply

##### Cables:

- a LVDS cable SMU-Z7
- 2 BNC cables
- an RF cable
- an optical cable
- an USB cable

#### 7.2.5.3 Setup of the Devices

##### Cabling

1. Connect the R&S EX-IQ-BOX to the AC supply.  
The R&S EX-IQ-BOX is power supplied with an external power supply unit and a separate power cable.
2. Connect the CPRI breakout board to the R&S EX-IQ-BOX, i.e. at the Z-DOK user interface connector.  
The R&S EX-IQ-BOX powers the CPRI breakout board via the user interface.
3. Establish the connection between the BBOU of the R&S signal generator and the DIG IQ IN/OUT 1 of the R&S EX-IQ-BOX.  
Currently, the interface DIG IQ IN/OUT 1 is firmly set to input.

4. Connect the analyzer's REF OUT and the generator's REF IN, and connect the generator's REF OUT with REF IN of the R&S EX-IQ-BOX.
5. Connect the USB cable plug A to the PC, and plug B to the R&S EX-IQ-BOX (USB IN)
6. Plug the SFP module into the SFP cage on the breakout board
7. Connect the power supply to the RRH.
8. Establish the optical connection between the breakout board and the Rx/Tx input of the RRH.
9. Connect the RF output of the RRH, i.e. the RRH antenna with the analyzer's RF input.



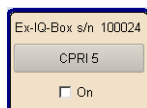
Make sure that you use adequate attenuation in order not to damage the analyzer, as the output power may exceed the analyzer's maximum power. You find the maximum input level of your analyzer in the data sheet.

### Setting the R&S Signal Generator

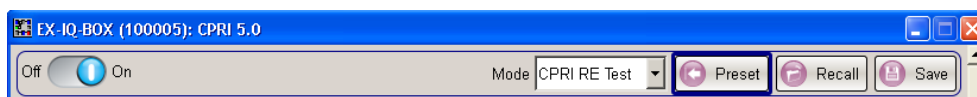
1. Preset the R&S signal generator.
2. Set reference frequency on externally, as the reference frequency is fed in from the signal analyzer.
3. Activate the test signal, e.g. 3GPP FDD in the respective baseband block.
4. Set the sample rate of the digital signal output according to the settings in R&S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

### Setting the CPRI Protocol

1. Start the R&S DigIConf software on the PC.  
R&S DigIConf recognizes connected R&S EX-IQ-BOX devices and indicates their IDs inside the block diagram symbol.



2. Press the CPRI standard button  
The main CPRI setting dialog opens.



3. Press the "Preset" button to start in a defined state.

**Hardware** | L1 Analysis | Downlink (Tx) | Uplink (Rx) | C & M | Vendor Data | Diagnostics | ARB | Recorder

**General Information**

FPGA CPRI Version: ---  
 FPGA Base Version: 00.16.006 Release  
 BOB FPGA Version: 01.02.001 Debug  
 EX-IQ-BOX Board Revision: 313  
 Breakout Board Revision: 00.00

**Link Settings**

CPRI Line Bit Rate: 2x (1228.8 Mbit/s)  
 Protocol Version: 1.0

**Input/Output**

Input/Output: Loopback (Internal)

**General Purpose Input Output**

| Direction | Signal          |
|-----------|-----------------|
| GPIO 1    | Off   No Signal |
| GPIO 2    | Off   No Signal |
| GPIO 3    | Off   No Signal |

**Reference Clock**

Source: REF IN  
 Clock Synthesis Locked: ☒  
 10MHz Reference Output Locked: ☒

**Timing Measurements**

Diagram: REC (1, 2, 3, 4) and RE (1, 2, 3, 4) with timing parameters T12, T14, T34, and TOffset.

T14: 0 ns  
 TOffset: 0 ns  
 R21: 0 ns

- Select the appropriate output port in the "Hardware" tab, and set the "CPRI Line Bit Rate", the SFP connection supports.
- Switch to the "Downlink (Rx)" tab, and select the *3GPP FDD* signal.

**Signal Definition**

Signal 1

Signal State: ☒ On

Signal Name: signal\_1

Physical Source: DIG IQ IN 1

Standard: 3GPP FDD

Sample Rate: 3.840 000 000 MHz

Oversampling: 1

Show Signal Details >>>

Number Of Groups: 1 | Auto

- Set "Oversampling" 2.

**Signal Definition**

Signal 1

Signal State: ☒ On

Signal Name: signal\_1

Physical Source: DIG IQ IN 1

Standard: 3GPP FDD

Sample Rate: 3.840 000 000 MHz

Oversampling: 2

Show Signal Details >>>

Number Of Groups: 1 | Auto

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

$$\text{Sample Rate}_{\text{EX-IQ-BOX}} \cdot \text{Oversampling} = \text{Sample Rate}_{\text{Signal Generator}}$$
$$3.84 \text{ MHz} \cdot 2 = 7.68 \text{ MHz}$$

Now the R&S EX-IQ-BOX is configured to communicate with the RRH via the CPRI transmission protocol in downlink mode.

8. Switch on "Signal State" and "State".
9. Press "Apply Setup" to assign the settings.

### Setting the RRH



#### DUT dependent settings

For the setup of the RRH, refer to the information on your instruments and the respective tools and utilities.

---

### Setting the R&S Signal Analyzer

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

#### 7.2.5.4 Measuring process

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

### Measuring the I/Q Signal

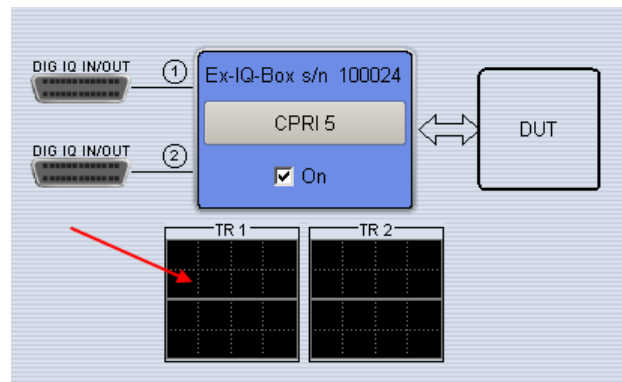


#### Check signal output

To see if the signal is properly transmitted, you can record and display the signal with the transient recorder.

---

1. To access the settings of a transient recorder, double click the smart graphic of the active R&S EX-IQ-BOX in the block diagram.



State: ☒ On

Data Source: DIG IQ IN 1

Display Settings:

Display Type: Power Spectrum

Acquisition Settings:

Acquisition Length: 1024

2. To capture the digital I/Q signal, set:

- a) "Data Source": *Dig IQ IN 1*
- b) "Display Type": *Power Spectrum*
- c) "Acquisition Length": *1024*

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

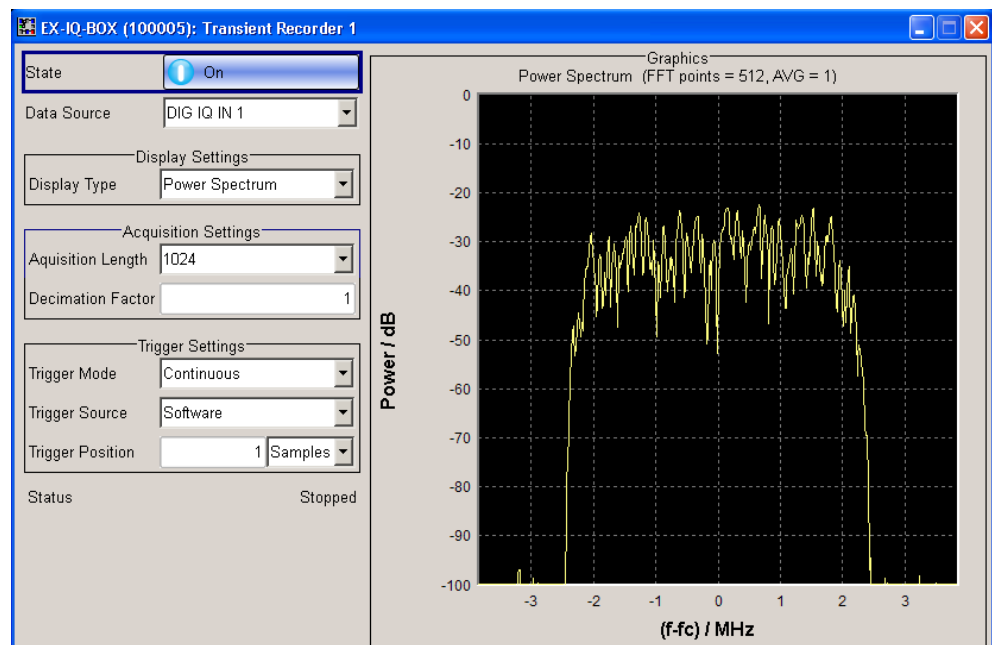
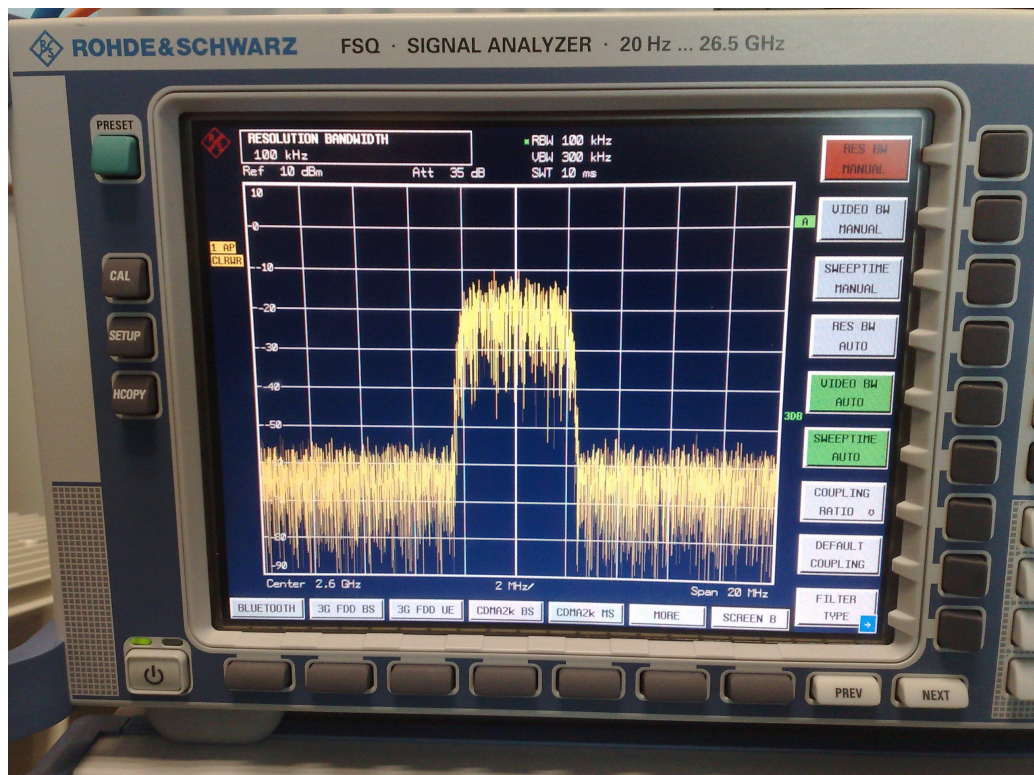


**Fig. 7-55: Recording the outgoing digital standard signal 3GPP FDD**



### Measuring the RF Output Signal of the RRH

The RRH sends the RF signal to the R&S spectrum analyzer.



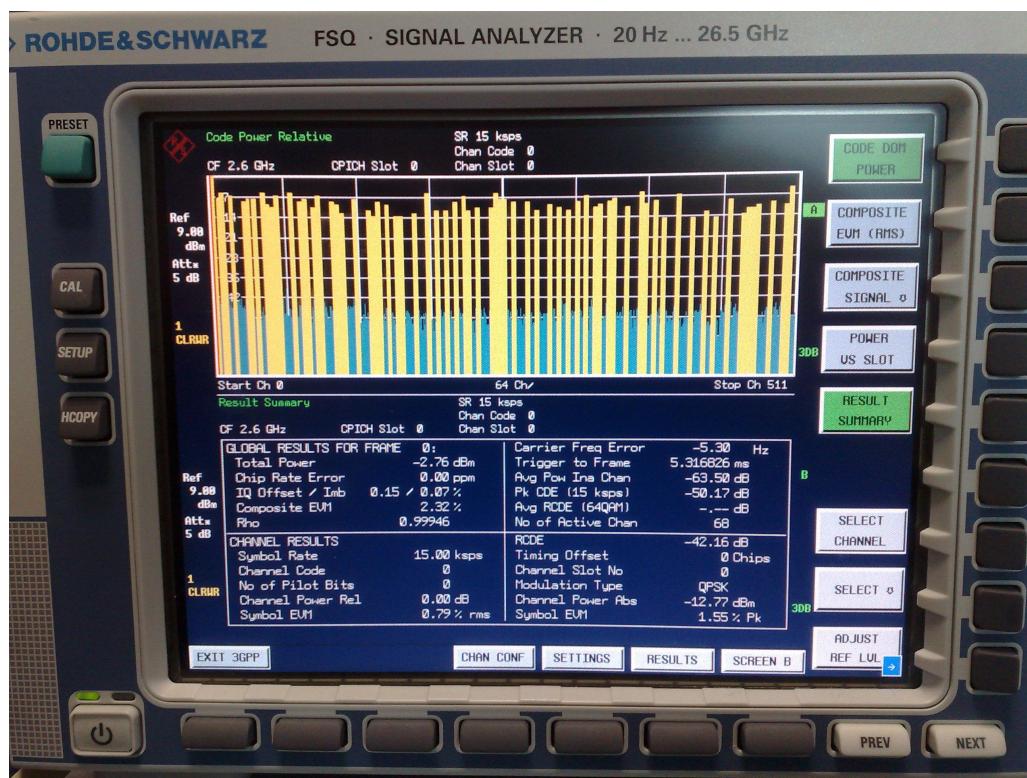
The analyzer displays power spectrum of the 3GPP FDD signal.

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

## 7.2.6 Main Configuration Dialog

Besides the settings that are relevant for CPRI protocol settings, the CPRI configuration dialog comprises the common main controls as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading previously defined settings. The main controls are fixed and always indicated, independently from the sselected tab, and from the active transmission protocol. A detailed description of these general functions is given in [chapter 7.2.6.1, "Main Controls"](#), on page 152.

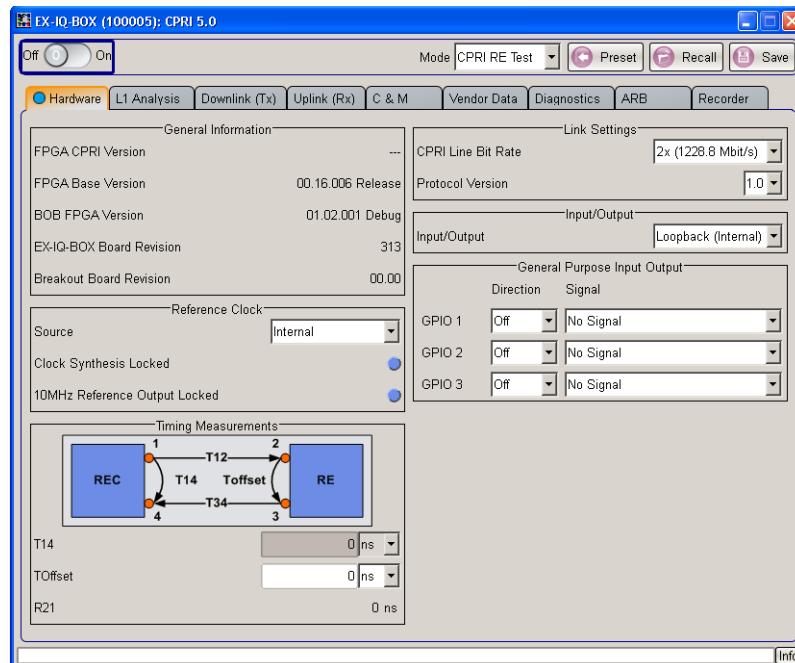


**Fig. 7-56: CPRI main configuration dialog (1409.7208.04)**

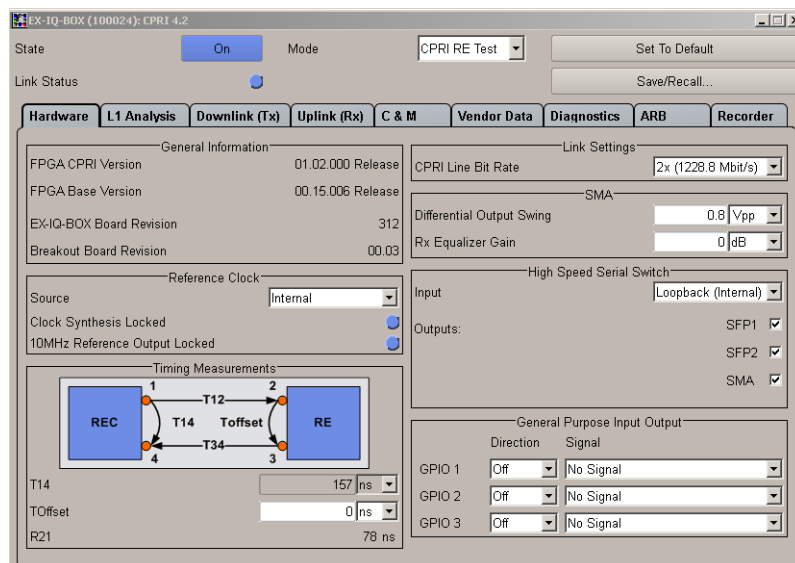


**Fig. 7-57: CPRI main configuration dialog (1409.7208.02)**

Grouped by functionality the configuration dialog also comprises tabs for Hardware settings, for Downlink and Uplink configuration, for Control & Management parameters and Test & Diagnostics. For the description in detail, refer to [chapter 7.2.7, "Hardware"](#), on page 153, [chapter 7.2.8, "L1 Analysis"](#), on page 163, [chapter 7.2.10, "Control & Management"](#), on page 193, [chapter 7.2.9, "Downlink and Uplink"](#), on page 170, and [chapter 7.2.12, "Diagnostics"](#), on page 203.

Additionally, you find a tab for ARB settings in the dialog, that is used if the R&S EX-IQ-BOX is equipped with an option for waveform memory. Find the respective information on ARB functions in [chapter 7.2.13, "ARB"](#), on page 205.

Finally, you find the "Recorder" tab, see [chapter 7.2.14, "Recorder"](#), on page 207 for description. If the R&S EX-IQ-BOX is equipped with the appropriate option for waveform recording, you can record the I/Q signals.

### 7.2.6.1 Main Controls

Besides the settings that are relevant for the CPRI transmission protocol, the CPRI configuration dialog contains the common main controls as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading settings. The main controls are permanently indicated, independently of the active tab and interface standard.

#### State

Activate or deactivate the CPRI standard. The corresponding FPGA (Field Programmable Array) is loaded automatically into the R&S EX-IQ-BOX.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:STATe` on page 316

#### Mode

Select a CPRI test scenario. In RE test mode, the R&S EX-IQ-BOX is working as a base-band 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 (Radio Equipment) test mode.

"CPRI REC Test" Select REC (Radio Equipment Control) test mode.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:MODE` on page 315

#### Link Status

Indicates whether the CPRI link is established or any transmission error has occurred.

This indicator includes all verified transmission parameters.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:ALArM?` on page 298

#### Set To Default / Preset

Set all parameters to default values. Refer to [chapter A.3.2, "CPRI Default Settings"](#), on page 372, containing an overview of the most important CPRI default settings.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:PRESet` on page 315

#### Save / Recall

Accesses the dialogs for storing or loading CPRI settings. The dialogs also provide access to the file manager.

CPRI settings are stored as files with the predefined file extension \*.cpri. The file name and the directory user-selectable.

#### "Recall CPRI Settings"

Open the file select window for loading a previously saved CPRI configuration. Load the configuration of the selected (highlighted) file by pressing the "Select" button.

#### "Save CPRI Settings"

Opens the file select window for storing the CPRI settings. Determine the file name and save with the "Save" button.

This procedure stores the complete CPRI settings of the current configuration.

"File Manager" Calls the "File Manager". \*.cpri is preset in the "File Type" entry field. The file manager is used to copy, delete, and rename files and to create new directories.

Remote command:

Settings files catalog: [:SOURCE<hw>]:EBOX:CPRI:SETTing:CATalog?  
on page 322

Recall file: [:SOURCE<hw>]:EBOX:CPRI:SETTing:LOAD on page 323

Save file: [:SOURCE<hw>]:EBOX:CPRI:SETTing:STORe on page 323

## 7.2.7 Hardware

The **Hardware** tab contains all settings of CPRI hardware parameters, including the assignment to the connected interfaces, special settings of the link, status information, reference clock settings, and general information on the CPRI option R&S EXBOX-B85.

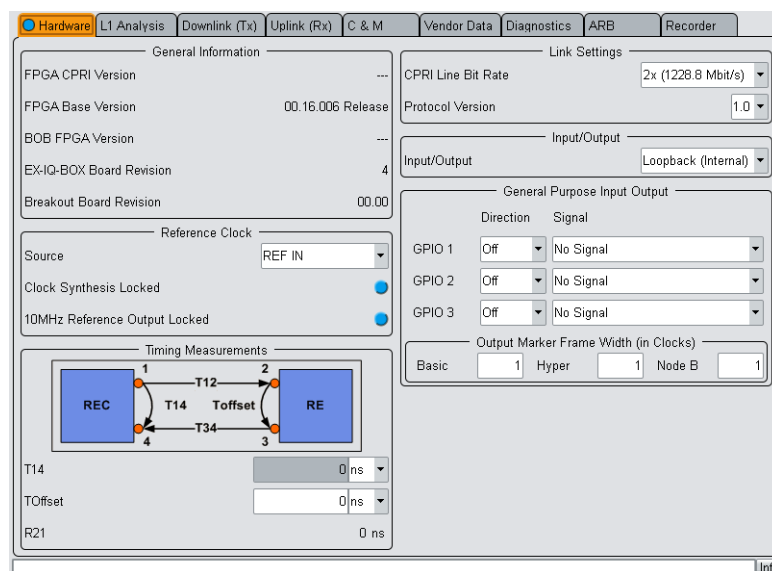


Fig. 7-58: CPRI hardware dialog (1409.7208.04)

The screenshot shows the 'Hardware' tab of the CPRI hardware dialog. It is divided into several sections:

- General Information:** Fields for FPGA CPRI Version, FPGA Base Version, EX-IQ-BOX Board Revision, and Breakout Board Revision.
- Link Settings:** CPRI Line Bit Rate set to 2x (1228.8 Mbit/s).
- SMA:** Differential Output Swing set to 0.8 Vpp and Rx Equalizer Gain set to 0 dB.
- Reference Clock:** Source set to REF IN, with checkboxes for Clock Synthesis Locked and 10MHz Reference Output Locked.
- High Speed Serial Switch:** Input set to SFP1, and Outputs for SFP1, SFP2, and SMA.
- Timing Measurements:** A diagram showing a loop between REC and RE blocks with timing points 1, 2, 3, and 4. Measurements T12, T14, T34, and TOffset are indicated. Below the diagram, input fields for T14, TOffset, and R21 are shown, all set to 0 ns.
- General Purpose Input Output:** A table for GPIO 1, 2, and 3, each with Direction (Off) and Signal (No Signal) settings.

Fig. 7-59: CPRI hardware dialog (1409.7208.02)

### 7.2.7.1 General Information

Section "General Information" indicates the board revisions, and the FPGA versions of the R&S EX-IQ-BOX and of the breakout board.

#### FPGA CPRI Version

Indicates the version of the FPGA (Field Programmable Gate Array) CPRI design.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:FCVersion?` on page 300

#### FPGA Base Version

The version of the FPGA (Field Programmable Gate Array) basic design.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:FBVersion?` on page 300

#### BOB FPGA Version

The version of the FPGA (Field Programmable Gate Array) design inside the break out board.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:FBVersion?` on page 300

#### R&S EX-IQ-BOX Board Revision

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

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:EBRevision?` on page 300

**Breakout Board Revision**

Shows the revision number of the connected breakout board.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:BBRevision?` on page 298

**7.2.7.2 Reference Clock**

Section "Reference Clock" provides the selection of the clock source for the CPRI communication link. Depending on the CPRI test mode, the possible sources for the reference signal differ.

**Source**

Selects the source of the reference signal. In test mode CPRI RE, the R&S EX-IQ-BOX is synchronized either external or internally. Test mode CPRI REC uses the reference clock embedded in the CPRI link.

|                  |                                                                                                                                                                                                                                                                   |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "REF IN"         | CPRI RE test setup with a connected R&S instrument.<br>The R&S EX-IQ-BOX synchronizes the CPRI communication link with the reference signal provided by an R&S instrument. The 10 MHz signal is fed to the BNC connector REF IN on the back of the R&S EX-IQ-BOX. |
| "Internal"       | CPRI RE test setup, if the R&S EX-IQ-BOX is working stand-alone.<br>The R&S EX-IQ-BOX uses its internal reference oscillator for synchronization.                                                                                                                 |
| "Clock Recovery" | CPRI REC test mode.<br>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.                                                                            |

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:RCLock:SOURce` on page 308

**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 command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:RCLock:CSLocked?` on page 307

**Clock Recovery Locked**

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

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:RCLock:CRLocked?` on page 307

**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 command:

[ :SOURce<hw> ] :EBOX:CPRI:HW:RCLock:ROLocked? on page 308

### 7.2.7.3 Timing Measurements

The graph in the GUI shows the relation between downlink and uplink frame timing for the single-hop configuration.

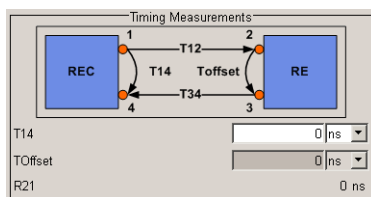


**Fig. 7-60: CPRI timing measurements > downlink <-> uplink frame timing**

T12 = delay of downlink signal from the output point of REC (R1) to the input point of RE (R2)

T34 = delay of uplink signal from the output point of RE (R3) to the input point of REC (R4)

TOffset = frame offset between the input signal at R2 and the output signal at R3

T14 = frame timing difference between the output signal at R1 and the input signal at R4

While TOffset is the internal processing delay inside the RE, T12 and T34 are the propagation delays over the physical media.

Depending on the CPRI mode, CPRI RE test or CPRI REC test, either T14 or TOffset is calculated, while the other parameter can be input if the internal delay of the DUT is known.

To calculate the cable delay R21, subtract T14 and TOffset and divide the result by 2.

$$R21 = (T14 - TOffset) / 2$$

The following graph shows an overview of the different sources of delay.

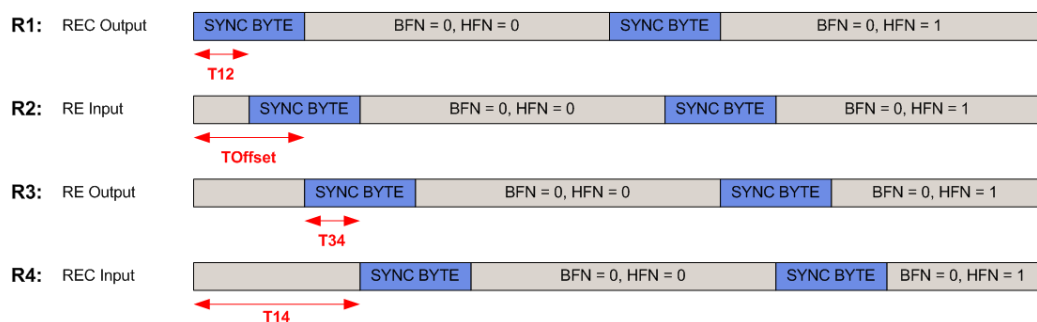


**Fig. 7-61: CPRI timing measurements > delays**



**T14**

Sets (REC Test) or displays (RE Test) the frame timing difference between the output signal at R1 and the input signal at R4.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:HW:T14T on page 311

**TOffset**

Sets (RE Test) or displays (REC Test) the frame offset between the input signal at R2 and the output signal at R3.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:HW:TOFFset on page 311

**R21**

Indicates the cable delay, calculated automatically by the given timing parameters.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:HW:R21T? on page 307

**7.2.7.4 Link Settings**

In section "Link Settings" you can set the line bit rate for the communication link.

**CPRI Line Bit Rate**

Select the line bit rate for the communication link. The line bit rate defines the total number of bits transferred per second over the CPRI communication link, including control and I/Q data, and 8B10B line coding.

**Note:**

Difference between the R&S EXBOX-B85 breakout board versions

- 1409.7208.02 supports 2x, 4x and 5x line bit rates.
- 1409.7208.04 covers all line speeds.

See the overview in [table 7-4](#).

**Table 7-4: Supported line bit rates**

| Line bit rate         | R&S EXBOX-B85 |              |
|-----------------------|---------------|--------------|
|                       | 1409.7208.04  | 1409.7208.02 |
| "1x (614.4 Mbit/s)"   | x             | -            |
| "2x (1228.8 Mbit/s)"  | x             | x            |
| "4x (2457.6 Mbit/s)"  | x             | x            |
| "5x (3072.0 Mbit/s)"  | x             | x            |
| "8x (4915.2 Mbit/s)"  | x             | -            |
| "10x (6144.0 Mbit/s)" | x             | -            |
| "16x 9830.4 Mbit/s)"  | x             | -            |

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:HW:LBRate on page 305



**Protocol Version**

Selects the CPRI protocol version.

For the higher line rates the CPRI standard introduces a scrambling functionality to increase the signals stability. The scrambling functionality is enabled if protocol version 2.0 is selected and a non zero seed is defined.

Available protocol versions are:

- "1.0"
- "2.0"

| Line bit rate [Mbit/s] | Scrambling support | Highest available protocol version number                  |
|------------------------|--------------------|------------------------------------------------------------|
| 1x (614.4)             | Not supported      | 1.0                                                        |
| 2x (1228.8)            | Not supported      | 1.0                                                        |
| 4x (2457.6)            | Not supported      | 1.0                                                        |
| 5x (3072.0)            | Not supported      | 1.0                                                        |
| 8x (4915.2)            | Recommended        | 1.0: scrambling not supported<br>2.0: scrambling supported |
| 10x (6144.0)           | Recommended        | 1.0: scrambling not supported<br>2.0: scrambling supported |
| 16x (9830.4)           | Recommended        | 1.0: scrambling not supported<br>2.0: scrambling supported |

**Note:** When working with higher line speeds, it is strongly recommended that you use the CPRI protocol version which supports scrambling.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:HW:PROTOCOL](#) on page 306

**Scrambling Seed**

Defines the scrambling seed.

The initial condition of the side stream scrambler is defined by a 31 bit vector. If protocol version 2.0 is chosen, a non zero seed has to be defined in order to activate the scrambling functionality.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:HW:SEED:SCRAMbling](#) on page 309

**Received Seed**

Indicates the scrambling seed used by the connected transmitter.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:HW:SEED:RECEIVED?](#) on page 309

**7.2.7.5 SMA Settings**

This section of the "Hardware" tab contains the electrical parameters of the SMA interface.

**Differential Output Swing**

Determine the differential output voltage swing of the CML (Current Mode Logic) transmitter.

**Note:**

Difference between the R&S EXBOX-B85 breakout board versions

- 1409.7208.02 supports variable differential output swing.
- 1409.7208.04 has a fixed output level of 0.8 Vpp.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:SMA:DOSWing` on page 310

**Rx Equalizer Gain**

Set the input gain of the equalizer. This equalizer is an active high-pass filter, that equalizes the low-pass behavior of the transmission medium, such as for example the FR4 backplane. The gain, expressed in dB, relates to the frequency of 2 GHz.

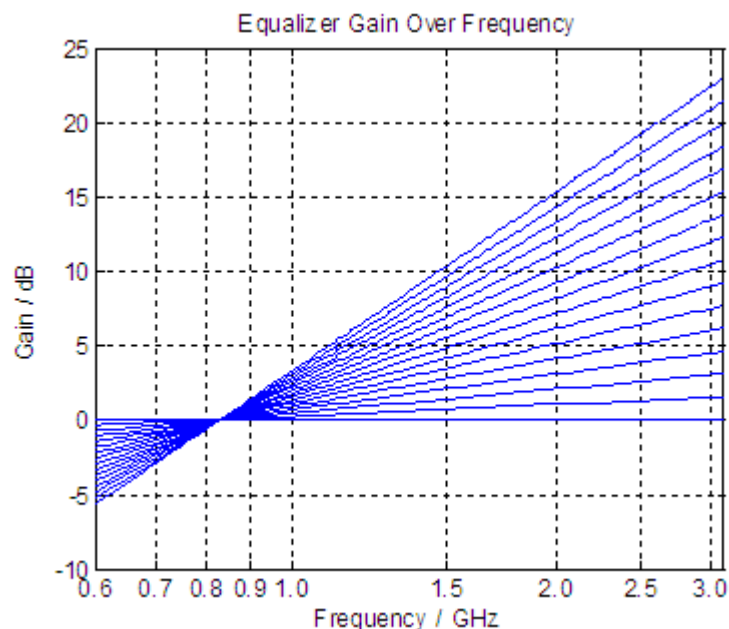


*Fig. 7-62: CPRI - equalizer gain over frequency*

**Note:**

Difference between the R&S EXBOX-B85 breakout board versions

- 1409.7208.02 supports a variable equalizer gain.
- 1409.7208.04 implements a dynamic automated adjustment.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:HW:SMA:RXEGain` on page 310

**7.2.7.6 High Speed Serial Switch**

In this section, you can assign input or output to the connected interfaces.



Note that CPRI recommends to use optical transceivers that follow the High Speed Serial Link standards. CPRI mainly transfers the signal via the optical connection.  
Use the electrical connection at the SMA connectors for debugging routines.

Basically the R&S EX-IQ-BOX receives a CPRI signal via one of the optical interfaces SFP1, or SFP2. SMA is used, primarily, to the diagnosis.

For test purposes, the signal can be looped back internally. Then all the signal processing, as well as the CPRI transmitter and receivers operate normally without having an external device to be connected.



Difference between the R&S EXBOX-B85 breakout board versions

- 1409.7208.02 supports multiple outputs.
- 1409.7208.04 is limited to a corresponding I/O interface.

### Input (1409.7208.02) ; Input/Output (1409.7208.04)

Determines the interface for signal input, and for EXBOX-B85 version 1409.7208.04, also for the signal output.

Note that only one interface can be active at the same time.

If you are working with a CPRI breakout board 1409.7208.02, the R&S EX-IQ-BOX can receive a signal via one of the optical interfaces SFP1 or SFP2. The EXBOX-B85 breakout board 1409.7208.04, however, has only one interface.

"SFP1/2 (1409.7208.02)"; "SFP (1409.7208.04)"

Selects the SFP (**S**mall **F**orm-factor **P**luggable) interface for connection with the DUT.

"SMA" Selects the SMA (**S**ub**M**iniatur version **A**) interface.

"Loopback internal"  
Assigns the internal loopback.

"None (1409.7208.02)"  
Deactivates the input, if no connection is established.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:HW:HSSS:INPut on page 303

### Outputs

Determine the interface for signal output, that means align the transmitter type of the DUT.

For the signal output, more than one interface can be activated simultaneously, for example SFP1 for signal transmission to the DUT, and SMA for the signal monitoring.

"SFP1 / 2" Select the respective SFP (**S**mall **F**orm-factor **P**luggable) interface, at which the R&S EX-IQ-BOX is connected to the DUT for sending the signal.

"SMA" Select the SMA (**Sub**Miniatur version **A**) interface, if the R&S EX-IQ-BOX is sending the signal to the DUT on this transmission line.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:HW:HSSS:OUTPut:SFP1 [ :STATe ] on page 304

[ :SOURce<hw> ] :EBOX:CPRI:HW:HSSS:OUTPut:SFP2 [ :STATe ] on page 304

[ :SOURce<hw> ] :EBOX:CPRI:HW:HSSS:OUTPut:SMA [ :STATe ] on page 305

### 7.2.7.7 Input/Output

In this section, you can select the physical I/O interface.



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.

Difference between the R&S EXBOX-B85 breakout board versions

- 1409.7208.02 supports multiple outputs.
- 1409.7208.04 is limited to a corresponding I/O interface.

#### Input (1409.7208.02) ; Input/Output (1409.7208.04)

Determines the interface for signal input, and for EXBOX-B85 version 1409.7208.04, also for the signal output.

Note that only one interface can be active at the same time.

If you are working with a CPRI breakout board 1409.7208.02, the R&S EX-IQ-BOX can receive a signal via one of the optical interfaces SFP1 or SFP2. The EXBOX-B85 breakout board 1409.7208.04, however, has only one interface.

"SFP1/2 (1409.7208.02)"; "SFP (1409.7208.04)"

Selects the SFP (**S**mall **F**orm-factor **P**luggable) interface for connection with the DUT.

"SMA" Selects the SMA (**Sub**Miniatur version **A**) interface.

"Loopback internal"

Assigns the internal loopback.

"None (1409.7208.02)"

Deactivates the input, if no connection is established.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:HW:HSSS:INPut on page 303

### 7.2.7.8 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 for example 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 transmission direction at the connected GPIO interfaces. You can individually activate each of the three interfaces separately. Find additional information on the connectors in [chapter 7.2.4.1, "Top View"](#), on page 140, and [chapter 10.3.3.1, "Connector Locations - CPRI Breakout Board"](#), on page 367.

|          |                                                                                                                                              |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------|
| "OFF"    | Deactivate the GPIO interface.                                                                                                               |
| "Output" | Select the respective GPIO interface as output, that means 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, for example for trigger purposes. |

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:HW:GPIO<ch>:DIRection on page 301

### Signal GPIO 1-3

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

|                            |                                                                                                                                                                               |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "Constant Low/High"        | GPIO output<br>Set the control signal to constant level high or low.                                                                                                          |
| "DL/UL Basic Frame"        | GPIO output<br>Take the information in the CPRI basic frame for control. According to the WCDMA clock rate, the CPRI protocol synchronizes its basic frame with 3.84 MHz.     |
| "DL/UL Hyper Frame"        | GPIO output<br>Use the CPRI hyper frame clock for control. The hyper frame clock rate is 15 kHz.                                                                              |
| "DL/UL Node B Frame"       | GPIO output<br>Use the information in the CPRI Node B frame for control. CPRI updates the B node every 10 ms, that means you can control the DUT with a clock rate of 100 Hz. |
| "Timing Measurement Clock" | GPIO output<br>Use the CPRI signal processing clock, for example 61.44 MHz at 2x line rate. This clock is used for timing measurements like response time, latency, etc..     |

**"10 MHz Reference Clock"**

GPIO output

Use the CPRI signal processing clock, for example 61.44 MHz at 2x line rate. This clock is used for timing measurements like response time, latency, etc..

**"External Trigger 1/2/3"**

GPIO input

In input mode, each of the three GPIO ports provide also an external trigger signal.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:HW:GPIO<ch>:SIGnal](#) on page 302**7.2.7.9 Output Marker Frame Width (in Clocks)**

Section "Output Marker Frame Width (in Clocks)" contains additional settings for the frame width of the selected GPIO control signal.

**Basic ; Hyper ; Node B**

Enables you to increase the frame width of the corresponding output marker signal.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:HW:GPIO:MFWidth:BFRame](#) on page 300[\[:SOURce<hw>\]:EBOX:CPRI:HW:GPIO:MFWidth:HFRame](#) on page 301[\[:SOURce<hw>\]:EBOX:CPRI:HW:GPIO:MFWidth:NFRame](#) on page 301**7.2.8 L1 Analysis**

The **L1 Analysis** tab contains information on the CPRI link status. By means of an LED display, R&S DigIConf indicates alarm and error messages as e.g LOF or LOS. The LEDs are blue, if the transmission is working properly. Red LEDs indicate transmission errors.

The screenshot shows the 'L1 Analysis' tab selected in the 'Protocol Settings' window. The window has a top bar with tabs: Hardware, L1 Analysis, Downlink (Tx), Uplink (Rx), C & M, Vendor Data, Diagnostics, ARB, and Recorder. The 'L1 Analysis' tab is active and contains several sections:

- L1 Inband Protocol:**
  - Protocol Version: Z 2.0
  - HDLC Rate: Z 66.0, No HDLC
  - Section Z 130.0:
    - LOF (Loss of Frame): ☒
    - LOS (Loss of Signal): ☒
    - RAI (Remote Alarm Indication): ☒
    - SDI (SAP Defect Indication): ☒
    - Reset: ☒
  - Section Z 194.0:
    - Ethernet Pointer: 20
  - Events:
    - SDI: ☐ On
    - RE Reset: ☐ On
- Link Status:**
  - Link Status: ☒
  - Core Mode: ☐
  - CPRI Mode: ☐
  - Protocol version setup: Master
- Local Alarms:**
  - LOF: ☒
  - LOS: ☒
  - RAI: ☒
- Remote Alarms:**
  - LOF: ☒
  - LOS: ☒
  - RAI: ☒
  - SDI: ☒
  - Reset: ☒

An 'Info' button is located at the bottom right of the dialog.

Fig. 7-63: CPRI L1 Analysis dialog

#### 7.2.8.1 L1 Inband Protocol

The L1 inband protocol is transmitted in subchannel 2 of a hyperframe protocol set. It uses the control words with index 2, 66, 130 and 194.

The data transmitted is related to the link and is directly transported by the physical layer. This information is required, for example for system start up, layer 1 link maintenance and the transfer of time critical information that has a direct time relationship to layer 1 user data.

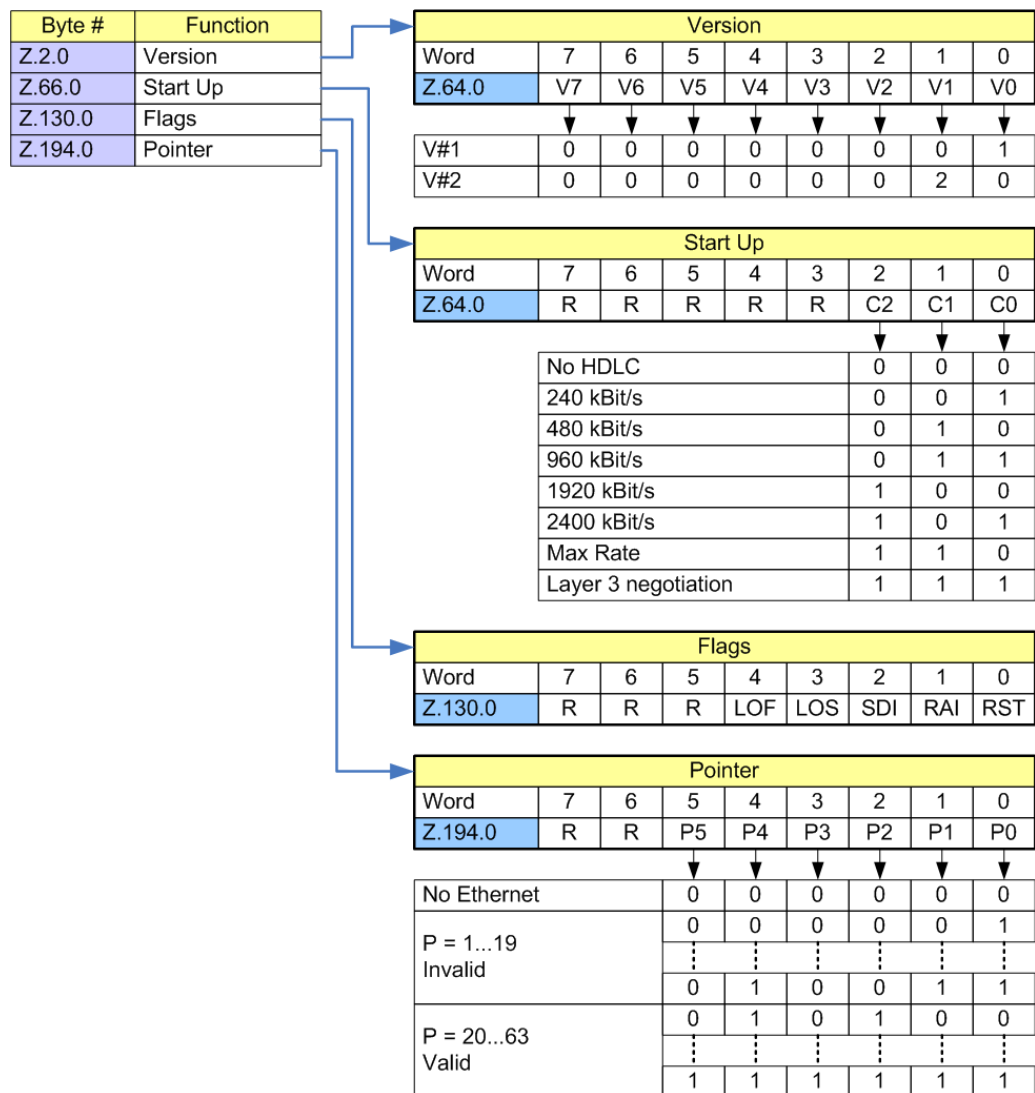


Fig. 7-64: CPRI L1 inband protocol

**Protocol Version**

Indicates the CPRI protocol version.

According to the protocol version, the link supports data scrambling or descrambling, as shown below.

**Note:** It is strongly recommended that you use scrambling at higher line bit rates.

| Line rate [Mbit/s] | Scrambling support | Highest available protocol version number |
|--------------------|--------------------|-------------------------------------------|
| 1x (614.4)         | not supported      | 1                                         |
| 2x (1228.8)        | not supported      | 1                                         |
| 4x (2457.6)        | not supported      | 1                                         |
| 5x (3072.0)        | not supported      | 1                                         |



| Line rate [Mbit/s] | Scrambling support | Highest available protocol version number              |
|--------------------|--------------------|--------------------------------------------------------|
| 8x (4915.2)        | recommended        | 1: scrambling not supported<br>2: scrambling supported |
| 10x (6144.0)       | recommended        | 1: scrambling not supported<br>2: scrambling supported |
| 16x(9830.4)        | recommended        | 1: scrambling not supported<br>2: scrambling supported |

Remote command:

[ :SOURce<hw>] :EBOX:CPRI:L1:VERSion? on page 315

### HDLC Rate

Indicates the Slow C&M HDLC bit rate during link setup.

You can determine this parameter in the C&M tab, which is embedded in the CPRI protocol. RE and REC then read the value of the other, and agree on the smallest.

Supported values depend on the line speed:

| Bit rate [Mbit/s] |         |     |     |     |      |      |      |
|-------------------|---------|-----|-----|-----|------|------|------|
| 1x (614.4)        | no HDLC | 240 | 480 |     |      |      |      |
| 2x (1228.8)       | no HDLC | 240 | 480 | 960 |      |      |      |
| 4x (2457.6)       | no HDL  | 240 | 480 | 960 | 1920 |      |      |
| 5x (3072.0)       | no HDLC | 240 | 480 | 960 | 1920 | 2400 |      |
| 8x (4915.2)       | no HDLC | 240 | 480 | 960 | 1920 | 2400 | 3840 |
| 10x (6144.0)      | no HDLC | 240 | 480 | 960 | 1920 | 2400 | 4800 |
| 16x (9830.4)      | no HDLC | 240 | 480 | 960 | 1920 | 2400 | 7680 |

Remote command:

[ :SOURce<hw>] :EBOX:CPRI:L1:HDLC:BRATe? on page 312

### Flags

Shows various information about the link status, transmitted in control word 130.

The following flags are defined:

|       |                                                                                                                                      |
|-------|--------------------------------------------------------------------------------------------------------------------------------------|
| "LOS" | The LOS ( <b>L</b> oss <b>o</b> f <b>S</b> ignal) LED indicates a loss of signal.                                                    |
| "LOF" | LOF ( <b>L</b> oss <b>o</b> f <b>F</b> rame) indicates, when the received data lost the synchronization, that is loss of frame.      |
| "RAI" | RAI ( <b>R</b> emote <b>A</b> larm <b>I</b> ndication) indicates, if any remote part of the end-to-end link has failed.              |
| "SDI" | SDI ( <b>S</b> ervice <b>A</b> ccess <b>P</b> oint <b>D</b> efect <b>I</b> ndication) indicates, that the data communication failed. |

"Reset" Indicates that 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 command:

[ :SOURce<hw> ] :EBOX:CPRI:TEST:RX:LOS? on page 326

[ :SOURce<hw> ] :EBOX:CPRI:TEST:RX:LOF? on page 325

[ :SOURce<hw> ] :EBOX:CPRI:TEST:RX:RAI? on page 326

[ :SOURce<hw> ] :EBOX:CPRI:TEST:RX:SDI? on page 327

[ :SOURce<hw> ] :EBOX:CPRI:TEST:RX:RESet? on page 326

### Ethernet Pointer

Indicates the resulting Ethernet pointer after the link setup, that means the position after the handshake between the R&S EXBOX-B85 and the DUT.

You can determine this parameter in the C&M tab, which is embedded in the CPRI protocol. RE and REC then read the value of the other, and agree on the smallest.

Valid entries range from 20..63. Depending on the line speed and the pointer the following Ethernet bit rates are achievable:

| Line rate<br>[Mbit/s] | Length of control word<br>[bit] | min. Ethernet bit rate<br>[Mbit/s] | max. Ethernet bit rate<br>[Mbit/s] |
|-----------------------|---------------------------------|------------------------------------|------------------------------------|
| 1x (614.4)            | 8                               | 0.48                               | 21.12                              |
| 2x (1228.8)           | 16                              | 0.96                               | 42.24                              |
| 4x (2457.6)           | 32                              | 1.92                               | 84.48                              |
| 5x (3072.0)           | 40                              | 2.40                               | 105.60                             |
| 8x (4915.2)           | 64                              | 3.84                               | 168.96                             |
| 10x (6144.0)          | 80                              | 4.80                               | 211.20                             |
| 16x (9830.4)          | 128                             | 7.86                               | 337.92                             |

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:CM:ETH:PTR? on page 293

### 7.2.8.2 Link Status

This section 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.

#### Link Status

Indicates whether the CPRI link is established or any transmission error has occurred.

This indicator includes all verified transmission parameters.

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:HW:ALARM? on page 298

### Core Mode

Indicates the current state of the CPRI core.

The CPRI core can work in the following states:

| CPRI core state          | Description                                    |
|--------------------------|------------------------------------------------|
| "Link is up"             | normal operating mode                          |
| "Reset"                  | at the starting point of establishing the link |
| "L1 Synchronization"     | attempt of L1 synchronization                  |
| "Setup protocol version" | setting up the protocol version                |
| "Setup C&M parameter"    | setting up the C&M parameter                   |
| "Passive mode"           | only I/Q data are active, C&M is not used      |

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:HW:CORE? on page 299

### CPRI Mode

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

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:HW:CMODE? on page 299

### LOF (Loss of Frame)

Indicates whether the CPRI frame delimiter K28.5 is detected.

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:HW:LOF? on page 306

### LOS (Loss of Signal)

Indicates whether the data is synchronized.

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:HW:LOS? on page 306

### Local Alarms

These LEDs indicate if errors occur on the CPRI breakout board.

- "LOF"                      LOF (**L**oss **o**f **F**rame) indicates, when the received data lost the synchronization, that is loss of frame.
- "LOS"                      The LOS (**L**oss **o**f **S**ignal) LED indicates a loss of signal.

"RAI" RAI (**R**emote **A**larm **I**ndication) indicates, if any remote part of the end-to-end link has failed.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:L1:RX:LOCa1:LOF? on page 312

[ :SOURce<hw> ] :EBOX:CPRI:L1:RX:LOCa1:LOS? on page 312

[ :SOURce<hw> ] :EBOX:CPRI:L1:RX:LOCa1:RAI? on page 313

### Remote Alarms

The LEDs in this section show alarms that the DUT returns via the CPRI link.

"LOF" LOF (**L**oss **o**f **F**rame) indicates, when the received data lost the synchronization, that is loss of frame.

"LOS" The LOS (**L**oss **o**f **S**ignal) LED indicates a loss of signal.

"RAI" RAI (**R**emote **A**larm **I**ndication) indicates, if any remote part of the end-to-end link has failed.

"SDI" SDI (**S**ervice **A**ccess **P**oint **D**efect **I**ndication) indicates, that the data communication failed.

"Reset" Indicates that 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 command:

[ :SOURce<hw> ] :EBOX:CPRI:L1:RX:REMOte:LOF? on page 313

[ :SOURce<hw> ] :EBOX:CPRI:L1:RX:REMOte:LOS? on page 313

[ :SOURce<hw> ] :EBOX:CPRI:L1:RX:REMOte:RAI? on page 314

[ :SOURce<hw> ] :EBOX:CPRI:L1:RX:REMOte:RESet? on page 314

[ :SOURce<hw> ] :EBOX:CPRI:L1:RX:REMOte:SAP? on page 314

### 7.2.8.3 Events

In CPRI RE test mode the R&S EX-IQ-BOX acts as a CPRI REC (master). As defined in the CPRI standard specification, the CPRI REC provides the generation of Layer 1 messages. In this section, you can simulate some events. Use this function to see how the DUT responds to these events.

#### SDI

Activate the SDI (**S**ervice **A**ccess **P**oint **D**efect **I**ndication) defect indicator. This function intentionally provokes an SDI event, in order to examine whether the DUT evaluates it. In realtime applications, the function detects whether an SAP (**S**ervice **A**ccess **P**oint) is defective or is not working properly.

**Note:** This function applies to CPRI RE test mode. In this mode, the R&S EX-IQ-BOX acts as a CPRI REC (master). As defined in the CPRI standard specification, the CPRI REC provides the generation of Layer 1 messages. In this section, you can simulate some events. Use this function to see how the DUT responds to these events.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TEST:TX:SDI on page 329

**RE Reset**

Set or clear the bit on the downlink connection which requests the RE to reset.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TEST:TX:REReset on page 328

## 7.2.9 Downlink and Uplink

The **Downlink** and the **Uplink** tabs contain the settings for the CPRI basic frame. Downlink and uplink parameters are similar; they both define the signals I/Q data and its distribution inside the CPRI basic frame container (AxC allocation).

The CPRI basic frame contains 16 words. The first word, the control word, contains control information, like synchronization, timing, slow or fast C&M, or vendor specific data. The remaining words carry the I/Q data.



### Terms used in the description and familiar synonyms

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

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

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

- In **CPRI RE** test mode, the R&S EX-IQ-BOX works in the DL (downlink) as a transmitter (Tx) and in the UL (uplink) as a receiver (Rx).

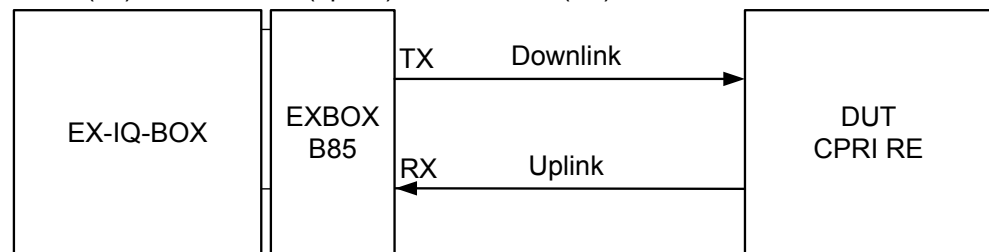


Fig. 7-65: CPRI RE test - schematic representation

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

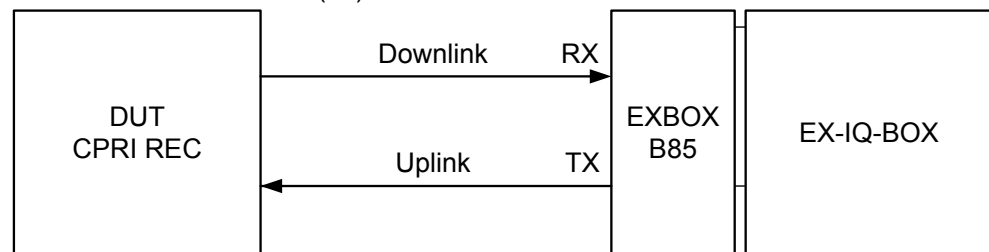


Fig. 7-66: CPRI REC test - schematic representation

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

Accordingly, the DL (downlink) dialog of CPRI RE and the UL (uplink) of CPRI REC are similar, and vice versa, the UL dialog of the CPRI RE test is identical to the DL dialog of CPRI REC.



The following description comprises the parameters of both dialogs, the UL and the DL, since they use the same parameters. Specific settings that relate to a particular link direction, are separately expressed.

The screenshot shows the 'Downlink (Tx)' tab in the CPRI settings dialog. The 'Signal Definition' section on the left includes fields for Signal State (On), Signal Name (signal\_2), Physical Source (ARB 1), Wave file (qpsk\_dirac\_3\_84MHz.wv), Sample Rate (3 840 000.000 Hz), Numeric Format (2's Complement), I/Q Resolution (16), Gain (0.00 dB), Crest Factor (0.00 dB), RMS Level (0.00 dBFS), AxC Allocation (Packed), AxC(s) / Data Rate (1 / 122.88Mbit/s), and Number Of Groups (3). The 'AxC Container Definition' section on the right shows a 'CPRI Basic Frame' diagram with 16 words, where word 1 is highlighted. Below the diagram, it lists AxC 0 (signal\_1, DIG IQ IN 1) and AxC 1 (signal\_2, ARB 1). The 'Start Condition' is set to 'Basic Frame' and the 'Arm' button is visible.

| Name  | Source   | Word Addr   | Bit Addr | Size /bits | Conf |
|-------|----------|-------------|----------|------------|------|
| AxC 0 | signal_1 | DIG IQ IN 1 | 1        | 0          | 32   |
| AxC 1 | signal_2 | ARB 1       | 1        | 0          | 32   |

Fig. 7-67: CPRI downlink dialog

**Signal Definition**

Signal State: ☐ Off

Signal Name: signal\_2

Signal Output: DIG IQ OUT 2 / Recorder

Standard: 3GPP FDD

Sample Rate: 3.840 000 000 MHz

Oversampling: 1

<<< Hide Signal Details

Numeric Format: 2's Complement

I/Q Resolution: 16

AxC Allocation: Packed

AxC(s) / Data Rate: 1 / 122.88Mbit/s

(Assigned): 1 / 122.88Mbit/s

Number Of Groups: 3 Auto

|            | G #0 | G #1 | G #2 |
|------------|------|------|------|
| Repetition | 1    | 1    | 1    |
| State      | On   | On   | On   |

**AxC Container Definition**

CPRI Basic Frame

w=0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

☐ Control Word ☒ signal\_1 ☒ signal\_2

Available Data Rate (I/Q): 921.60Mbit/s

Assigned Data Rate (AxC): 0.00Mbit/s

I/Q Data Deinterleaving: ☒

|       | Name     | Sink       | Word Addr | Bit Addr | Size /bits | Conf |
|-------|----------|------------|-----------|----------|------------|------|
| AxC 0 | signal_1 | DIG IQ OUT | 1         | 0        | 32         |      |
| AxC 1 | signal_2 | DIG IQ OUT | 3         | 0        | 32         |      |

Start Condition: Basic Frame Arm

Append Copy + Append Delete Apply Setup

Fig. 7-68: CPRI uplink dialog

### 7.2.9.1 Signal Definition

Section "Signal Definition" contains all information which is important to define the I/Q signals to be transmitted, or received via the CPRI link. On the left the table lists all defined signals, and on the right of it input and display fields show the respective settings of the selected signal. Signals are added, copied or removed by means of buttons and a groups table indicates the AxCs assigned to a group.



The active AxCs are shown on the top right of this tab graphically. You find the description to this graphic under [chapter 7.2.9.2, "AxC Container Definition"](#), on page 186.

#### 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 command:

`[ :SOURCE<hw> ] :EBOX:CPRI:TX|RX:SIGNAL:APPend` on page 337

### 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 command:

`[ :SOURCE<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:COPY` on page 342

### Delete

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

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:DElete` on page 343

### Signal State

Activate a selected signal.

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:STATE` on page 352

### 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 command:

`[ :SOURCE<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:NAME` on page 346

### Physical Source

Select the signal source for signal transmission to the DUT. The signal comes either from an R&S instrument via the digital interface of the R&S EX-IQ-BOX, or the signal is generated internally or by means of the waveform memory in the R&S EX-IQ-BOX.

The R&S EX-IQ-BOX converts the I/Q format of the signal into the CPRI protocol format. Embedded with additional control information, the link transfers the data to the DUT.

**Note:** You can select the signal source if the R&S EX-IQ-BOX works as transmitter, that means if it sends a signal to the DUT. That is, if you work in the **RE Test Downlink** or the **REC Test Uplink** mode. Hence, the parameter is available only in the corresponding DL or UL tab.



However, when the R&S EX-IQ-BOX receives a signal, "Signal Output" is available in the corresponding tabs instead of "Physical Source". See also ["Signal Output"](#) on page 174.

"Sync Pattern" Use the internal pattern generator as signal source.

"DIG IQ IN 1" An R&S instrument applies a digital baseband signal at DIG IQ IN 1 connector of the R&S EX-IQ-BOX.  
The green IN/OUT LED of this interface indicates, that it operates in input mode.

"ARB 1...4" Selects one of the waveform memories with a loaded I/Q signal.

**Note:**

- This feature requires, that the R&S EX-IQ-BOX is equipped with the appropriate waveform memory option.
- A conflict arises, if no signal is loaded in the memory, or is not activated. The LED next to "Wave File" and "Sample Rate" turns red.

The Multi Waveform option supports simultaneous playback of up to four signals. For information on the available options refer to [chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory"](#), on page 23.

"Static Frame" Enables you to fill the complete CPRI frame with a static pattern for debugging purposes. This pattern is transmitted as it is, without scaling, rounding or interleaving.

"PRBS" Generates a PRBS pattern.  
If you additionally set [Signal Output](#) to "BER Test", you can perform a bit error test with this pattern, to evaluate the signal transmission in the Rx path.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:TX:SIGNal<ch>:SOURce](#) on page 332

### Signal Output

Select an output interface, to transmit the received baseband signal from the DUT to an R&S instrument and/or to the built-in I/Q recorder.

The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, and forwards it to an R&S instrument. Simultaneously, you can also record the signal with the I/Q recorder, see [chapter 7.2.14, "Recorder"](#), on page 207.

**Note:** You can select "Signal Output" if the R&S EX-IQ-BOX works as receiver, that means if it receives a signal from the DUT. That is, if you work in the **RE Test Uplink** or the **REC Test Downlink** mode. Hence, the parameter is available only in the corresponding DL or UL tab.

However, when the R&S EX-IQ-BOX transmits a signal, "Physical Source" is available in the corresponding tabs instead of "Signal Output". See also ["Physical Source"](#) on page 173.

"DIG IQ OUT <n> / Recorder"

Selects the digital output interface DIG IQ IN 2 of the R&S EX-IQ-BOX to send the signal to an R&S instrument.

The yellow IN/OUT LED of this interface indicates, that it operates in input mode.

- "Recorder" Selects the built-in I/Q recorder as the destination for the received signal.  
This feature requires, that the R&S EX-IQ-BOX is equipped with the appropriate recording memory option. For information on the available options refer to [chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory"](#), on page 23.
- "Sync Pattern" Enables you to check one AxC inside the CPRI frame against a static synchronization pattern. If you additionally select "Sync Pattern" as start condition in the Rx path, [Start Condition](#), the scheduling starts as soon as the specified pattern is detected.
- "BER Test" Enables you to measure the **Bit Error Rate** of the link, provided the [Physical Source](#) "PRBS" is selected.  
Section "LOW Level BER Test" appears with the corresponding parameters. You can find the setting parameters described in [chapter 7.2.9.3, "Low Level BER Test"](#), on page 191, including details to the BER Test.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:RX:SIGNAL<ch>:OUTPut](#) on page 331

### 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, that means the physical signal sources DIG IQ IN or DIG IQ OUT.

- "GSM/EDGE" Select a signal that follows the GSM/EDGE standard.  
GSM/EDGE (**G**lobal **S**ystem for **M**obile Communications/**E**nhanced **D**ata Rates for **G**SM **E**volution) covers the 2nd generation mobile radio technology. Selecting this signal standard, the sample rate is set to 270,833333 kSps. This sample rate does not fit well into the CPRI basic frame rate. Therefore, the sampling rate of GSM/EDGE is only achieved by using a rather complicated group setup, the AxC settings over time.
- "3GPP FDD" Select the parameters of the W-CDMA standard 3GPP FDD.  
W-CDMA (**W**ideband **C**ode **D**ivision **M**ultiple **A**ccess) covers the radio technology UMTS (**U**niversal **M**obile **T**elecommunications **S**ystem).  
3GPP (**3**rd **G**eneration **P**artnership **P**roject) is a collaboration between groups of telecommunication associations, which define a globally applicable third generation mobile phone system specification. 3GPP standardization comprises all GSM and W-CDMA specifications.
- "CDMA 2000" Select a signal that follows the CDMA standard.  
**CDMA2000** (**C**ode **D**ivision **M**ultiple **A**ccess) uses a multiple access scheme for digital radio, to send voice, data, and signaling data (such as a dialed telephone number) between mobile phones and cell sites.

- "LTE" Select an LTE (Long Term Evolution) signal. Based on UMTS, LTE provides a wireless broadband internet system with voice and other services built on top, like for example authentication.  
LTE bandwidths: 1.4 | 3.0 | 5.0 | 10.0 | 15.0 | 20.0 MHz
- "IEEE 802.16 WiMAX" Select the digital standard IEEE 802.16 WiMAX (Worldwide Inter-operability for Microwave Access). WiMAX provides wireless transmission of data using a variety of transmission modes, as for example point-to-multipoint links or mobile internet access.  
WiMAX bandwidths: 3.5 | 5.0 | 7.0 | 8.75 | 10.0 | 20 MHz
- "User defined" Specify a user defined signal for transmission, define a signal with arbitrary parameters.

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:STANDARD on page 350

### Wave file

Indicates the loaded waveform file, if the physical signal source is one of the waveform memories.

**Note:** This parameter is relevant when operating with ARB. 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 command:

[ :SOURCE<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:ARB:FILE? on page 338

### Frame Data

Sets the user defined pattern of the frame.

**Note:** The parameter applies to the physical source "Static Frame".

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:SFRAME<st>:DATA on page 332

### Sample Rate

Shows the sample rate. If you process user defined signals, you can set the value.

**Note:** Consider that the sampling rate of the R&S signal generator fits to the sampling rate of R&S DigIConf, as well as to the sampling rate of the R&S signal analyzer.

The table shows the predefined sample rates of the available signals. The sample rate of a digital standard varies corresponding to the frequency.

**Table 7-5: Sample rate values, depending on the signal type**

| Standard  | Frequency variant | Sample Rate  |
|-----------|-------------------|--------------|
| GSM/EDGE  |                   | 270.8333 kHz |
| 3GPP FDD  |                   | 3.84 MHz     |
| CDMA 2000 |                   | 1.228 MHz    |

| Standard     | Frequency variant | Sample Rate |
|--------------|-------------------|-------------|
| 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    |
| Static Frame |                   | 3.84 MHz    |
| Sync Pattern |                   | 3.84 MHz    |
| PRBS         |                   | 3.84 MHz    |

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:TX|RX:SIGNAL<ch>:SRATe](#) on page 349

### Pattern Length

Define the length of the pattern used by the internal pattern generator.

**Note:** The parameter applies to the physical source "Sync Pattern" and the PRBS sequence length.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:TX|RX:SIGNAL<ch>:PLENgtH](#) on page 348

### Oversampling

Determine the oversampling factor.

Values: 1 | 2 | 4

**Note:** Oversampling refers to external signals, like 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 command:

[\[:SOURce<hw>\]:EBOX:CPRI:TX|RX:SIGNAL<ch>:OSAMpling](#) on page 348

### Show/Hide Signal Details

Shows/hides a section with additional parameters for more detailed signal definition.

### Numeric format

Select a numeric representation for data transmission.

**"2's Complement"**

Format the signal in two's-complement.

The most significant bit has a value of  $-2^{-1}$ , the bits of lesser significance follow as:

$$+2^{-2} \dots +2^0$$

**"Binary Offset"**

Format the data in binary offset.

A binary offset of  $-2^{-1}$  is added such that the final values are always positive.

**Example:**

$$n = 4 \rightarrow -8 \leq z < 8$$

**Table 7-6: CPRI > Numeric format coding**

| z  | 2's Complement |   |   |   |  | Binary Offset |   |   |   |
|----|----------------|---|---|---|--|---------------|---|---|---|
| -8 | 1              | 0 | 0 | 0 |  | 0             | 0 | 0 | 0 |
| -7 | 1              | 0 | 0 | 1 |  | 0             | 0 | 0 | 1 |
| -6 | 1              | 0 | 1 | 0 |  | 0             | 0 | 1 | 0 |
| -5 | 1              | 0 | 1 | 1 |  | 0             | 0 | 1 | 1 |
| -4 | 1              | 1 | 0 | 0 |  | 0             | 1 | 0 | 0 |
| -3 | 1              | 1 | 0 | 1 |  | 0             | 1 | 0 | 1 |
| -2 | 1              | 1 | 1 | 0 |  | 0             | 1 | 1 | 0 |
| -1 | 1              | 1 | 1 | 1 |  | 0             | 1 | 1 | 1 |
| 0  | 0              | 0 | 0 | 0 |  | 1             | 0 | 0 | 0 |
| 1  | 0              | 0 | 0 | 1 |  | 1             | 0 | 0 | 1 |
| 2  | 0              | 0 | 1 | 0 |  | 1             | 0 | 1 | 0 |
| 3  | 0              | 0 | 1 | 1 |  | 1             | 0 | 1 | 1 |
| 4  | 0              | 1 | 0 | 0 |  | 1             | 1 | 0 | 0 |
| 5  | 0              | 1 | 0 | 1 |  | 1             | 1 | 0 | 1 |
| 6  | 0              | 1 | 1 | 0 |  | 1             | 1 | 1 | 0 |
| 7  | 0              | 1 | 1 | 1 |  | 1             | 1 | 1 | 1 |

**"2's Complement 9E2"**

Format the signal in two's-complement variant 9E2.

9E2 encoding format is used in mobile base stations to extend the dynamic range of I and Q, while reducing the needed amount of bits. The coding is 9E2 with 9 bits mantissa and 2 bits exponent, that are shared from I and Q, as shown in the figure:

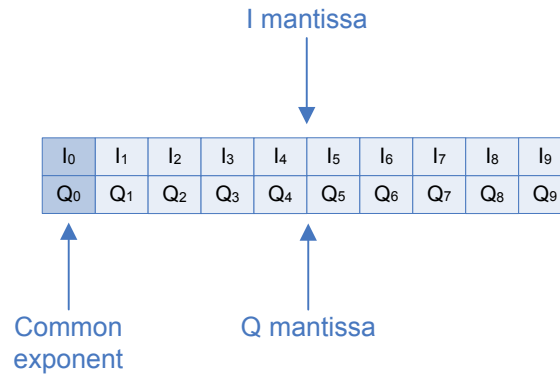


**Fig. 7-69: 2's complement 9E2**

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, bit<sub>0</sub> exponent

$$I = \left( \left( \sum_{i=0}^7 2^i \cdot I_{i+1} \right) - 2^8 \cdot I_9 \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

Q sample 10 bits: 9 bits Q mantissa + 1 bit, bit<sub>1</sub> exponent

$$Q = \left( \left( \sum_{i=0}^7 2^i \cdot Q_{i+1} \right) - 2^8 \cdot Q_9 \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:NFORMAT` on page 346

**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 command:

`[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:IQRResolution` on page 345

**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 command:

`[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:GAIN` on page 343

**Crest Factor**

This parameter is required for the correct display of the **RMS Level** value.

The rms level is calculated with the formula:

$$\text{RMS [dB]} = \text{Peak [dB]} - \text{Crest Factor [dB]} + \text{Gain [dB]}$$

The crest factor must correspond to the input signal. Enter the value, for example a connected baseband generator provides.

**Note:** Crest factor applies to external signals, like 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 command:

`[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:CRESt` on page 342

**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:

$$(\text{SQR}(\text{I}^2 + \text{Q}^2)).$$

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:

$$\text{RMS [dB]} = \text{Peak [dB]} - \text{Crest Factor [dB]} + \text{Gain [dB]}$$

**Note:** The RMS level refers to external signals, like digital standard or 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 command:

`[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:RMS?` on page 348

Response: `-10 dbFS`

**AxC Allocation**

Define how to allocate the AxCs to the signal. R&S DiglConf automatically assigns the AxCs to a signal, and this parameter specifies the method.

- |            |                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "Packed"   | The AxCs allocate a continuous area inside the CPRI basic frame. Word address and offset address of the first AxC define the starting position. If possible, the following AxCs are placed successively. The signal AxCs are automatically laid in a free area of the CPRI frame. If there is not enough free space, the signal AxCs are placed at the beginning of the base frame, at the position of word 1. |
| "Flexible" | Manually assign the position of the AxCs by word address and offset address.<br><b>Tip:</b> Use this setting, to embed each sample of a signal individually within the CPRI basic frame.                                                                                                                                                                                                                       |

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:ALLocation`

on page 339

**AxC(s) / Data Rate**

Indicates the needed number of AxCs and the required data rate.

Depending on the sample rate, a signal needs one or more AxCS to carry its I/Q data. If possible, R&S DigIConf automatically assigns the number of needed AxCs to the signal.

**Note:** The maximum number of AxCs for all signals is 24.

The needed number of AxCs is calculated with the formula:

$$AxCs_{needed} = \text{ceil}\left(\frac{\text{Sample Rate} \cdot \text{Oversampling}}{3.84[\text{MHz}]}\right)$$

The data rate is calculated with the formula:

$$\text{Data Rate}_{needed} [\text{Mbit/s}] = \text{SampleRate} \cdot \text{Oversampling} \cdot 2 \cdot I/Q \text{ Resolution}$$

**Note:** For signal source "Pattern" the needed number of AxCs is 1.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:COUNt:NEEDed?`

on page 340

#### (Assigned)

Displays the assigned number of AxCs and the assigned data rate. The assigned data rate depends on the signal group settings, that means on the repetition rate and the number of active AxCs per group.

The assigned data rate is calculated with the formula:

$$\text{Data Rate}_{assigned} [\text{Mbit/s}] = 3.84[\text{MHz}] \cdot 2 \cdot I/Q \text{ Resolution} \left( \frac{\text{AssignedAxCs} \cdot \text{OnTime}}{\text{OnTime} + \text{OffTime}} \right)$$

**Note:** In case of "Sync Pattern" signals, the assigned data rate depends on the pattern length and the sample rate. It is calculated by the sample rate as shown:

$$\text{Data Rate}_{assigned} = \text{Sample Rate} \cdot \text{Pattern Length}$$

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:COUNt:ASSign?`

on page 339

#### Status LED

In case of mismatch between the assigned data rate and the required data rate, the LED turns red. Blue indicates that the data rates fit.

**Note:** Deviations in data rates!. Refer to the example under [chapter 7.2.9.2, "AxC Container Definition"](#), on page 186, on what to do if the status LED turns red.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:DRATe:STATus?`

on page 341

#### 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 (means repetitions). Thus you can change the AxC assignment over time by using more than one group with different settings.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SOURce<ch>:GROup:COUNT on page 344

### Auto

Automatically calculates the recommended scheduling sequences.

According to the standard, the following relations are taken as calculation basis:

$$K = \frac{LCM \cdot (f_s, f_c)}{f_s}$$

$$N_C = \text{ceil}\left(\frac{N_A \cdot S}{K}\right)$$

$$N_V = N_C \cdot K - N_A \cdot S$$

$$S = \frac{LCM \cdot (f_s, f_c)}{f_c}$$

LCM = Last Common Multiple

$N_A = 1$

$N_V$  = Number of stuffing samples to match the CPRI frame rate of 3.84 MHz

$S$  = Number of active samples

$f_s$  = sample rate of digital standard

$f_c$  = CPRI basic frame rate (3.84 MHz)

The standard recommends the following settings for listed digital standards:

**Table 7-7: IEEE 802.16 (WiMAX™): recommended number  $N_V$  of stuffing samples for  $N_A=1$ ,  $N_A=2$**

| fs [MHz] | $N_A$ | S   | K  | $N_C$ | $N_V = N_C \cdot K - N_A \cdot S$ |
|----------|-------|-----|----|-------|-----------------------------------|
| 4.0      | 1     | 25  | 24 | 2     | 23                                |
| 5.6      | 1     | 35  | 24 | 2     | 13                                |
| 8.0      | 1     | 25  | 12 | 3     | 11                                |
| 10.0     | 1     | 125 | 48 | 3     | 19                                |
| 11.2     | 1     | 35  | 12 | 3     | 1                                 |
| 22.4     | 1     | 35  | 6  | 6     | 1                                 |
| 4.0      | 2     | 25  | 24 | 3     | 22                                |
| 5.6      | 2     | 35  | 24 | 3     | 2                                 |
| 8.0      | 2     | 25  | 12 | 5     | 10                                |
| 10.0     | 2     | 125 | 48 | 6     | 38                                |

| fs [MHz] | N <sub>A</sub> | S  | K  | N <sub>C</sub> | N <sub>V</sub> = N <sub>C</sub> *K - N <sub>A</sub> *S |
|----------|----------------|----|----|----------------|--------------------------------------------------------|
| 11.2     | 2              | 35 | 12 | 6              | 2                                                      |
| 22.4     | 2              | 35 | 6  | 12             | 2                                                      |

**Table 7-8: EUTRA/LTE: recommended number N<sub>V</sub> of stuffing samples for N<sub>A</sub>=1, N<sub>A</sub>=2**

| fs [MHz] | N <sub>A</sub> | S | K | N <sub>C</sub> | N <sub>V</sub> = N <sub>C</sub> *K - N <sub>A</sub> *S |
|----------|----------------|---|---|----------------|--------------------------------------------------------|
| 1.92     | 1              | 1 | 2 | 1              | 1                                                      |
| 3.84     | 1              | 1 | 1 | 1              | 0                                                      |
| 7.68     | 1              | 2 | 1 | 2              | 0                                                      |
| 15.36    | 1              | 4 | 1 | 4              | 0                                                      |
| 23.04    | 1              | 6 | 1 | 6              | 0                                                      |
| 30.72    | 1              | 8 | 1 | 8              | 0                                                      |
| 1.92     | 2              | 1 | 2 | 1              | 0                                                      |

**Table 7-9: GSM/EDGE: recommended number N<sub>V</sub> of stuffing samples**

| fs [MHz] | N <sub>A</sub> | S   | K    | N <sub>C</sub> | N <sub>V</sub> = N <sub>C</sub> *K - N <sub>A</sub> *S |
|----------|----------------|-----|------|----------------|--------------------------------------------------------|
| 1625/6   | 1              | 325 | 4608 | 1              | 4283                                                   |
| 1625/6   | 8              | 325 | 4608 | 1              | 2008                                                   |
| 1625/6   | 14             | 325 | 4608 | 1              | 58                                                     |
| 325      | 1              | 65  | 768  | 1              | 703                                                    |
| 325      | 6              | 65  | 768  | 1              | 378                                                    |
| 325      | 11             | 65  | 768  | 1              | 53                                                     |
| 960      | 1              | 1   | 4    | 1              | 3                                                      |
| 960      | 4              | 1   | 4    | 1              | 0                                                      |
| 1625     | 1              | 325 | 768  | 1              | 443                                                    |
| 1625     | 2              | 325 | 768  | 1              | 118                                                    |
| 3250     | 1              | 325 | 384  | 1              | 59                                                     |

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TX | RX:SOURce:GROup:CALC on page 344

### 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 physical source.

**Note:** The groups settings apply to a single physical source, which can be switched "On" for a number of basic frames and switched "Off" for another period of frames. If more than one signal uses the same physical source, the group settings for the fractional "ON/Off" transmission apply to all signals using this physical 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, that means how many CPRI basic frames follow the current group setting.                                                               |
| "State"         | Indicates the status of the respective physical source. By default, all sources are "On". Click the desired field or press the enter key to switch between On and Off. |

**"Pattern"**

Shows the binary data pattern of an AxC in hexadecimal format. By default, all data pattern is set to zero. Click a field or press the ENTER key to insert the required pattern. You can basically set up to 36 bits, but the currently possible number depends on the signal length that is specified in [Pattern Length](#).

**Note:** Pattern is displayed when you are working with "Sync Pattern" signals.

**Example:**

The following example explains the need of the CPRI group definition: Let us assume we want to transmit an I/Q signal over the CPRI link with a sampling rate of 5.76 MS/s. The CPRI basic frame rate amounts the defined 3.84 MHz.

This means, if we assign one AxC per basic frame, we have the sample rate of 3.84 MS/s. If we assign two AxCs, we get a sample rate of 7.68 MS/s.

**Note:** An AxC is a container for one I/Q sample.

But, for the required sample rate of 5.76 MS/s, we would need 1.5 AxCs per basic frame.

**How can we reach that?**

| Number Of Groups |      |      |
|------------------|------|------|
|                  | G #0 | G #1 |
| Repetition       | 3    | 1    |
| State            | On   | On   |

- We allocate 2 AxCs in the AxC container definition which corresponds to: ceiling = 1.5. For example, we use "AxC0" and "AxC1".
- In the "Number of Groups" entry field, we define two groups.
- Then, in the groups table, we define:
  - G#0: Repetition = 3, State = On
  - G#1: Repetition = 1, State = 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.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SOURce<ch>:GROup<user0>:REPetition on page 345

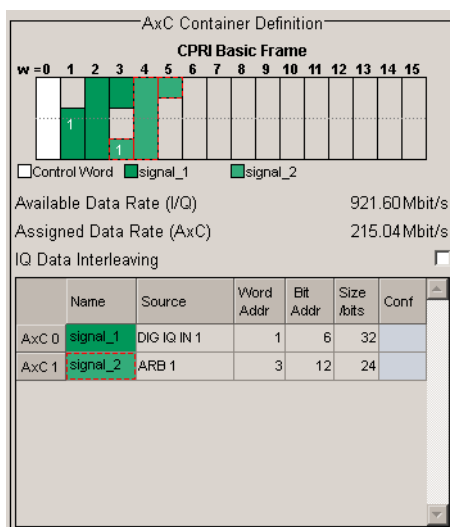
[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SOURce<ch>:GROup<user0>:STATe on page 345

[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:GROup<user0>:PATtern on page 344

[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:SOURce:GROup:CALC on page 344

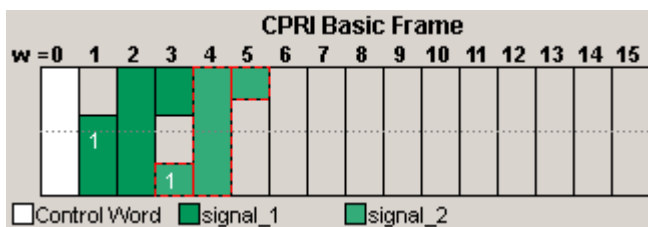
### 7.2.9.2 AxC Container Definition

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 structured in AxCs (antenna carriers). A signal needs one or more AxCs for carrying the I/Q data, depending on the sample rate.



The word length depends on the CPRI line bit rate parameter. This parameter defines the number of bits transferred per second over the CPRI communication link, including control and I/Q data.

The following table shows the word length related to the bit rate.

**Table 7-10: CPRI Line bit rate vs. Word length**

| Line bit rate [Mbit/s] | Word length [bits] | [Bytes] |
|------------------------|--------------------|---------|
| 1x (614.4)             | 8                  | 1       |
| 2x (1228.8)            | 16                 | 2       |
| 4x (2457.6)            | 32                 | 4       |
| 5x (3072.0)            | 40                 | 5       |

| Line bit rate [Mbit/s] | Word length [bits] | [Bytes] |
|------------------------|--------------------|---------|
| 8x(4915.2)             | 64                 | 8       |
| 10x (6414.0)           | 80                 | 10      |
| 16x (9830.4)           | 128                | 16      |

**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, that means the I/Q data.

R&S DigIConf shows the signals in different colors, as well as the related AxCs. Active signals are strongly colored, while the inactive signals are shown in pale colors. If the signals in the graph overlap, the active signals are always in the foreground. Below the graph, a legend explains the signals and their assigned colors.

#### Available Data Rate (I/Q)

Displays the available data rate of the I/Q data, calculated with the formula:

$$\begin{aligned} \text{Data Rate}_{\text{available}} [\text{Mbit/s}] &= \text{Data Word Count} \cdot \text{Word Length} [\text{bit}] \cdot 3.84 [\text{MHz}] \\ &= 15 \cdot \text{Word Length} [\text{bit}] \cdot 3.84 [\text{MHz}] \end{aligned}$$

**Note:** The word length depends on the line bit rate, as listed in "CPRI Basic Frame Graph" on page 186.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:DRATe:AVAIlable? on page 337

#### 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:

$$\text{Data Rate}_{\text{assigned}} [\text{Mbit/s}] = \sum \text{AxC\_size}_{\text{axc}} \cdot 3.84 [\text{MHz}]$$

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TX|RX:DRATe:ASSigned? on page 336

#### I/Q Data Interleaving

Activates I/Q data interleaving.

The following graphs show the sample arrangement and transmission order for uplink and downlink:

- I/Q data interleaved

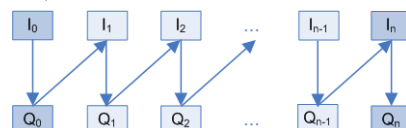


Fig. 7-70: Interleaved I/Q data transmission within a CPRI link

- I/Q data non interleaved.

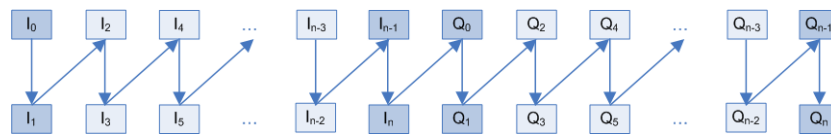


Fig. 7-71: Non Interleaved I/Q data transmission within a CPRI link

Remote command:

[ :SOURCE<hw>] :EBOX:CPRI:TX|RX:INTERleaving on page 337

### AxC Table

Shows the settings of the assigned AxCs. An AxC is defined by the position inside the CPRI basic frame and its length.

"Source" Indicates the signal the AxC is assigned to.

"Word Address"

The position of the AxC within the CPRI basic frame is defined by word address and bit address. The word address specifies, with which word the AxC begins, while the bit address specifies the bit index inside the word.

"Bit Address" Specifies the starting bit inside the word.

"Size /bits" Displays the size of the AxC in bits. The size depends on the selected signal source. With the exception of signals from the signal source Sync Pattern, the size is calculated using the following formula:

$$AxC\_size_{axc}[bit] = I/Q Resolution_{signal} \cdot 2$$

For Sync Pattern signals, calculate the source with the formula:

$$AxC\_size_{axc}[bit] = Pattern Length_{signal}$$

"Conflict" A conflict arises, when AxCs overlap. A red LED indicates the overlapping with a previous AxC.

Remote command:

[ :SOURCE<hw>] :EBOX:CPRI:TX|RX:AXC<ch0>:SOURCE? on page 335

[ :SOURCE<hw>] :EBOX:CPRI:TX|RX:AXC<ch0>:WADDRESS on page 336

[ :SOURCE<hw>] :EBOX:CPRI:TX|RX:AXC<ch0>:BADDRESS on page 334

[ :SOURCE<hw>] :EBOX:CPRI:TX|RX:AXC<ch0>:SIZE? on page 335

[ :SOURCE<hw>] :EBOX:CPRI:TX|RX:AXC<ch0>:CONFLICT? on page 334

### Start Condition

Defines the start condition for the scheduler, for data transmission and analysis.

#### Note:

To define a fractional scheduling scheme, consider the following:

- align the start of the scheduling scheme either to a Hyper Frame, or a Node B Frame.
- make sure that the total number of repetitions, for example "1 On"; "3 Off" is an integer multiple of basic frames inside a Hyper Frame (256) or Node B Frame (38400). Otherwise
- use a Sync Pattern in both, the Tx and Rx path.

|                      |                                                                                                                                                                                                                               |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "Software"           | Starts scheduling and data transmission/reception after a software trigger.                                                                                                                                                   |
| "Ext. Trigger 1...3" | Starts the scheduling and data transmission/reception with an external trigger signal. To supply the trigger signal use one of the GPIOs and configure it accordingly in the "Hardware" tab.                                  |
| "Basic Frame"        | Starts scheduling and data transmission/reception with the next Basic Frame. This corresponds to a free running trigger.                                                                                                      |
| "Hyper Frame"        | Aligns scheduling and data transmission/reception to the next Hyper Frame.                                                                                                                                                    |
| "Node B Frame"       | Aligns scheduling and data transmission/reception to the next Node B Frame.                                                                                                                                                   |
| "Sync Pattern"       | Aligns the timing and data transmission/reception in the Rx path according to a received sync pattern defined within a specified AxC. This trigger mode requires that you have assigned "Sync Pattern" to one of the signals. |

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TX | RX:TRIGger:SOURce on page 332

### Arm

Stops the data transmission, the scheduler and analysis. A subsequent trigger event restarts the activities.

To select the trigger signal source, see [Start Condition](#)

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TX | RX:APPLy on page 333

### Run

Restarts data transmission, the scheduler and analysis manually.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TX | RX:TRIGger:ARM on page 332

### Apply Setup

Assign the settings in order to become effective.

If you have modified settings, and not yet confirmed, the red  arrow next to the "Apply Setup" button prompts you to confirm your settings.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TX | RX:WARNing? on page 352

[ :SOURce<hw> ] :EBOX:CPRI:TX | RX:APPLy on page 333

### Example to CPRI Groups Concept

**Note:** Since the CPRI protocol is based on the standards of 3G and LTE, the CPRI basic frame length uses the UTRA FDD Chip period, 1/3.84 MHz, that means 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.

The screenshot shows the 'Protocol Settings' window for the R&S EX-IQ-BOX. The 'Signal Definition' tab is active, showing settings for 'signal\_1'. The 'AxC Container Definition' tab is also visible, showing the 'CPRI Basic Frame' and a table of AxCs.

**Signal Definition:**

- Signal State: On
- Signal Name: signal\_1
- Physical Source: DIG IQ IN 1
- Standard: WiMAX 10 MHz
- Sample Rate: 11.200 000 000 MHz
- Oversampling: 1
- Numeric Format: 2's Complement
- I/Q Resolution: 16
- Gain: 0.00 dB
- Crest Factor: 0.00 dB
- RMS Level: 0.00 dBFS
- AxC Allocation: Packed
- AxC(s) / Data Rate (Assigned): 3 / 358.40 Mbit/s
- Number Of Groups: 2
- Repetition: 35
- State: On

**AxC Container Definition:**

CPRI Basic Frame

| w | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| 1 |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |
| 2 |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |
| 3 |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |

Available Data Rate (I/Q): 921.60 Mbit/s

Assigned Data Rate (AxC): 368.64 Mbit/s

IQ Data Interleaving: ☐

| Name  | Source   | Word Addr   | Bit Addr | Size (bits) | Conf |
|-------|----------|-------------|----------|-------------|------|
| AxC 0 | signal_1 | DIG IQ IN 1 | 1        | 6           | 32   |
| AxC 1 | signal_1 | DIG IQ IN 1 | 3        | 6           | 32   |
| AxC 2 | signal_1 | DIG IQ IN 1 | 5        | 6           | 32   |

Start Condition: Basic Frame

Buttons: Append, Copy + Append, Delete, Apply Setup

In this example, the WiMAX data rate is 11.2 MHz and requires 3 AxCs for its data. Since 3.84 MHz does not fit into 11.2 MHz, change the following parameters:

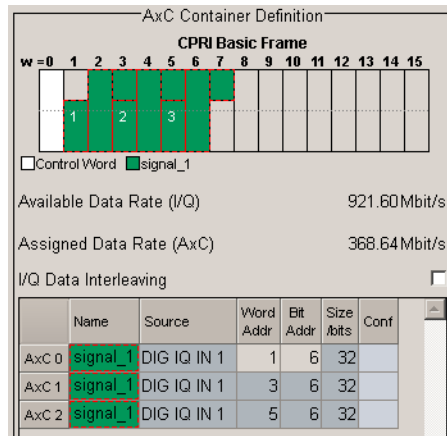
- Increase the number of groups to 2.

|                    |                   |
|--------------------|-------------------|
| AxC(s) / Data Rate | 3 / 358.40 Mbit/s |
| (Assigned)         | 3 / 358.40 Mbit/s |
| Number Of Groups   | 2                 |

- Enter 35 repetitions for Group "G #0", and 1 for "G #1".
- Allocate all the AxCs of the first group consecutively, and from the second group only AxC0 and AxC1.

|            | G #0 | G #1 |
|------------|------|------|
| Repetition | 35   | 1    |
| State      | On   | On   |

The graph in the AxC Container Definition shows the distribution of the data in the CPRI frame slots.



### Argument

Let us prove that using the formula:

$$Data\ Rate_{assigned} [Mbit / s] = 3.84 [MHz] \cdot 2 \cdot I / Q\ Resolution \left( \frac{Assigned\ AxCs \cdot OnTime}{OnTime + OffTime} \right)$$

$$DataRate_{assigned} [Mbit / s] = 3.84 [MHz] \cdot 2 \cdot 16 [bit] \cdot 3 \cdot \frac{35}{36} = 358.4 [Mbit / s]$$

#### 7.2.9.3 Low Level BER Test

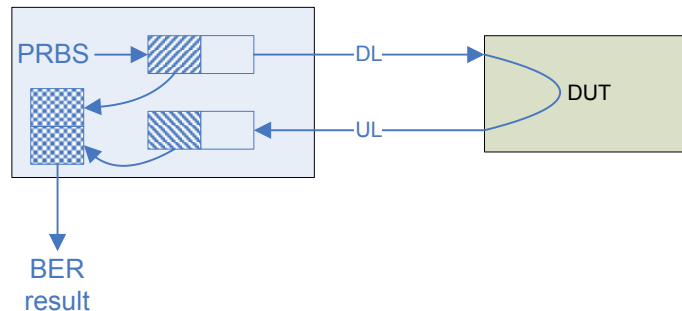
In section **Low Level BER Test**, you can check the data transmission in the Rx path of the CPRI link, provided "Signal Output > BER Test" is set. The Bit-Error-Rate function evaluates the bit error ratio with a defined data sequence.

Therefore, the PRBS AxCs of the uplink and downlink must be identical regarding "Pattern Length" and position, defined with "Word Addr." and "Bit Addr.".

- To process the "Low Level BER" test, select "Tx Source > PRBS" , and "Rx Signal Output > BER Test".  
Depending on the Test mode, "[Physical Source](#)" on page 173 "(Tx)", and "[Signal Output](#)" on page 174 "(Rx)" are given in the corresponding downlink and uplink tab.



The position and the length of the downlink and uplink AxCs must be identical and the CPRI line must be looped back, e.g. in the DUT.

**Example to Low Level BER Test using CPRI RE test mode****Fig. 7-72: Low Level BER Test**

For testing a signal execute the following steps.

1. Define a signal in the downlink tab: Select "Physical Source > PRBS" in the downlink tab and configure the AxC parameters regarding "Pattern Length" and position by means of adjusting the "Word and Bit address" inside the CPRI frame.
2. Define a signal in the uplink tab: Select "Signal Output > BER Test", and set the same values for AxC "Pattern length" and position as in the downlink tab  
**Note:** For testing the function itself, the signals in the downlink and uplink tab must be identical.
3. Apply the Tx and Rx settings.
4. Set the connected DUT to CPRI loopback mode.  
**Note:** The integrated loop-back function in the CPRI breakout board provides sending and receiving signals, without plugging in an SFP module.
5. Reset the PRBS Test, if necessary.  
**Note:** It is recommended that you reset the "PRBS Test", after you have changed the settings at the DUT, or unplugged external cables.
6. The function extracts received data from the uplink signal and compares it with the expected PRBS data. The total number of received words and the calculated BER are displayed.

The bit error rate test function embeds a known PRBS sequence in the CPRI protocol and synchronizes the analysis on the receiver side with the received (looped) signal. It synchronizes the data which are returned internally, compares these data with the data being sent, and counts the bit errors. The ratio of the number of error bits to the total number of bits is the BER-result.

Use this function to see whether the link is working properly. You can monitor the test result continuously in the "Test & Diagnostics" tab.

**Expected Results:**

When you send a signal and the settings for the received signal are identical, the error must be "0".

Simulate an error:

1. Configure different AxC positions in uplink and downlink while in loopback mode.
2. In the uplink tab, 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.

### Rx Received Bits

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 command:

`[ :SOURce<hw> ] :EBOX:CPRI:TEST:BER:RX:WORDS?` on page 325

### 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 command:

`[ :SOURce<hw> ] :EBOX:CPRI:TEST:BER:RX:RATE?` on page 324

### Reset

Restarts the PRBS test.

Performing a reset is recommended after changes of CPRI link parameters or external connections, to start from a defined initial state.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:PRBS:RST` on page 325

## 7.2.10 Control & Management

The **Control & Management** (C&M) tab comprises all settings related to the process of exchanging control information between RE (**R**adio **E**quipment) and REC (**R**adio **E**quipment **C**ontrol) in base station systems. CPRI supports two different protocols for C&M data, the slower variation HDLC (**H**igh-Level **D**ata **L**ink **C**ontrol) and the fast Ethernet.

### 7.2.10.1 Slow C&M (HDLC)

The **HDLC Settings** section comprises the necessary parameters for activating HDLC control and management data protocol.



In chapter [chapter 4.5, "Connecting the R&S EX-IQ-BOX"](#), on page 42, you find information on how to connect the interface. For more information on the hardware, see the data sheet of the R&S EX-IQ-BOX, option R&S EXBOX-B85 (CPRI breakout board).

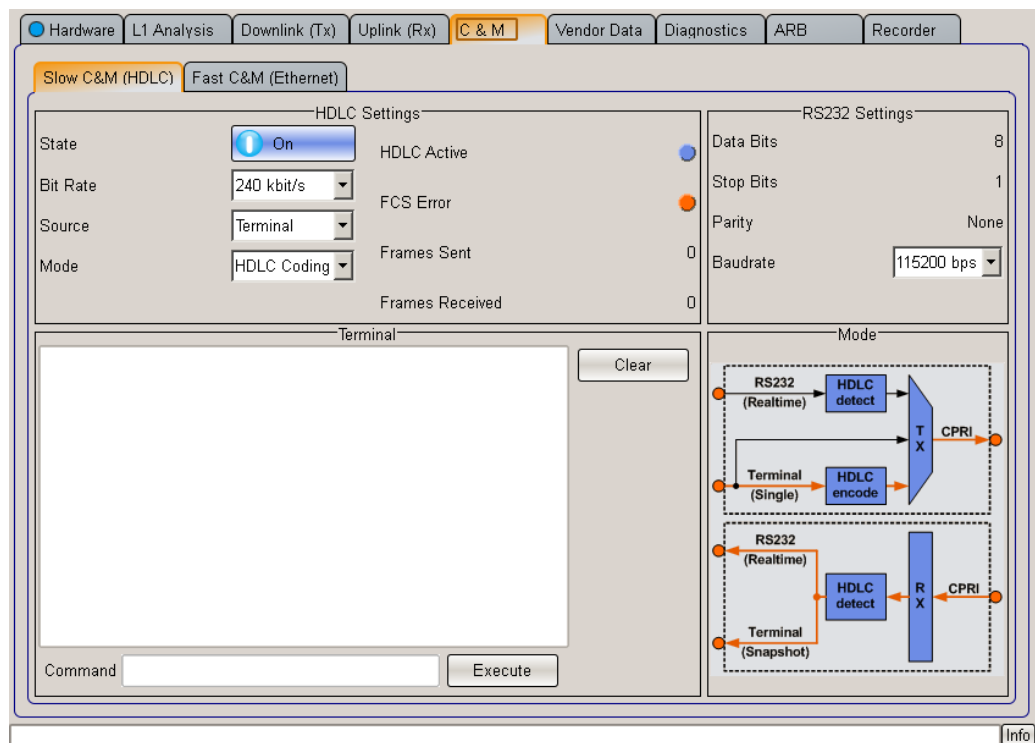
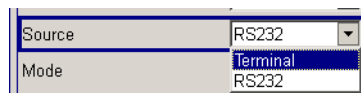


Fig. 7-73: CPRI Control & Management dialog - Slow C&M (HDLC)

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 CPRI breakout board either encodes the plain text commands in HDLC format or transmits the raw data over the CPRI link. Then, it transmits the data over the CPRI link.
2. Using the **RS232** interface, the CPRI breakout board expects already HDLC encoded data on the RS-232-C input. Then, it transmits the encoded data in direct mode to the DUT. The internal encoding and decoding are deactivated. This method works full duplex, that means encoded HDLC frames are received from the DUT and output at the RS-232-C port. In the other direction, encoded HDLC frames are entered on the RS-232-C and then transmitted via the slow C&M CPRI link to the DUT.



You can use this method in both test modes, the CPRI RE and the CPRI REC test mode.

**State**

Activate the C&M data exchange by means of HDLC protocol.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:CM:HDLC:STATe on page 297

**Bit Rate**

Set the bit rate for transmission of the C&M data.

"<bit rate> kbit/s "

Selects a bit rate from the available values in the list.

**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.

**Table 7-11: Possible HDLC rates of the respective line bit rates**

| Bit rate [Mbit/s] |     |     |     |      |      |      |
|-------------------|-----|-----|-----|------|------|------|
| 1x (614.4)        | 240 | 480 |     |      |      |      |
| 2x (1228.8)       | 240 | 480 | 960 |      |      |      |
| 4x (2457.6)       | 240 | 480 | 960 | 1920 |      |      |
| 5x (3072.0)       | 240 | 480 | 960 | 1920 | 2400 |      |
| 8x (4915.2)       | 240 | 480 | 960 | 1920 | 2400 | 3840 |
| 10x (6144.0)      | 240 | 480 | 960 | 1920 | 2400 | 4800 |
| 16x (9830.4)      | 240 | 480 | 960 | 1920 | 2400 | 7680 |

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:CM:HDLC:BRATe on page 294

**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.

"RS232" Use the RS232 interface for C&M data input or output.

**Note:** This method applies to both, the CPRI RE and the CPRI REC test mode.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:CM:HDLC:SOURce on page 296

**Mode**

Selects the mode for HDLC C&M data transmission.

While the RS232 interface acts as a *Real Time* sink and source, the "Terminal" provides only "Snapshot functionality".

The block diagram shows the internal connections.

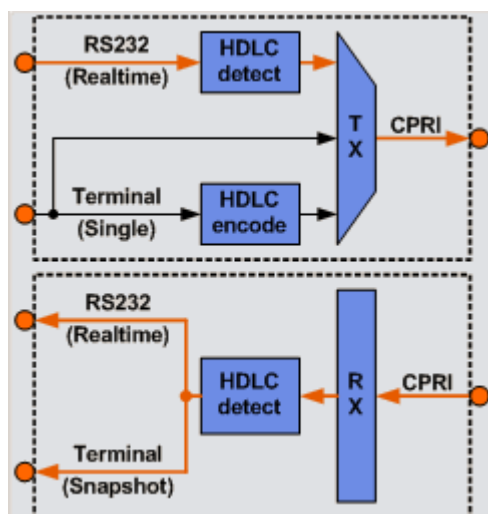


Fig. 7-74: CPRI Slow C&M internal connections

The "Terminal" sink periodically polls the internal receive buffer for new frames. When a high bit rate HDLC signal is received over the CPRI link, not every new frame will be captured and displayed.

On the transmitter side, only single commands can be send using the "Terminal" window.

The RS232 connection however acts as a *Real Time* interface in its speed limits. Every received HDLC frame will be output via RS232 using the specified speed. If the received signal has a higher bit rate than the RS232 interface, frames will be lost.

On the transmitter side the RS232 speed will always be slower than the CPRI slow C&M bit rate so all frames will be transmitted.

"Direct" The R&S EX-IQ-BOX transmits the data directly to the DUT, that means without internal encoding or decoding.

"HDLC EN/DE Coding" The R&S EX-IQ-BOX either encodes the plain text data before transmission to the DUT, or it decodes and then displays the incoming data.

**Note:** This mode applies to HDLC source "Terminal".

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:CM:HDLC:MODE` on page 295

### HDLC Active

The blue LED indicates that the interface is active, red accordingly shows that it is inactive.

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:CM:HDLC:ACTive?` on page 293

### Frames Sent

Indicates the number of sent HDLC frames.

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:CM:HDLC:SFRames?` on page 296

**Frames Received**

Indicates the number of received HDLC frames.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:CM:HDLC:RFRames? on page 295

**Terminal**

The "Terminal" section contains an entry field for control commands, an EXECUTE button to process the entered commands or the command sequences, and a CLEAR button for reset.

**Note:** You can execute this command only, if the number of symbols is divisible by 2. Odd values ☐☐ are not accepted.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:CM:HDLC:COMMand on page 294

[ :SOURce<hw> ] :EBOX:CPRI:CM:HDLC:EXECute on page 295

[ :SOURce<hw> ] :EBOX:CPRI:CM:HDLC:RX? on page 296

[ :SOURce<hw> ] :EBOX:CPRI:CM:HDLC:RST on page 296

**RS232 Settings**

This section contains information on the RS232 interface, as:

"Data Bits"            number of information units.

"Stop Bits"            number of stop bits.

"Parity"                even or odd number of set bits in the binary representation.

"Baudrate"            number of bits that are transmitted per second.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:CM:HDLC:BAUDrate on page 291

**7.2.10.2 Fast C&M (Ethernet)**

The **Ethernet Settings** section comprises the necessary parameters for activating fast control and management data exchange via the Ethernet interface.



In chapter [chapter 4.5, "Connecting the R&S EX-IQ-BOX"](#), on page 42, you find information on how to connect the interface. For more information on the hardware, see the data sheet of the R&S EX-IQ-BOX, option R&S EXBOX-B85 (CPRI breakout board).



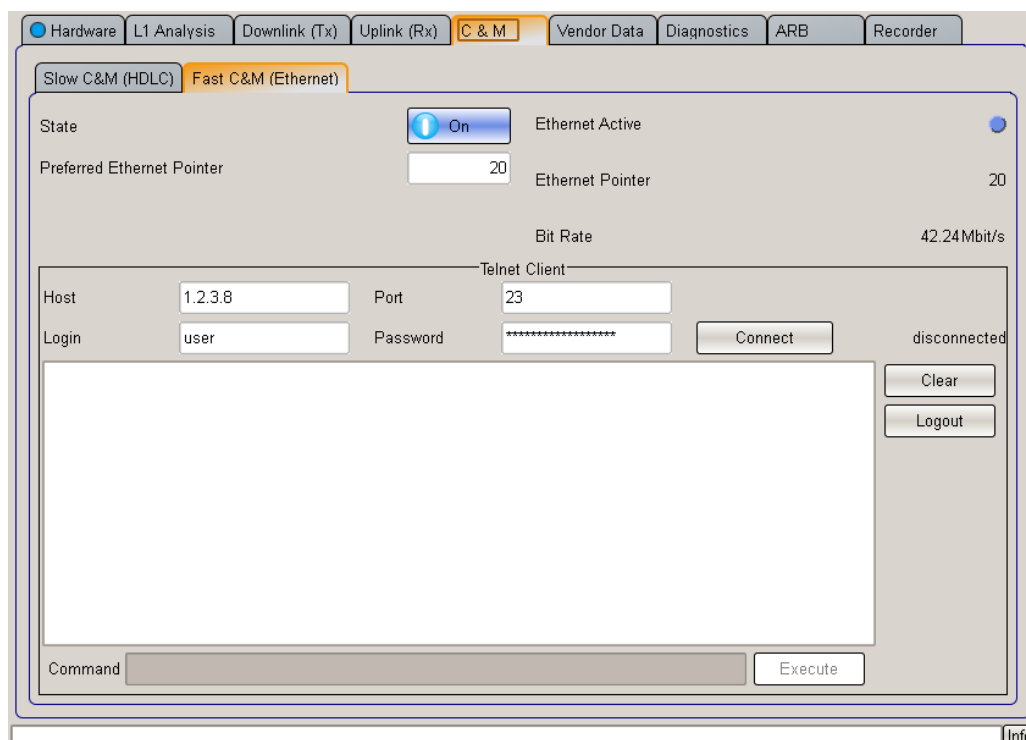


**Fig. 7-75: CPRI Control & Management dialog - Fast C&M (Ethernet)**

R&S DigIConf provides the following setup for transmitting or receiving Fast C&M Data:

By using the fast C&M option, the R&S EX-IQ-BOX tunnels the **Ethernet** protocol over CPRI. The Ethernet port on the breakout board therefore refers to the Ethernet port of the DUT. The Ethernet settings of the DUT are forwarded to the connector of the breakout board. If the DUT uses IP (**I**nternet **P**rotocol), you can access the DUT directly with its IP address via the Ethernet connector on the breakout board.

In CPRI RE test mode, R&S DigIConf also provides an integrated **Telnet** console for fast C&M. However, this console requires that the DUT offers a telnet server on its Fast C&M port.

#### State

Activate the C&M data exchange via the Ethernet interface.

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:CM:ETH:STATE` on page 293

#### Pref. Eth. Pointer

Set the CPRI Ethernet pointer. This setting determines the Fast C&M bit rate, since this pointer represents the boundary between vendor data and Fast C&M Data in the CPRI control block. See also [chapter 7.2.2, "CPRI Transmission Protocol - Overview"](#), on page 129.

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:CM:ETH:PPTR` on page 292

**Ethernet Pointer**

Indicates the resulting Ethernet pointer after the link setup, that means the position after the handshake between the R&S EXBOX-B85 and the DUT.

You can determine this parameter in the C&M tab, which is embedded in the CPRI protocol. RE and REC then read the value of the other, and agree on the smallest.

Valid entries range from 20..63. Depending on the line speed and the pointer the following Ethernet bit rates are achievable:

| Line rate<br>[Mbit/s] | Length of control word<br>[bit] | min. Ethernet bit rate<br>[Mbit/s] | max. Ethernet bit rate<br>[Mbit/s] |
|-----------------------|---------------------------------|------------------------------------|------------------------------------|
| 1x (614.4)            | 8                               | 0.48                               | 21.12                              |
| 2x (1228.8)           | 16                              | 0.96                               | 42.24                              |
| 4x (2457.6)           | 32                              | 1.92                               | 84.48                              |
| 5x (3072.0)           | 40                              | 2.40                               | 105.60                             |
| 8x (4915.2)           | 64                              | 3.84                               | 168.96                             |
| 10x (6144.0)          | 80                              | 4.80                               | 211.20                             |
| 16x (9830.4)          | 128                             | 7.86                               | 337.92                             |

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:CM:ETH:PTR?](#) on page 293

**Ethernet Active**

The LED indicates red, if the interface is inactive. Blue indicates that the Ethernet data transfer is active.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:CM:ETH:ACTive?](#) on page 291

**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 command:

[\[:SOURce<hw>\]:EBOX:CPRI:CM:ETH:BRATe?](#) on page 291

**Host**

Enter the IP Address of the DUT.

**Note:** This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

**Port**

TCP port address for the access to the Telnet server of the DUT.

**Note:** This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

**Login / Password**

If a specific user name and password are requested for login, enter the user name in this field, and the password in the field right beside.

**Note:** This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

**Connect**

Set up the Telnet connection. On the right of the connect button, R&S DiglConf indicates the current status of the connection.

**Note:** This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

**Input Window, Command line, Execute**

The lower part of the fast C&M tab provides an entry field to enter control commands manually. The commands are displayed in the input window above. EXECUTE executes the command, or the command sequence.

**Note:** This functionality refers to the integrated telnet client and applies only to CPRI RE test mode.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:CM:ETH:COMMand on page 292

[ :SOURce<hw> ] :EBOX:CPRI:CM:ETH:EXECute on page 292

**Clear**

Erases the entries and the input window.

Remote command:

n.a.

**Logout**

Logs off the session.

Remote command:

n.a.

## 7.2.11 Vendor Data

The **Vendor Data** tab provides the input of user-specific information, like for example additional control data. The R&S EX-IQ-BOX then transmits the data embedded in the CPRI protocol.

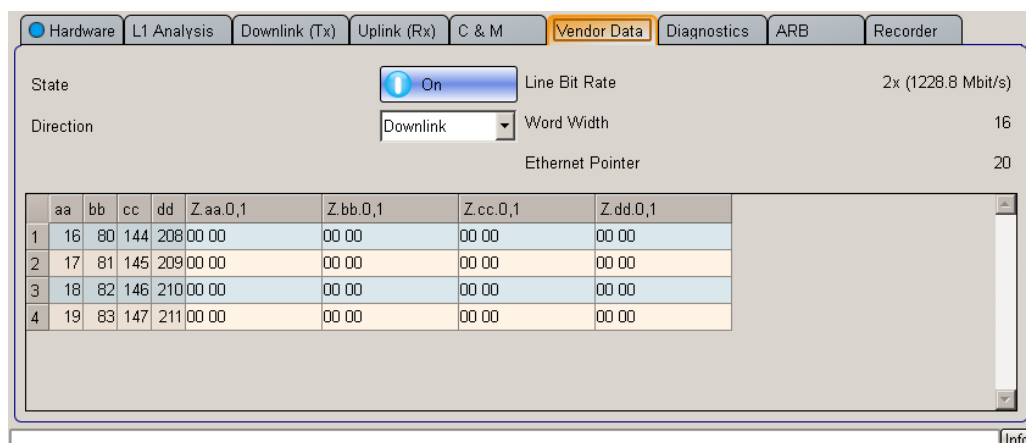


Fig. 7-76: CPRI Vendor Data dialog

**State**

Activate the vendor data exchange.

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:VENDOR:STATE on page 353

**Direction**

Select the transmission path of the data shown in the "Vendor Data Table" on page 203.

"Downlink"

- **CPRI RE test mode (Tx)**  
User data entered in the table is embedded in the CPRI link for transmission to the DUT.
- **CPRI REC test mode (Rx)**  
Vendor data is extracted from the CPRI link and displayed in the table.

"Uplink"

- **CPRI RE test mode (Rx)**  
Vendor data is extracted from the CPRI link and displayed in the table.
- **CPRI REC test mode (Tx)**  
User data entered in the table is embedded in the CPRI link for transmission to the DUT.

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:VENDOR:DIRECTION on page 353

**Line Bit Rate**

Indicates the line bit rate. Depending on the line bit rate, the vendor data words can be 2, 4 or 5 bytes wide.

**Note:** Set the bit rate in the hardware tab, under "CPRI Line Bit Rate" on page 157. The bit rate and thus the word length is determined by the DUT.

Remote command:

[ :SOURCE<hw> ] :EBOX:CPRI:HW:LBRate on page 305

### Word Width

Indicates the word width. The word width depends on the CPRI line bit rate.

The following table shows the word width related to the line bit rate.

**Table 7-12: Word width related to the line bit rate**

| Line bit rate [Mbit/s] | Word width [bits] |
|------------------------|-------------------|
| 1x (614.4)             | 8                 |
| 2x (1228.8)            | 16                |
| 4x (2457.6)            | 32                |
| 5x (3072.0)            | 40                |
| 8x (4915.2)            | 64                |
| 10x (6144.0)           | 80                |
| 16x (9830.4)           | 128               |

**Note:** By determining the line bit rate, the DUT also defines the word width. See also ["CPRI Line Bit Rate"](#) on page 157.

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:VENDor:WWIDth?](#) on page 353

### Ethernet Pointer

Indicates the resulting Ethernet pointer after the link setup, that means the position after the handshake between the R&S EXBOX-B85 and the DUT.

You can determine this parameter in the C&M tab, which is embedded in the CPRI protocol. RE and REC then read the value of the other, and agree on the smallest.

Valid entries range from 20..63. Depending on the line speed and the pointer the following Ethernet bit rates are achievable:

| Line rate [Mbit/s] | Length of control word [bit] | min. Ethernet bit rate [Mbit/s] | max. Ethernet bit rate [Mbit/s] |
|--------------------|------------------------------|---------------------------------|---------------------------------|
| 1x (614.4)         | 8                            | 0.48                            | 21.12                           |
| 2x (1228.8)        | 16                           | 0.96                            | 42.24                           |
| 4x (2457.6)        | 32                           | 1.92                            | 84.48                           |
| 5x (3072.0)        | 40                           | 2.40                            | 105.60                          |
| 8x (4915.2)        | 64                           | 3.84                            | 168.96                          |
| 10x (6144.0)       | 80                           | 4.80                            | 211.20                          |
| 16x (9830.4)       | 128                          | 7.86                            | 337.92                          |

Remote command:

[\[:SOURce<hw>\]:EBOX:CPRI:CM:ETH:PTR?](#) on page 293

### Vendor Data Table

For CPRI RE downlink or CPRI REC uplink, you can determine vendor-specific data for transmission. In receive direction, that means in uplink for CPRI RE and downlink for CPRI REC test modes, the table shows the received vendor specific data, and switches into read-only mode.

Find additional information on vendor data exchange in the CPRI specification.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:VENDor:DATA<ch> on page 352

## 7.2.12 Diagnostics

The "Diagnostics" tab comprises information about the optical transceiver modules.

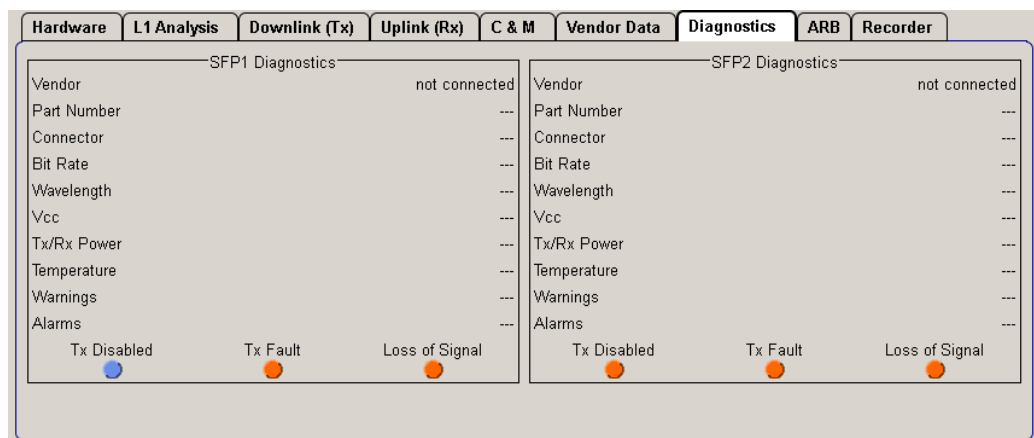


Fig. 7-77: CPRI Diagnostics dialog (1409.7208.02)



Fig. 7-78: CPRI Diagnostics dialog (1409.7208.04)

### 7.2.12.1 SFP Diagnostics

Sections **SFP1/SFP2 Diagnostics** indicate the most important parameters of the SFP transceiver modules.



Difference between the R&S EXBOX-B85 breakout board versions

- 1409.7208.02 covers two SFP cages.
- 1409.7208.04 has a single SFP cage.

#### SFP Diagnostics

Contains information on the SFP modules and their characteristics.

**Note:** The CPRI breakout board (1409.7208.02) covers two SFP cages, while the variant (1409.7208.04) has a single SFP cage.

|               |                                                                                                                                            |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| "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, like 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, that is if one or more of the Vcc, Tx/Rx power or temperature values are out of the permitted value range. |

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:TEST:SFP<st>:INFO?` on page 327

#### SFP LEDs

The LEDs in sections SFP 1 and 2 indicate the states at the SFP interfaces. The LEDs must be blue. Red LEDs indicate errors.

|               |                                                                                                                |
|---------------|----------------------------------------------------------------------------------------------------------------|
| "Tx Disabled" | Indicates, if the interface of the breakout board and the SFP transmission line is disabled.                   |
| "Tx Fault"    | Indicates when a transmission error occurs. If the SFP is disconnected, R&S DigIConf displays "Not Available". |

"Loss of Signal" Indicates that data communication failed and the signal is lost.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:TEST:SFP<st>:TX:DISabled? on page 328

[ :SOURce<hw> ] :EBOX:CPRI:TEST:SFP<st>:TX:FAULt? on page 328

[ :SOURce<hw> ] :EBOX:CPRI:TEST:SFP<st>:LOS? on page 327

### 7.2.13 ARB

The "ARB Sources" section displays all fields that are relevant for loading a waveform file in the waveform memory of the R&S EX-IQ-BOX.

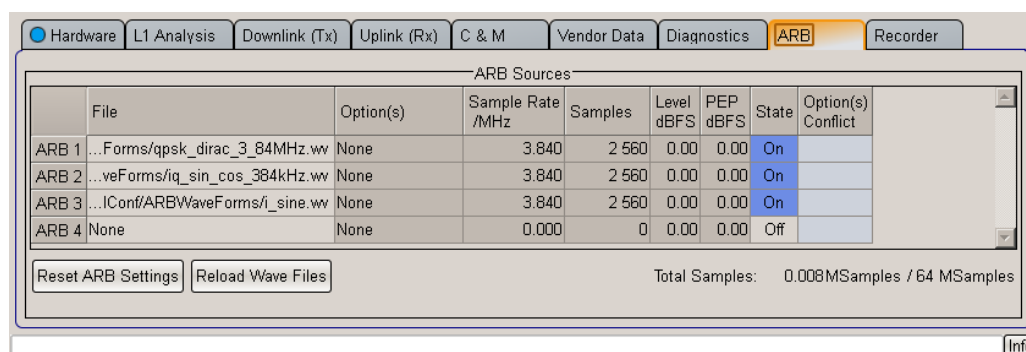


Fig. 7-79: CPRI ARB dialog



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, that means in CPRI RE test mode, the R&S EX-IQ-BOX sends in the downlink, and in CPRI REC test mode in the uplink.

Conversely, for operating in receiver mode, the R&S EX-IQ-BOX provides a recording memory. The signal data, coming from the DUT can be recorded over a period of time and then saved in a file, see [chapter 7.2.14, "Recorder"](#), on page 207.

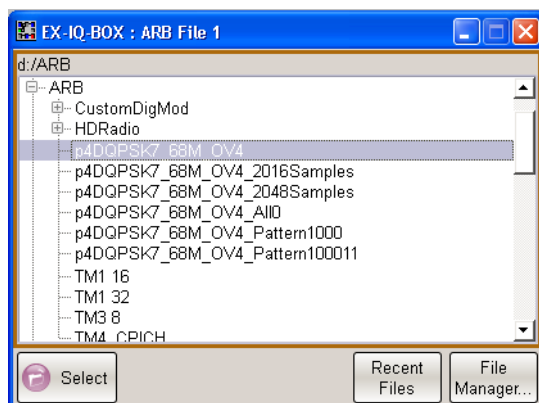


Waveform Memory and Recording Memory require that the R&S EX-IQ-BOX is equipped with the respective options. For information on available options refer to [chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory"](#), on page 23.

#### File

Open an explorer dialog for loading a waveform file.





The **recent data sets** directory shows the files last used.

Select the directory where waveform files are stored. The available waveform files, identifiable by the file extension \*.wav are shown.

The "Select" button loads the marked file and returns to the "ARB" dialog. The "ARB Sources" table indicates the file name and its path, that means the directory where the file is stored.

**Note:** The FILE MANAGER button leads to a dialog used to copy, delete and rename files, and to create new directories.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB<ch>:FILE on page 289

### 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 EXBOX-K242, which represents the 3GPP-FDD-Standard. "None" indicates that the loaded waveform file was created with another software, or does not base on a digital standard signal.

**Note:** Find the list of supported R&S options in chapter [chapter 3.2.2.4, "Digital Standards with R&S WinIQSIM2"](#), on page 23.

Remote command:

Installed options: [ :SOURce<hw> ] :EBOX:OPT on page 250

### 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 command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB<ch>:SRATe? on page 290

### Samples

Indicates the number of samples the loaded signal is composed of.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB:SAMPles:TOTal? on page 288

**Level dBFS**

Displays the signal level in terms of an rms value, in dBFS (Full Scale ratio).

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB:RMS? on page 288

**PEP dBFS**

Displays the signal level in terms of a peak envelope power value (PEP). The unit of the peak envelope power is dBFS (Full Scale ratio).

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB:PEAK? on page 287

**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 173. The R&S EX-IQ-BOX then embeds the signal into the CPRI protocol.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB<ch>:STATe on page 290

**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 command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB<ch>:CONFLICT? on page 289

**Reset**

Erases the ARB table, that means all loaded waveform files and their settings.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB:PRESet on page 288

**Reload**

Update the waveform file in R&S DigIConf, in case waveform data have changed. Reload updates all currently assigned files.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB:RELoad on page 288

**Total Samples**

Indicates the total number of samples, added up from all active ARB files.

Remote command:

[ :SOURce<hw> ] :EBOX:CPRI:ARB:SAMPLEs:TOTAL? on page 288

## 7.2.14 Recorder

The **Recorder** dialog covers the parameters relevant for recording an I/Q signal and storing the data in a waveform file.

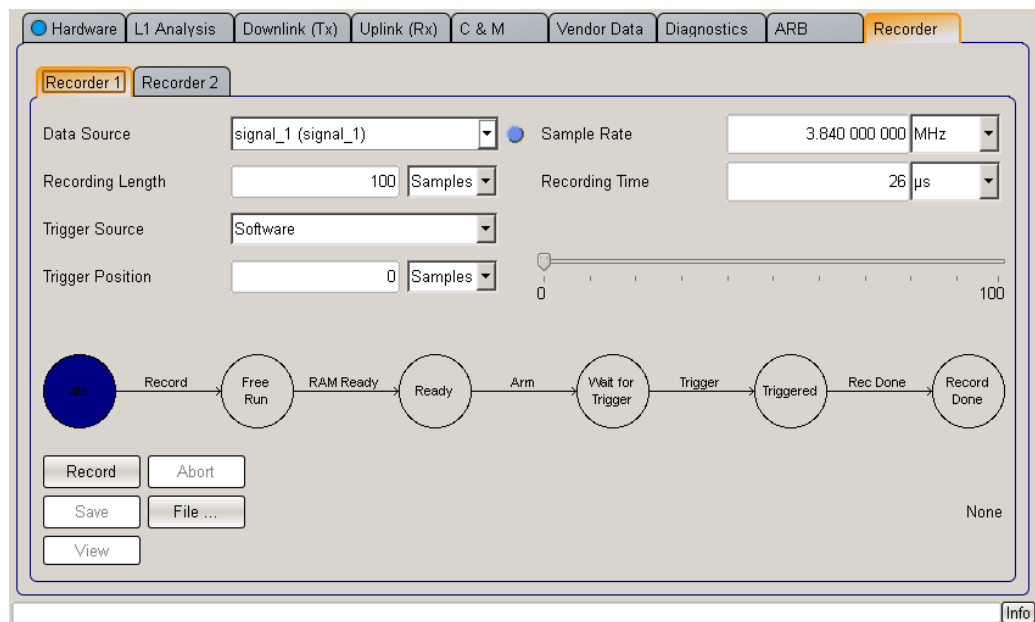


**Fig. 7-80: CPRI Recorder dialog**

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 for example, each uses 64 MS.

The recording memory provides a predefined resolution of 16 bits, each for I and Q. That means the recorded I/Q data use always 16 bits in memory, regardless of the resolution of the source.

The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, records it over a period of time and provides storing the recorded data in a waveform file.



The recorder function applies to receiver mode, when the R&S EX-IQ-BOX is receiving a signal from the DUT. That means, it is possible to record an uplink signal of the CPRI RE test mode or a downlink signal of the CPRI REC test mode.

Conversely, for operating as transmitter, the R&S EX-IQ-BOX provides a waveform memory, see [chapter 7.2.13, "ARB"](#), on page 205. Stored signal data can be replayed and then sent to the DUT.



Waveform Memory and Recording Memory are provided, when the R&S EX-IQ-BOX is equipped with the respective options. For information on available options refer to [chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory"](#), on page 23.

The I/Q signal data are stored in the R&S waveform format (.wav), the same format as used in the ARB.

The stored waveforms can be used customer-specific, or replayed in the ARB of the R&S EX-IQ-BOX. Use this function for post-processing the signals offline.

### Data Source

Select the signal source. All Rx signals are available. In order to record a signal, the signal must be selected and activated in the respective Rx. Either the uplink signal in CPRI RE test mode, or the downlink signal of the CPRI REC test mode are possible.

Assign a signal and turn it on with [Signal State](#)

The LED next to "Data Source" must be blue. It indicates that the selected signal is active. Otherwise recording cannot be started.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:REOrder<ch>:DATA:SOURce:CATalog?`

on page 317

`[ :SOURce<hw> ] :EBOX:CPRI:REOrder<ch>:DATA:SOURce` on page 317

### Recording Length

Set the length of data trace in samples.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:REOrder<ch>:RLENgth` on page 319

### 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" Starts the recording immediately after the RECORD button is pressed. No other event is necessary.

"External Trigger 1...3"  
Starts 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 PURPOSE IO interface.

"Tx/Rx Hyper Frame"  
Starts recording after a Tx/Rx Hyper frame is received.

"Tx/Rx NodeB Frame"  
Starts recording after a Tx/Rx NodeB frame is received.

"Sync Pattern" Starts recording after a specific *Sync Pattern* is received.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:REOrder<ch>:TRIGger:SOURce` on page 321

### Trigger Position

Determine the position of the trigger event on the waveform. The position provides to realize a pre-trigger recording, as well as a post-trigger recording. The value is set in samples from 0 to "Recording Length"-1.

- **Post-trigger**, that means position 0 at the beginning of the waveform enables you to evaluate the signal after the trigger event.

- **Pre-trigger**, 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 command:

[\[:SOURCE<hw>\]:EBOX:CPRI:RECOder<ch>:TRIGger:POSition](#) on page 320

### Sample Rate

Indicates the sample rate of the signal to be recorded.

Remote command:

[\[:SOURCE<hw>\]:EBOX:CPRI:RECOder<ch>:DATA:SRATe?](#) on page 317

### Recording Time

Indicates the duration of recording. The recording time results from the recording length and the sample rate.

Remote command:

[\[:SOURCE<hw>\]:EBOX:CPRI:RECOder<ch>:RTIME?](#) on page 319

### Recorder Status Diagram



Displays graphically the current process step of the recording.

- "Idle" The recording process is inactive. Configure the recorder in that state. The recorder remains in Idle state until you start with the "Record" button.
- "Free Run" The recorder records the signal continuously in a ring memory. These data are required for pre-trigger analyzes.
- "Ready" Recording passed through the ring memory once at least, and thus 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 command:

[\[:SOURCE<hw>\]:EBOX:CPRI:RECOder<ch>:STATus?](#) on page 320

**Record**

Starts the recording.

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:RECOOrder<ch>:EXECute` on page 318

**Abort / Discard**

Stops and cancels the recording. You can abort the recording process at any time.

After recording "Record Done", the ABORT button label changes to DISCARD.

**Note:** Avoid data loss!. Discard erases the recorder memory. In order to keep the data, save it first by pressing TARGET FILE....

DISCARD changes the recording status from "Record Done" back to "Idle" and is ready for a new recording.

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:RECOOrder<ch>:ABORT` on page 317

**Save to File**

Save the data in a file.

**Note:** CPRI stores the recorded data in the R&S WinIQSim2 waveform file format with the predefined file extension `*.wv`. By default, waveform files are stored in the directory **%Program Files%/Rohde-Schwarz/DigIConf/Settings**, unless another directory is selected. File name and the directory are user-selectable.

Remote command:

`[ :SOURCE<hw> ] :EBOX:CPRI:RECOOrder<ch>:FILE:CREate` on page 318

**Save**

Open a file dialog to select directory and file name for storing the recorded data.

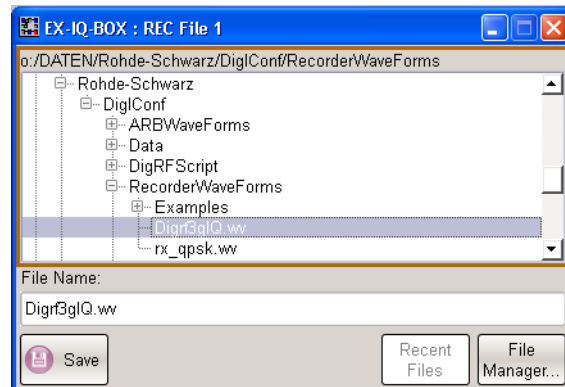


**Fig. 7-81: CPRI Recorder > File dialog**

The "Recent Files" directory shows the files last used. Select the directory where recorded files are stored. The available files, identifiable by the file extension `*.wv` are shown. The "Select" button loads the marked file and returns to the "Recorder" settings dialog.

The "File Manager" button leads to a dialog used to copy, delete and rename files, and to create new directories.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:REOrder<ch>:FILE:SElect` on page 318

### **View**

Calls the ARB toolbox, a viewer program to display the loaded IQ data stream.

Remote command:

`[ :SOURce<hw> ] :EBOX:CPRI:REOrder<ch>:VIEW` on page 321

## 8 Remote Control Basics

This chapter provides basic information on operating R&S DigIConf via remote control.



### Information on used term for R&S DigIConf

Throughout this description, the term “instrument” is used to indicate R&S DigIConf; the terms “instrument”, “software” and R&S DigIConf are used interchangeably.

## 8.1 Remote Control Interfaces and Protocols

R&S DigIConf supports a LAN (Local Area Network) interface for remote control, using socket communication protocol, i.e. Raw Socket (simple telnet). The interface is based on TCP/IP with VISA resource string composed of:

TCPIP::<ipaddr>::<port>::SOCKET



No VISA installation is necessary to remote control while using socket communication.

For a description of the protocol refer to [chapter 8.1.2, "LAN interface"](#), on page 214.

### SCPI (Standard Commands for Programmable Instruments)

SCPI commands - messages - are used for remote control. Commands that are not taken from the SCPI standard follow the SCPI syntax rules. R&S DigIConf supports the SCPI version 1999. The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers. The tutorial "Automatic Measurement Control - A tutorial on SCPI and IEEE 488.2" from John M. Pieper (R&S order number 0002.3536.00) offers detailed information on concepts and definitions of SCPI.

Tables provide a fast overview of the bit assignment in the status registers. The tables are supplemented by a comprehensive description of the status registers.

### 8.1.1 Messages

There are different types of instrument messages, depending on the direction they are sent:

- Commands
- Responses



Structure and syntax of messages are described in [chapter 8.2, "SCPI Command Structure"](#), on page 222. A detailed description of all messages available for R&S DigIConf is provided in [chapter 9, "Remote Control Commands"](#), on page 236.



## Commands

Commands (program messages) are messages the controller sends to R&S DigIConf. They operate functions and request information.

The commands are subdivided according to two criteria:

- According to the effect they have on the instrument:
  - **Setting commands** cause instrument settings such as a reset of the instrument or setting the frequency.
  - **Queries** cause data to be provided for remote control, e.g. for identification of the instrument or polling a parameter value. Queries are formed by directly appending a question mark to the command header.
- According to their definition in standards:
  - **Common commands:** their function and syntax are precisely defined in standard IEEE 488.2. They are employed identically on all instruments (if implemented). They refer to functions such as management of the standardized status registers, reset and self test.
  - **Instrument control commands** refer to functions depending on the features of the instrument such as frequency settings. Many of these commands have also been standardized by the SCPI committee. These commands are marked as "SCPI compliant" in the command reference chapters. Commands without this SCPI label are device-specific, however, their syntax follows SCPI rules as permitted by the standard.

## Instrument responses

Instrument responses (response messages and service requests) are messages the R&S EX-IQ-BOX sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status.

### 8.1.2 LAN interface

For remote control via a network, the controller and the PC on that the R&S DigIConf is installed (if not the same) must be connected via the LAN interface to a common network with TCP/IP network protocol. They are connected using a commercial RJ-45 cable.

Software for remote control must be installed on the controller.

#### IP address

Only the IP address or the computer name (LAN device name) is required to set up the connection. The IP address/computer name is part of the "visa resource string" used by the programs to identify and control the instrument. The visa resource string has the form:

TCPIP::host address::[LAN device name]::[SOCKET], where:

- **TCPIP** designates the network protocol
- **host address** is the IP address
- **LAN device name** is the computer name of the control device (alternative to IP address)
- **SOCKET** indicates that the socket protocol is used

In case the R&S DigIConf and the controller are installed on the same PC, the IP address *127.0.0.1* or *Local Host* is used. Hence the valid visa resource string is:

```
TCPIP::127.0.0.1::INSTR
```



### Identifying instruments in a network

If several instruments are connected in a network, each instrument has its own IP address and associated resource string. The controller identifies these instruments by means of the resource string.

### Socket communication

An alternative way for remote control of the software is to establish a simple network communication using sockets. The socket communication, also referred as "Raw Ethernet communication" or "Raw socket", does not require a VISA installation on the remote controller side. Connection can also be performed with "Win Socket" communication.



An alternative way to establish a socket communication is to use a build-in telnet program. The telnet program is part of every operating system and supports a communication with the software on a command-by-command basis. For better utilization and to enable automation by means of programs, user defined sockets can be programmed.

Socket connections are established on a specially defined port. The socket address is a combination of the IP address or the host name of the instrument and the number of the port configured for remote-control. R&S DigIConf uses port number 5026 for this purpose by default, but can be set. The port is configured for communication on a command-to-command basis and for remote control from a program.

## 8.1.3 Starting a Remote Control Session

The instrument and the controller have to be connected with the suitable cable and switched on.

A remote control program must open a connection to R&S DigIConf (using Raw socket or VISA functionality), before it can send commands to and receive device responses from R&S DigIConf.

Refer to [chapter 8.1.5, "Examples"](#), on page 216 for practical examples on setting up of a remote control link and starting of a remote control session.

## 8.1.4 Switching to Remote Control

When it is started, the software is always in the manual operating state and can be operated via the block diagram.

### Starting remote control

Send a command from a controller to the signal generation software.

The software is in a remote control state as soon as it receives a command from the controller.

### 8.1.5 Examples

These sections provides examples for setting up of remote control connection and starting a remote control session over LAN interface.

This section assumes basic knowledge of programming and operation of the controller. A description of the interface commands can be obtained from the relevant manuals.

#### 8.1.5.1 Remote Control Over LAN Using Socket Protocol

Through the examples in this section, the program 'Measurement & Automation Explorer' from National Instruments under Windows operating system is used for setting up a LAN remote control link and starting a remote control session.

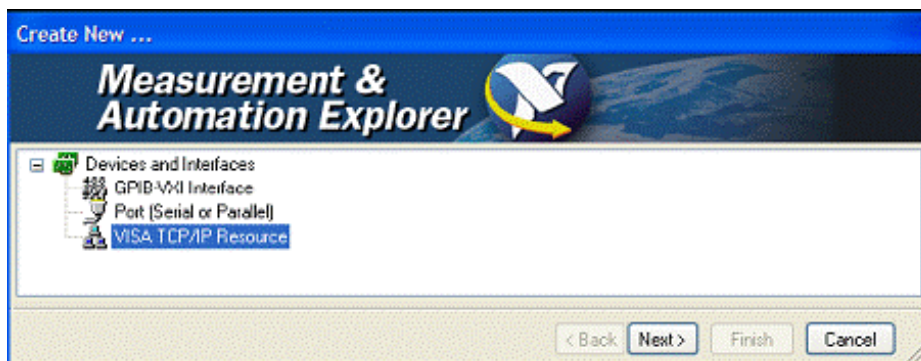
##### Configuring the controller

To enable the external controller to communicate with the software via TCP/IP protocol, set up a remote control link as follow:

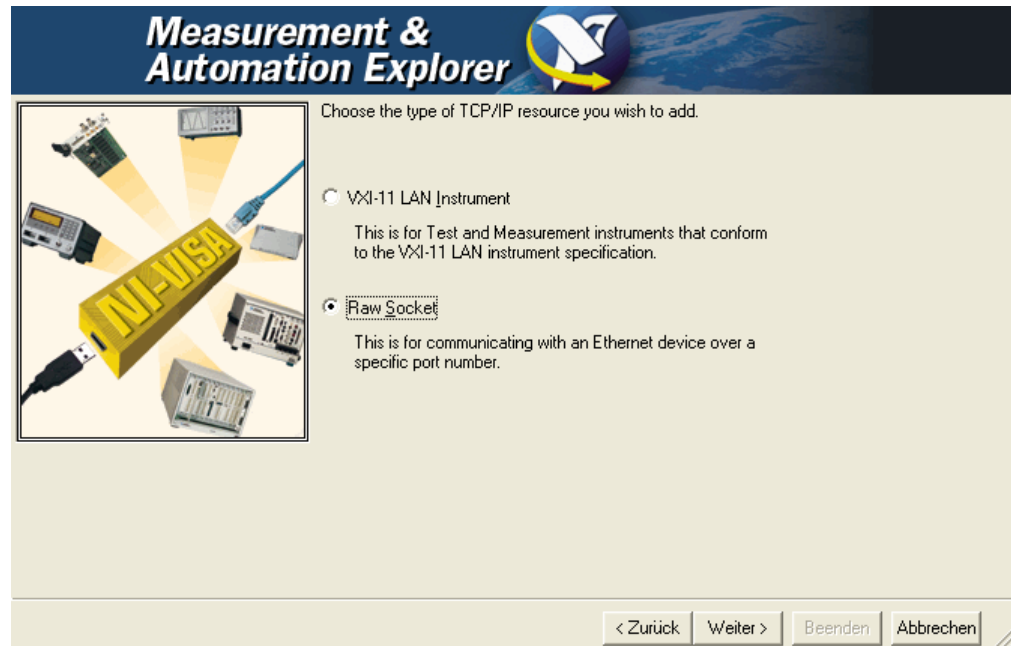
1. Connect the controller and the instrument to the network (network cable) and switch them on.
2. Start the 'Measurement & Automation Control' program on the controller.
3. Select "Devices and Interfaces > Create New".



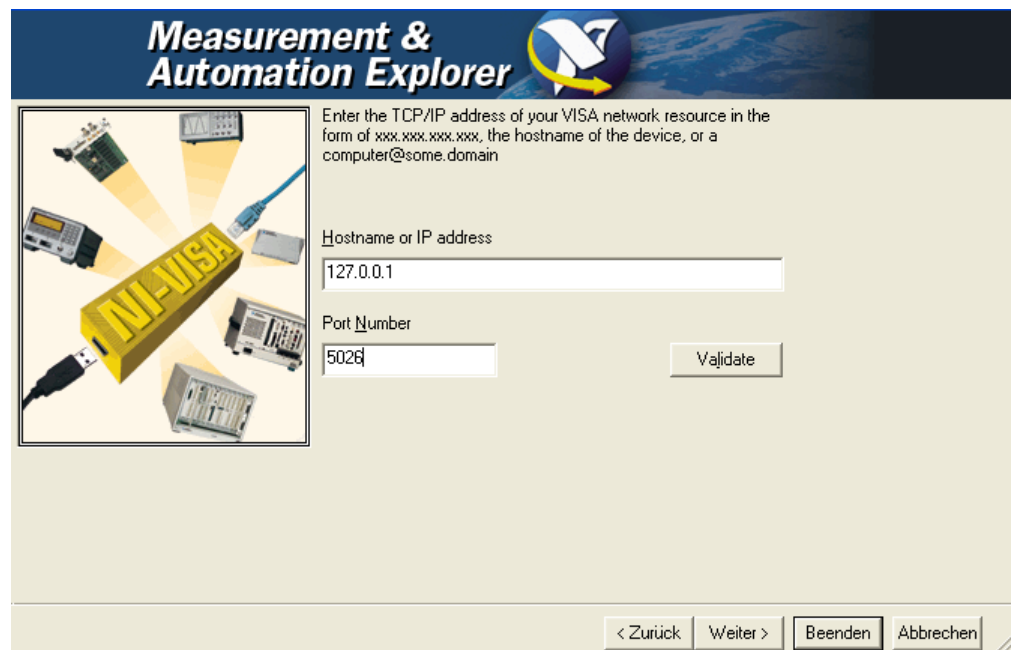
4. Select "VISA TCP/IP Resource" and confirm with "Next".



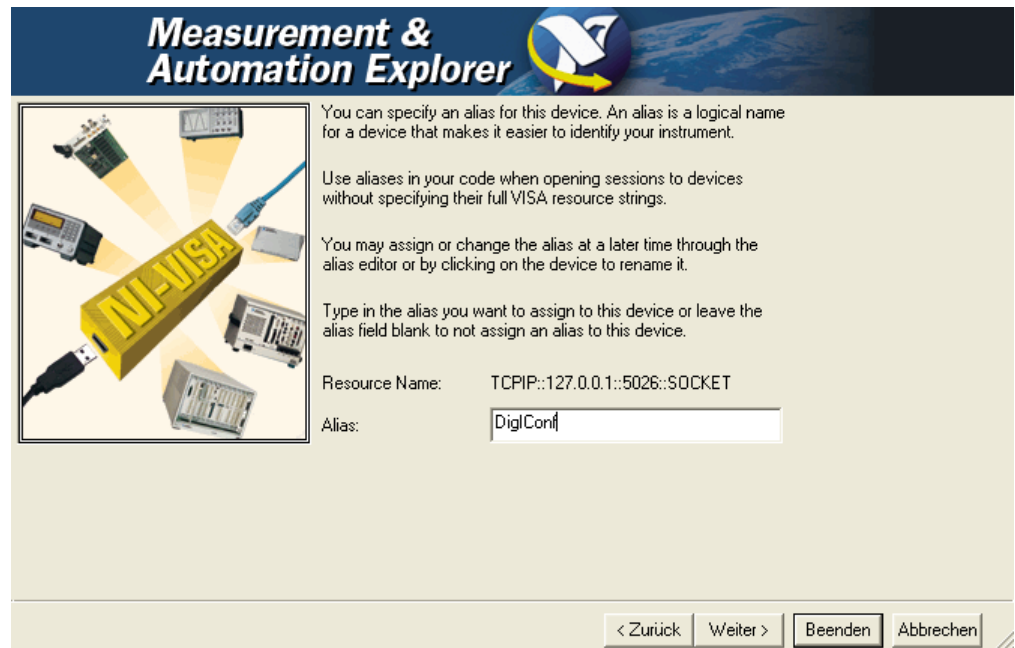
5. Choose the type of TCP/IP resource you wish to add and select "Next".



6. Enter the IP address or the host name of R&S DigIConf and select "Next".

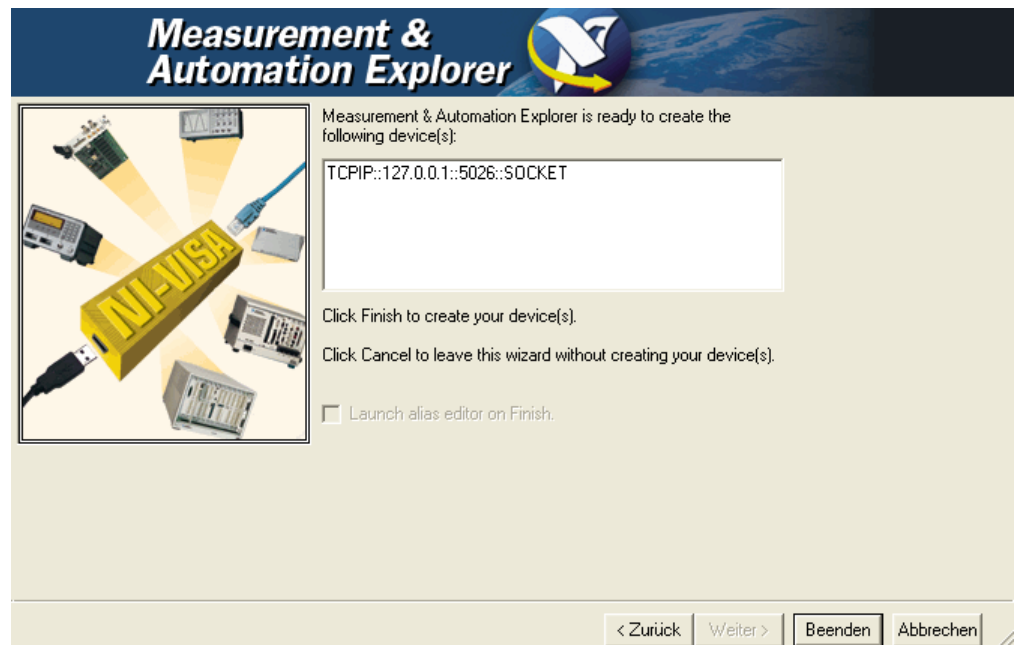


7. Enter the alias name if required.

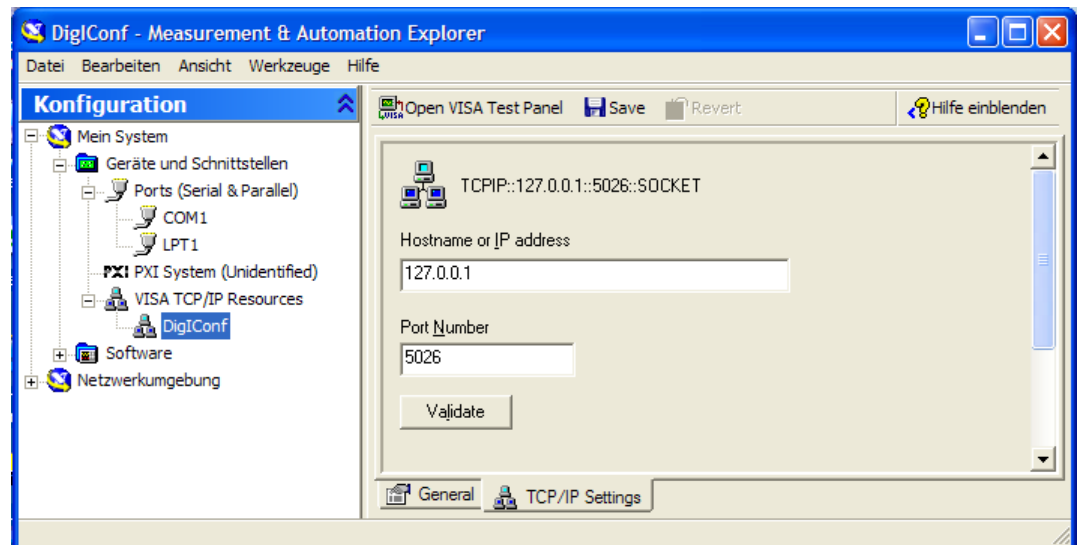


The alias name must not be mistaken for the computer name. It is only used for instrument identification within the program and displayed in the menu as an option in case of an Ethernet link.

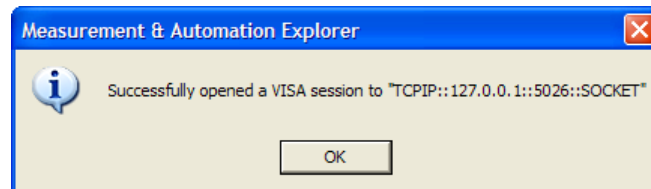
8. Confirm the settings with "Finish".



The instrument is configured and the settings are displayed in the "TCP/IP Settings" tab.



9. To test the connection, select "Validate".



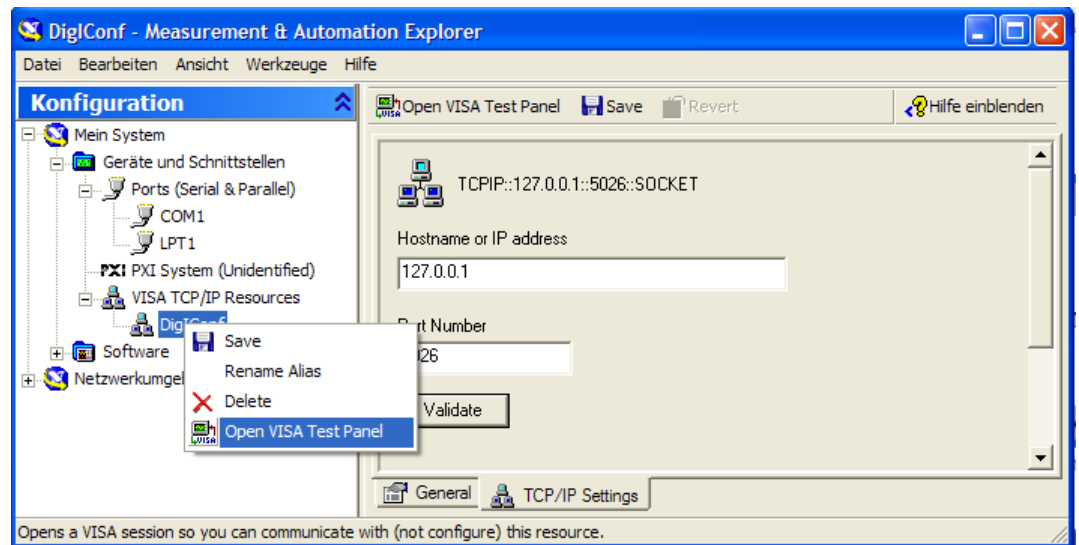
A message indicates whether the link to the instrument can be set up or not.

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.

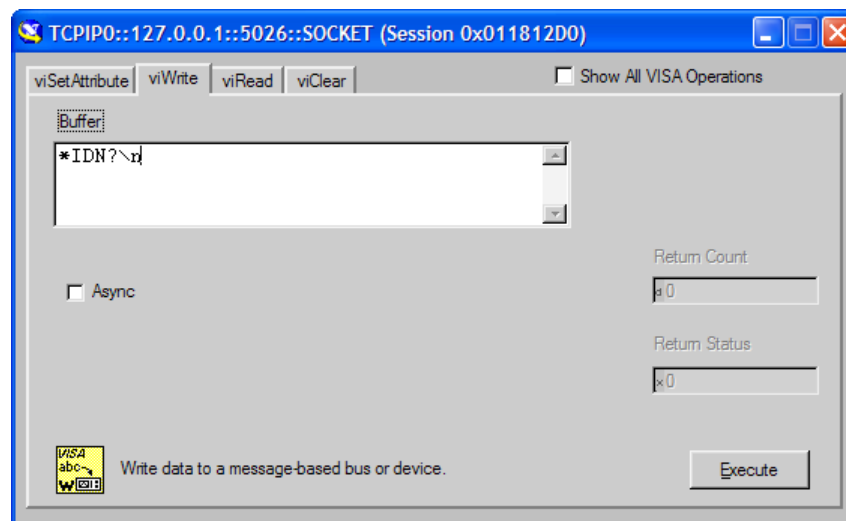
R&S DigIConf is now registered in the program and can be addressed via the resource string or alias name.

### Starting a remote control over LAN

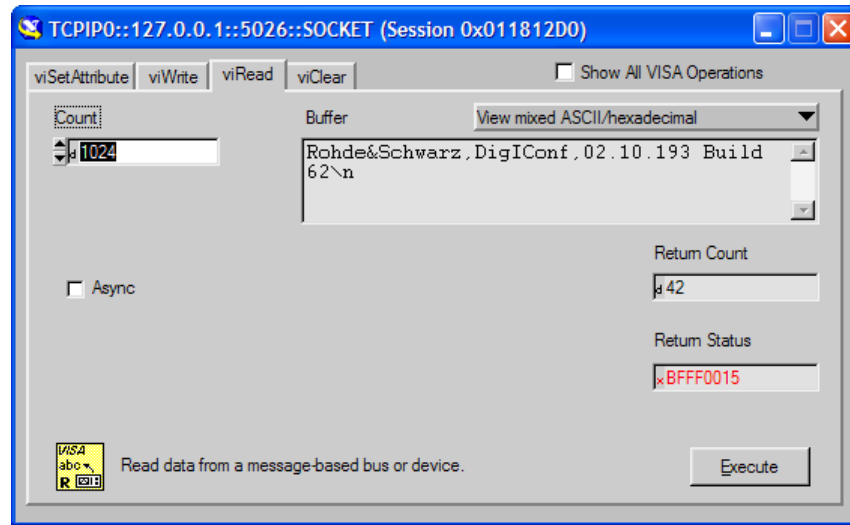
1. Start the 'Measurement & Automation Explorer' on the controller.
2. In the "Configuration" window, select "Device and Interfaces > VISA TCP/IP Resources", select the required instrument and select "Open VISA Test Panel".



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.



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.

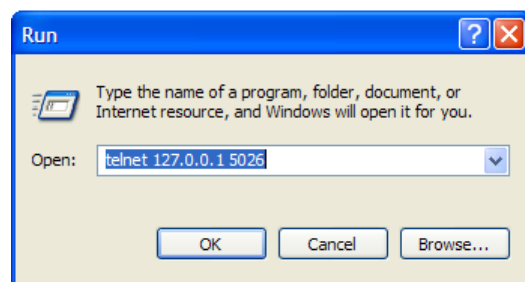
To control the software, only a telnet program is required. The telnet program is part of every operating system.

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.

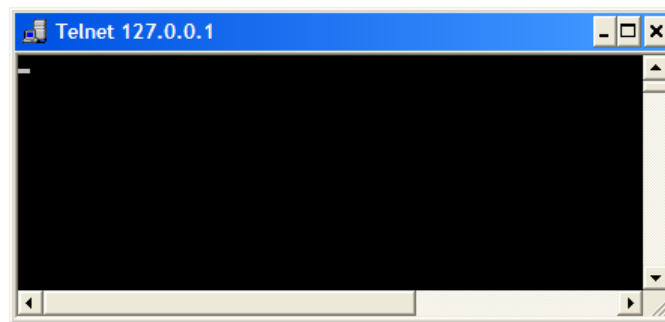
**Tip:**

R&S DigIConf uses the port number 5026 for remote connection via Telnet.

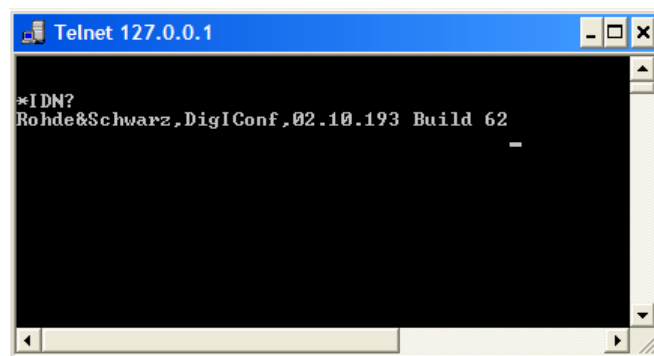


The connection to the instrument is set up and remote-control commands can be sent.

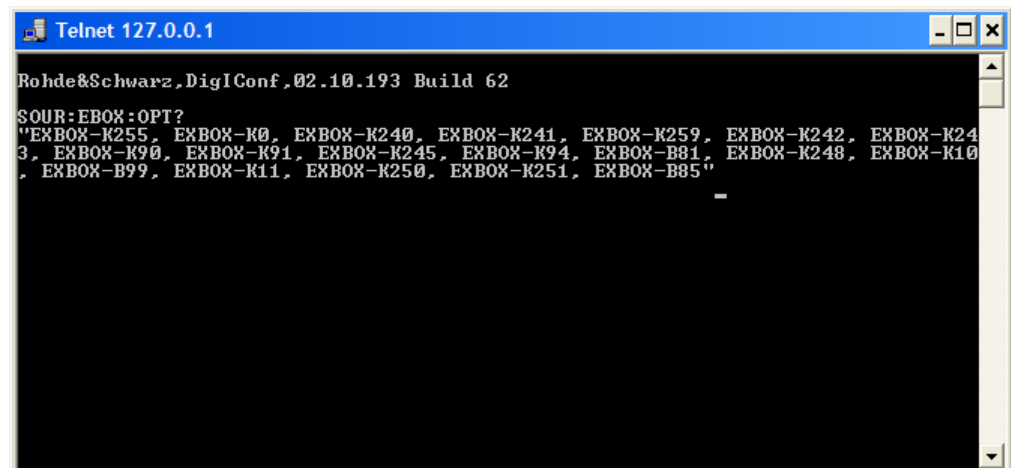




2. Even if the cursor is not visible on the screen, enter blind a remote-control command and confirm with Enter.



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.

## 8.2 SCPI Command Structure

SCPI commands consist of a so-called header and, in most cases, one or more parameters. The header and the parameters are separated by a "white space" (ASCII code 0

to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several mnemonics (key-words). Queries are formed by appending a question mark directly to the header.

The commands can be either device-specific or device-independent (common commands). Common and device-specific commands differ in their syntax.



#### Restrictions in the use of SCPI commands in R&S DigIConf

R&S DigIConf does not support the entire functionality of the SCPI commands. Note the following restrictions:

- 2 commands entered in a row are not provided (usually divided by a semicolon)
- only a limited subset of Common Commands is available
- no status reporting system

### 8.2.1 Syntax for Common Commands

Common (=device-independent) commands consist of a header preceded by an asterisk (\*) and possibly one or more parameters.

#### Example:

|       |                             |                                                 |
|-------|-----------------------------|-------------------------------------------------|
| *RST  | RESET                       | Resets the instrument.                          |
| *IDN? | IDENTIFICATION QUERY        | Queries the instrument identification string.   |
| *OPT? | OPTION IDENTIFICATION QUERY | Queries the options included in the instrument. |

## 8.2.2 Syntax of Device-Specific Commands



### Optional note heading

Not all commands used in the following examples are necessarily implemented in the instrument.

For demonstration purposes only, assume the existence of the following commands for this section:

- `DISPlay[:WINDow<1...4>]:MAXimize <Boolean>`
- `FORMat:READings:DATA <type>[,<length>]`
- `HardCOPy:DEvice:COLor <Boolean>`
- `HardCOPy:DEvice:CMAP:COLor:RGB <red>,<green>,<blue>`
- `HardCOPy[:IMMediate]`
- `HardCOPy:ITEM:ALL`
- `HardCOPy:ITEM:LABel <string>`
- `HardCOPy:PAGE:DIMensions:QUADrant [<N>]`
- `HardCOPy:PAGE:ORientation LANDscape | PORTrait`
- `HardCOPy:PAGE:SCALE <numeric value>`
- `MMEMemory:COPY <file_source>,<file_destination>`
- `SENSE:BANDwidth|BWIDth[:RESolution] <numeric_value>`
- `SENSe:FREQuency:STOP <numeric value>`
- `SENSe:LIST:FREQuency <numeric_value>{,<numeric_value>}`

### Long and short form

The mnemonics feature a long form and a short form. The short form is marked by upper case letters, the long form corresponds to the complete word. Either the short form or the long form can be entered; other abbreviations are not permitted.

#### Example:

`HardCOPy:DEvice:COLor ON` is equivalent to `HCOP:DEV:COL ON`



### Case sensitivity

Upper case and lower case notation only serves to distinguish the two forms in the manual, the instrument itself is case-insensitive.

### Numeric suffixes

If a command can be applied to multiple instances of an object, e.g. specific channels or sources, the required instances can be specified by a suffix added to the command.

Numeric suffixes are indicated by angular brackets (<1...4>, <n>, <i>) and are replaced by a single value in the command. Entries without a suffix are interpreted as having the suffix 1.

**Example:**

Definition: `HardCOpy:PAGE:DIMensions:QUADrant [<N>]`

Command: `HCOP:PAGE:DIM:QUAD2`

This command refers to the quadrant 2.

**Different numbering in remote control**

For remote control, the suffix may differ from the number of the corresponding selection used in manual operation. SCPI prescribes that suffix counting starts with 1. Suffix 1 is the default state and used when no specific suffix is specified.

Some standards define a fixed numbering, starting with 0. With GSM, for instance, slots are counted from 0 to 7. In remote control, the slots are selected using the suffixes 1 to 8. If the numbering differs in manual operation and remote control, it is indicated for the corresponding command.

**Optional mnemonics**

Some command systems permit certain mnemonics to be inserted into the header or omitted. These mnemonics are marked by square brackets in the description. The instrument must recognize the long command to comply with the SCPI standard. Some commands are considerably shortened by these optional mnemonics.

**Example:**

Definition: `HardCOpy[:IMMediate]`

Command: `HCOP:IMM` is equivalent to `HCOP`

**Optional mnemonics with numeric suffixes**

Do not omit an optional mnemonic if it includes a numeric suffix that is relevant for the effect of the command.

**Example:**

Definition: `DISPlay[:WINDow<1...4>]:MAXimize <Boolean>`

Command: `DISP:MAX ON` refers to window 1.

In order to refer to a window other than 1, you must include the optional `WINDow` parameter with the suffix for the required window.

`DISP:WIND2:MAX ON` refers to window 2.

**Parameters**

Parameters must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma (,). For a description of the parameter types, refer to [chapter 8.2.3, "SCPI Parameters"](#), on page 226.

**Example:**

Definition: `HardCOpy:DEvice:CMAP:COLor:RGB <red>,<green>,<blue>`

Command: `HCOP:DEV:CMAP:COL:RGB 3,32,44`

### Special characters

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | <p><b>Parameters</b></p> <p>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.</p> <p><b>Example:</b></p> <p>Definition: <code>HardCOPy:PAGE:ORIENTATION LANDscape   PORTRait</code></p> <p>Command: <code>HCOP:PAGE:ORI LAND</code> specifies landscape orientation</p> <p>Command: <code>HCOP:PAGE:ORI PORT</code> specifies portrait orientation</p> <p><b>Mnemonics</b></p> <p>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.</p> <p><b>Example:</b></p> <p>Definition: <code>SENSE:BANDwidth BWIDTH[:RESolution] &lt;numeric_value&gt;</code></p> <p>The two following commands with identical meaning can be created:</p> <p>Command: <code>SENS:BAND:RES 1</code></p> <p>Command: <code>SENS:BWID:RES 1</code></p> |
| []  | <p>mnemonics in square brackets are optional and may be inserted into the header or omitted.</p> <p><b>Example:</b></p> <p>Command: <code>HardCOPy[:IMMEDIATE]</code></p> <p>Command: <code>HCOP:IMM</code> is equivalent to <code>HCOP</code></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| { } | <p>Parameters in curly brackets are optional and can be inserted once or several times, or omitted.</p> <p><b>Example:</b></p> <p>Definition: <code>SENSe:LIST:FREQuency &lt;numeric_value&gt;{,&lt;numeric_value&gt;}</code></p> <p>The following are valid commands:</p> <p>Command: <code>SENS:LIST:FREQ 10</code></p> <p>Command: <code>SENS:LIST:FREQ 10,20</code></p> <p>Command: <code>SENS:LIST:FREQ 10,20,30,40</code></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

### 8.2.3 SCPI Parameters

Many commands are supplemented by a parameter or a list of parameters. The parameters must be separated from the header by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank).

Allowed parameters are:

- Numeric values
- Special numeric values
- Boolean parameters
- Text
- Character strings
- Block data

The parameters required for each command and the allowed range of values are specified in the command description.

### Numeric values

Numeric values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not allowed. In the case of physical quantities, the unit can be entered. Allowed unit prefixes are G (giga), MA (mega), MOHM and MHZ are also allowed), K (kilo), M (milli), U (micro) and N (nano). If the unit is missing, the basic unit is used.

#### Example:

```
SENSe:FREQ:STOP 1.5GHz = SENSe:FREQ:STOP 1.5E9
```

### Units

For physical quantities, the unit can be entered. Allowed unit prefixes are:

- G (giga)
- MA (mega), MOHM, MHZ
- K (kilo)
- M (milli)
- U (micro)
- N (nano)

If the unit is missing, the basic unit is used.

#### Example:

```
SENSe:FREQ:STOP 1.5GHz = SENSe:FREQ:STOP 1.5E9
```

Some settings allow relative values to be stated in percent. According to SCPI, this unit is represented by the PCT string.

#### Example:

```
HCOP:PAGE:SCAL 90PCT
```

### Special numeric values

The texts listed below are interpreted as special numeric values. In the case of a query, the numeric value is provided.

- **MIN/MAX**
- MINimum and MAXimum denote the minimum and maximum value.
- **DEF**
- DEFault denotes a preset value which has been stored in the EPROM. This value conforms to the default setting, as it is called by the \*RST command.
- **UP/DOWN**

- UP, DOWN increases or reduces the numeric value by one step. The step width can be specified via an allocated step command for each parameter which can be set via UP, DOWN.
- **INF/NINF**
- INFinity, Negative INFinity (NINF) represent the numeric values 9.9E37 or -9.9E37, respectively. INF and NINF are only sent as instrument responses.
- **NAN**
- Not A Number (NAN) represents the value 9.91E37. NAN is only sent as a instrument response. This value is not defined. Possible causes are the division of zero by zero, the subtraction of infinite from infinite and the representation of missing values.

**Example:**

Setting command: `SENSe:LIST:FREQ MAXimum`

Query: `SENS:LIST:FREQ?`, Response: `3.5E9`

**Queries for special numeric values**

The numeric values associated to MAXimum/MINimum/DEFault can be queried by adding the corresponding mnemonics to the command. They must be entered following the quotation mark.

**Example:**

`SENSe:LIST:FREQ? MAXimum`

Returns the maximum numeric value as a result.

**Boolean Parameters**

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0. The numeric values are provided as the response for a query.

**Example:**

Setting command: `HCOPy:DEV:COL ON`

Query: `HCOPy:DEV:COL?`

Response: `1`

**Text parameters**

Text parameters observe the syntactic rules for mnemonics, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

**Example:**

Setting command: `HardCOPy:PAGE:ORIENTATION LANDscape`

Query: `HCOP:PAGE:ORI?`

Response: `LAND`

### Character strings

Strings must always be entered in quotation marks (' or ").

#### Example:

HCOP:ITEM:LABel "Test1" or HCOP:ITEM:LABel 'Test1'

### Block data

Block data is a format which is suitable for the transmission of large amounts of data. A command using a block data parameter has the following structure:

#### Example:

FORMat:READings:DATA #45168xxxxxxxx

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted.

#0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

#### 8.2.3.1 Overview of Syntax Elements

The following table provides an overview of the syntax elements:

|   |                                                                                                                                                                                                                     |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| : | The colon separates the mnemonics of a command. In a command line the separating semicolon marks the uppermost command level.                                                                                       |
| ; | The semicolon separates two commands of a command line. It does not alter the path.                                                                                                                                 |
| , | The comma separates several parameters of a command.                                                                                                                                                                |
| ? | The question mark forms a query.                                                                                                                                                                                    |
| * | The asterisk marks a common command.                                                                                                                                                                                |
| " | Quotation marks introduce a string and terminate it.                                                                                                                                                                |
| # | The hash symbol introduces binary, octal, hexadecimal and block data. <ul style="list-style-type: none"> <li>• Binary: #B10110</li> <li>• Octal: #O7612</li> <li>• Hexa: #HF3A7</li> <li>• Block: #21312</li> </ul> |
|   | A "white space" (ASCII-Code 0 to 9, 11 to 32 decimal, e.g. blank) separates the header from the parameters.                                                                                                         |



### 8.2.3.2 Structure of a Command Line

A command line may consist of one or several commands. It is terminated by one of the following:

- a <New Line>
- a <New Line> with EOI
- an EOI together with the last data byte

Several commands in a command line must be separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

**Example:**

```
MMEM:COPY "Test1", "MeasurementXY";:HCOP:ITEM ALL
```

This command line contains two commands. The first command belongs to the MMEM system, the second command belongs to the HCOP system.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels. The colon following the semicolon must be omitted in this case.

**Example:**

```
HCOP:ITEM ALL; HCOP:IMM
```

This command line is represented in its full length and contains two commands separated from each other by the semicolon. Both commands are part of the HCOP command system, i.e. they have one level in common.

When abbreviating the command line, the second command begins with the level below HCOP. The colon after the semicolon is omitted. The abbreviated form of the command line reads as follows:

```
HCOP:ITEM ALL; IMM
```

However, a new command line always begins with the complete path.

**Example:**

```
HCOP:ITEM ALL
```

```
HCOP:IMM
```

### 8.2.3.3 Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

- The requested parameter is transmitted without a header.

**Example:**

```
HCOP:PAGE:ORI?, Response: LAND
```

- Maximum values, minimum values and all other quantities that are requested via a special text parameter are returned as numeric values.

**Example:**

SENSe:FREQuency:STOP? MAX, Response: 3.5E9

- Numeric values are output without a unit. Physical quantities are referred to the basic units or to the units set using the Unit command. The response 3.5E9 in the previous example stands for 3.5 GHz.
- Truth values (Boolean values) are returned as 0 (for OFF) and 1 (for ON).

**Example:**

Setting command: HCOPy:DEV:COL ON

Query: HCOPy:DEV:COL?

Response: 1

- Text (character data) is returned in a short form.

**Example:**

Setting command: HardCOPy:PAGE:ORIENTATION LANDscape

Query: HCOP:PAGE:ORI?

Response: LAND

## 8.3 Command Sequence and Synchronization

IEEE 488.2 defines a distinction between overlapped and sequential commands:

- A sequential command is one which finishes executing before the next command starts executing. Commands that are processed quickly are usually implemented as sequential commands. Sequential commands are not implemented in the instrument, however the execution time of most commands is so short that they act as sequential commands when sent in different command lines.
- An overlapping command is one which does not automatically finish executing before the next command starts executing. Usually, overlapping commands take longer to process and allow the program to do other tasks while being executed. If overlapping commands do have to be executed in a defined order, e.g. in order to avoid wrong measurement results, they must be serviced sequentially. This is called synchronization between the controller and the instrument.

Setting commands within one command line, even though they may be implemented as sequential commands, are not necessarily serviced in the order in which they have been received. In order to make sure that commands are actually carried out in a certain order, each command must be sent in a separate command line.

**Example:****Commands and queries in one message**

The response to a query combined in a program message with commands that affect the queried value is not predictable.

The following commands always return the specified result:

```
:FREQ:STAR 1GHZ;SPAN 100 :FREQ:STAR?
```

Result:

```
1000000000 (1 GHz)
```

Whereas the result for the following commands is not specified by SCPI:

```
:FREQ:STAR 1GHz;STAR?;SPAN 1000000
```

The result could be the value of `STAR` before the command was sent since the instrument might defer executing the individual commands until a program message terminator is received. The result could also be 1 GHz if the instrument executes commands as they are received.



As a general rule, send commands and queries in different program messages.

**Example:****Overlapping command with \*OPC**

The instrument implements `INITiate[:IMMediate]` as an overlapped command.

Assuming that `INITiate[:IMMediate]` takes longer to execute than `*OPC`, sending the following command sequence results in initiating a sweep and, after some time, setting the OPC bit in the ESR:

```
INIT; *OPC
```

Sending the following commands still initiates a sweep:

```
INIT; *OPC; *CLS
```

However, since the operation is still pending when the instrument executes `*CLS`, forcing it into the "Operation Complete Command Idle" State (OCIS), `*OPC` is effectively skipped. The OPC bit is not set until the instrument executes another `*OPC` command.

**Example:****Overlapped command followed by non-conflicting commands**

Suppose that the instrument is switched on to provide a real time test signal that requires some calculation time. At the same time some settings for the configuration of a different signal are made which do not interact with the generated signal (e.g. the signal may be used later on). The signal generation and the signal configuration are independent from each other, so none of the following overlapped commands needs to be synchronized:

```
SOUR:BB:3GPP:STAT ON
```

```
SOUR:BB:GSM:FORM FSK2
```

### 8.3.1 Preventing Overlapping Execution

To prevent an overlapping execution of commands, one of the commands `*OPC`, `*OPC?` or `*WAI` can be used. All three commands cause a certain action only to be carried out after the hardware has been set. By suitable programming, the controller can be forced to wait for the corresponding action to occur.

| Command            | Action                                                                                                                                                                                         | Programming the controller                                                                                                         |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <code>*OPC</code>  | Sets the Operation Complete bit in the ESR after all previous commands have been executed.                                                                                                     | Setting bit 0 in the ESE<br>Setting bit 5 in the SRE<br>Waiting for service request (SRQ)                                          |
| <code>*OPC?</code> | 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 <code>*OPC?</code> directly after the command whose processing should be terminated before other commands can be executed. |
| <code>*WAI</code>  | Stops further command processing until all commands sent before <code>*WAI</code> have been executed.                                                                                          | Sending <code>*WAI</code> directly after the command whose processing should be terminated before other commands are executed.     |

Command synchronization using `*WAI` or `*OPC?` appended to an overlapped command is a good choice if the overlapped command takes only little time to process. The two synchronization techniques simply block overlapped execution of the command.

For time consuming overlapped commands it is usually desirable to allow the controller or the instrument to do other useful work while waiting for command execution. Use one of the following methods:

#### **\*OPC with a service request**

1. Set the OPC mask bit (bit no. 0) in the ESE: `*ESE 1`
2. Set bit no. 5 in the SRE: `*SRE 32` to enable ESB service request.
3. Send the overlapped command with `*OPC`
4. Wait for a service request

The service request indicates that the overlapped command has finished.

#### **\*OPC? with a service request**

1. Set bit no. 4 in the SRE: `*SRE 16` to enable MAV service request.
2. Send the overlapped command with `*OPC?`
3. Wait for a service request

The service request indicates that the overlapped command has finished.

**Event Status Register (ESE)**

1. Set the OPC mask bit (bit no. 0) in the ESE: `*ESE 1`
2. Send the overlapped command without `*OPC`, `*OPC?` or `*WAI`
3. Poll the operation complete state periodically (by means of a timer) using the sequence: `*OPC; *ESR?`

A return value (LSB) of 1 indicates that the overlapped command has finished.

**\*OPC? with short timeout**

1. Send the overlapped command without `*OPC`, `*OPC?` or `*WAI`
2. Poll the operation complete state periodically (by means of a timer) using the sequence: `<short timeout>; *OPC?`
3. A return value (LSB) of 1 indicates that the overlapped command has finished. In case of a timeout, the operation is ongoing.
4. Reset timeout to former value
5. Clear the error queue with `SYStem:ERRor?` to remove the "-410, Query interrupted" entries.

**Using several threads in the controller application**

As an alternative, provided the programming environment of the controller application supports threads, separate threads can be used for the application GUI and for controlling the instrument(s) via SCPI.

A thread waiting for a `*OPC?` thus will not block the GUI or the communication with other instruments.

## 8.4 General Programming Recommendations

**Initial instrument status before changing settings**

Manual operation is designed for maximum possible operating convenience. In contrast, the priority of remote control is the "predictability" of the instrument status. Thus, when a command attempts to define incompatible settings, the command is ignored and the instrument status remains unchanged, i.e. other settings are not automatically adapted. Therefore, control programs should always define an initial instrument status (e.g. using the `*RST` command) and then implement the required settings.

**Command sequence**

As a general rule, send commands and queries in different program messages. Otherwise, the result of the query may vary depending on which operation is performed first (see also Preventing Overlapping Execution).

**Reacting to malfunctions**

The service request is the only possibility for the instrument to become active on its own. Each controller program should instruct the instrument to initiate a service request in case of malfunction. The program should react appropriately to the service request.

**Error queues**

The error queue should be queried after every service request in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

## 9 Remote Control Commands

In the following, all remote-control commands are presented in detail with their parameters and the ranges of numerical values.

Commands to the respective transmission protocols are described in separate chapters:

- User Defined [chapter 9.3, "User Defined - Remote Control Commands"](#), on page 257
- [chapter 9.4, "CPRI Remote Control Commands"](#), on page 286

For an introduction to remote control, refer to [chapter 8, "Remote Control Basics"](#), on page 213.

The remote-control commands are structured in subsystems according to the SCPI syntax, and then listed in alphabetical order.



Additionally, find a list of all commands for the R&S EX-IQ-BOX at the end of the manual, see "Alphabetical List of Commands".

### 9.1 Common Commands

Common commands are described in the IEEE 488.2 (IEC 625-2) standard. These commands have the same effect and are employed in the same way on different devices. The headers of these commands consist of "\*" followed by three letters. Many common commands are related to the Status Reporting System.

Available common commands:

|            |     |
|------------|-----|
| *CLS.....  | 236 |
| *IDN?..... | 237 |
| *OPC.....  | 237 |
| *OPT?..... | 237 |
| *RCL.....  | 238 |
| *RST.....  | 238 |
| *SAV.....  | 238 |
| ERR?.....  | 238 |

**\*CLS** <\*cls>

CLear Status

Sets the status byte (STB), the standard event register (ESR) and the `EVENT` part of the `QUESTionable` and the `OPERation` registers to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

**Setting parameters:**

<\*cls>                      string

**Usage:**                      Setting only

---

**\*IDN?**

IDeNtification query.

Queries the identificaion of the R&S EX-IQ-BOX.

The query returns "Rohde&Schwarz,<device type>,<serial number>,<firmware version>". The information is returned at fixed positions in a comma-separated string.

**Return values:**

<\*idn >                      string

**Example:**

\*IDN?  
query instrument identification.  
Rohde&Schwarz,<EX-IQ-BOX>,<101211>,  
<000.00.01-0>

**Usage:**                      Query only

---

**\*OPC <\*opc >**

OPeration Complete

Sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request. The query form writes a "1" into the output buffer as soon as all preceding commands have been executed. This is used for command synchronization.

**Parameters:**

<\*opc >                      string

---

**\*OPT?**

OPTion identification query.

Queries the options included in the R&S EX-IQ-BOX. For a list of all available options and their description refer to [chapter 3.2.2, "Options"](#), on page 22 or the R&S website of the R&S EX-IQ-BOX: <http://www.rohde-schwarz.com/product/EX-IQ-Box.html>.

**Return values:**

<\*opt >                      string

The query returns a list of options. The options are returned at fixed positions in a comma-separated string. A zero is returned for options that are not installed.

**Example:**

\*OPT ?  
query installed options.  
EXBOX-B85,EXBOX-K90,EXBOX-K91,EXBOX-K94,  
EXBOX-K240

**Usage:**                      Query only



---

**\*RCL** <\*rcl>

ReCaLI calls up the instrument settings from an intermediate memory identified by the specified number. The instrument settings can be stored to this memory using the command **\*SAV** on page 238 with the associated number.

It also activates the instrument settings which are stored in a file and loaded using the **MMEMory:LOAD** <number>, <file\_name.extension> command.

**Setting parameters:**

<\*rcl> string

**Usage:** Setting only

---

**\*RST** <\*rst>

## ReSeT

Sets the R&S EX-IQ-BOX to a defined default status. It is equivalent to **SYSTem:PRESet**. The default settings are indicated in the description of commands.

**Setting parameters:**

<\*rst> string

**Usage:** Setting only

---

**\*SAV** <\*sav>

SAVe stores the current instrument settings under the specified number in an intermediate memory. The settings can be recalled using the command **\*RCL** with the associated number.

To transfer the stored instrument settings in a file, use the command **MMEMory:STORe:STATe**.

**Setting parameters:**

<\*sav> string

**Usage:** Setting only

---

**ERR?****Return values:**

<Err > string

**0**

No error, i.e the error queue is empty.

**positive value**

Positive error numbers denote device-specific errors.

**negative value**

Negative error numbers denote error messages defined by SCPI.

|                 |                                                                                                                                              |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Example:</b> | ERR?<br>queries all entries in the error queue.<br>Response: 0, no error<br>no errors have occurred since the error queue was last read out. |
| <b>Usage:</b>   | Query only                                                                                                                                   |

## 9.2 R&S EX-IQ-BOX - Remote Control Commands

The following subsystems relate to the R&S EX-IQ-BOX and R&S instruments, as well as some general functions. The specific commands are described in the associated subsystems.

### 9.2.1 Device Subsystem

The **DEVIce** subsystem contains remote control commands of the device manager dialog of R&S DigIConf.

|                                                                            |     |
|----------------------------------------------------------------------------|-----|
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:CATalog?</a>                   | 239 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:CONTRoller?</a>                | 240 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:CPLD?</a>                      | 240 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:FPG:BASE?</a>                  | 240 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:FPG:BOB?</a>                   | 241 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:FPG:DIGio?</a>                 | 241 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:PART</a>                       | 241 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:PPCVersion?</a>                | 241 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:BOARd:PART?</a>                | 242 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:BOARd:REVIision?</a>           | 242 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:BOARd:SERial?</a>              | 242 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:BOB:REVIision?</a>             | 242 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:BOB:SERial?</a>                | 243 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:BOB:TYPE?</a>                  | 243 |
| <a href="#">[:SOURce]:BBIN:EXTernal:FIRMware:SUPPorted?</a>                | 243 |
| <a href="#">[:SOURce&lt;hw&gt;]:IQ:OUTPut:EXTernal:FIRMware:SUPPorted?</a> | 243 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:FIRMware:SUPPorted?</a>          | 243 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:FIRMware:SUPPorted?</a>        | 243 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:SELEct</a>                     | 244 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:DEVIce:SERial</a>                     | 244 |

#### **[\[:SOURce<hw>\]:EBOX:DEVIce:CATalog?](#)**

The command queries the R&S EX-IQ-BOXes operated by R&S DigIConf. The query returns the serial numbers in a comma-separated string.

#### **Return values:**

<Catalog>                      string

**Example:** SOUR:EBOX:CAT?  
list the connected R&S EX-IQ-BOXes.  
**Response:**  
900002, 900010  
currently the R&S EX-IQ-BOXes 90002 and **90010** are connected.

**Usage:** Query only

**Manual operation:** See ["EX-IQ-BOX Device"](#) on page 66

#### **[SOURce<hw>]:EBOX:DEVIce:CONTroller?**

The command queries the controller type the R&S EX-IQ-BOX is equipped with.

**Return values:**

<cnt> string

**Example:** SOUR:EBOX:DEV:CONT?  
shows the controller type of the R&S EX-IQ-BOX.

**Usage:** Query only

**Manual operation:** See ["Hardware Info"](#) on page 66

#### **[SOURce<hw>]:EBOX:DEVIce:CPLD?**

Queries the version of CPLD (**C**omplex **P**rogrammable **L**ogic **D**evice). This command is model specific and applies to R&S EX-IQ-BOX1409.5505.02.

**Return values:**

<cpld> string

**Example:** SOUR:EBOX:DEV:CPLD?  
query the CPLD of the R&S EX-IQ-BOX.

**Usage:** Query only

**Manual operation:** See ["Hardware Info"](#) on page 66

#### **[SOURce<hw>]:EBOX:DEVIce:FPG:BASE?**

Queries the version of the FPGA (**F**ield **P**rogrammable **G**ate **A**rray) basic design of the R&S EX-IQ-BOX.

**Return values:**

<base> string

**Example:** SOUR:EBOX:DEV:FPG:BAS?  
query the FPGA version of the R&S EX-IQ-BOX.

**Usage:** Query only

**Manual operation:** See ["Hardware Info"](#) on page 66

---

**[ :SOURce<hw>]:EBOX:DEVIce:FPG:BOB?**

Queries the FPGA (Field Programmable Gate Array) version of the breakout board connected to the R&S EX-IQ-BOX.

**Return values:**

<bob>                      string

**Example:**

SOURce:EBOX:DEV:FPG:BOB?  
query the FPGA of the breakout board.

**Usage:**

Query only

**Manual operation:** See "[Hardware Info](#)" on page 66

---

**[ :SOURce<hw>]:EBOX:DEVIce:FPG:DIGio?**

Queries the version of the digital interface standard. This command is model specific and applies to R&S EX-IQ-BOX 1409.5505K04.

**Return values:**

<fpga>                      string

**Example:**

SOUR:EBOX:DEV:FPG:DIG?  
query the digital interface standard.

**Usage:**

Query only

**Manual operation:** See "[Hardware Info](#)" on page 66

---

**[ :SOURce<hw>]:EBOX:DEVIce:PART <part>**

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

**Parameters:**

<part>                      string

**Example:**

SOUR:EBOX:DEV:PART?  
query the part number of the selected R&S EX-IQ-BOX.  
Response:  
101211  
currently the R&S EX-IQ-BOX with part number 101211 is connected.

**Manual operation:** See "[Hardware Info](#)" on page 66

---

**[ :SOURce<hw>]:EBOX:DEVIce:PPCVersion?**

Queries the R&S EX-IQ-BOX PPC firmware version, i.e. the version of the built-in power PC.

**Return values:**

<ver>                      string

**Example:** SOUR:EBOX:DEV:PPCV?  
query version of the PPC.

**Usage:** Query only

**Manual operation:** See "[Hardware Info](#)" on page 66

---

**[SOURce<hw>]:EBOX:DEVIce:BOARd:PART?**

Queries the part number of the R&S EX-IQ-BOX's internal board.

**Return values:**

<pn> string

**Example:** SOUR:EBOX:DEV:BOAR:PART?  
query the part number.

**Usage:** Query only

**Manual operation:** See "[Hardware Info](#)" on page 66

---

**[SOURce<hw>]:EBOX:DEVIce:BOARd:REVIision?**

Queries the revision number of the R&S EX-IQ-BOX's internal board.

**Return values:**

<rev> string

**Example:** SOUR:EBOX:DEV:BOAR:REV?  
query the board revision number.

**Usage:** Query only

**Manual operation:** See "[Hardware Info](#)" on page 66

---

**[SOURce<hw>]:EBOX:DEVIce:BOARd:SERIal?**

Queries the serial number of the R&S EX-IQ-BOX's internal board.

**Return values:**

<serial> string

**Example:** SOUR:EBOX:DEV:BOAR:SER?  
query the board serial number.

**Usage:** Query only

**Manual operation:** See "[Hardware Info](#)" on page 66

---

**[SOURce<hw>]:EBOX:DEVIce:BOB:REVIision?**

Queries the revision number of the connected breakout board.

**Return values:**

<rev> string

**Example:** SOUR:EBOX:DEV:BOB:REV?  
query the breakout board revision number.

**Usage:** Query only

**Manual operation:** See ["Hardware Info"](#) on page 66

---

**[SOURce<hw>]:EBOX:DEVIce:BOB:SERial?**

Queries the serial number of the connected breakout board.

**Return values:**  
<sn> string

**Example:** SOUR:EBOX:DEV:BOB:SER?  
query the breakout board serial number.

**Usage:** Query only

**Manual operation:** See ["Hardware Info"](#) on page 66

---

**[SOURce<hw>]:EBOX:DEVIce:BOB:TYPE?**

Queries the type of the connected breakout board.

**Return values:**  
<typ> string

**Example:** SOUR:EBOX:DEV:BOB:TYP?  
Response: "EXBOX-B85"  
a CPRI breakout board is connected.

**Usage:** Query only

**Manual operation:** See ["Hardware Info"](#) on page 66

---

**[SOURce]:BBIN:EXTernal:FIRMware:SUPPorted?**  
**[SOURce<hw>]:IQ:OUTPut:EXTernal:FIRMware:SUPPorted?**  
**[SOURce<hw>]:EBOX:USER:FIRMware:SUPPorted?**  
**[SOURce<hw>]:EBOX:DEVIce:FIRMware:SUPPorted?**

Queries the firmware available for the R&S EX-IQ-BOX 1407.5505.02.

**Return values:**  
<Supported> string

**Example:** SOUR:EBOX:DEV:FIRM:SUPP?  
check the supported firmware.

**Usage:** Query only

**Manual operation:** See ["Update EX-IQ-BOX Firmware"](#) on page 68

---

**[:SOURce<hw>]:EBOX:DEVIce:SElect <Select>**

Select a currently connected R&S EX-IQ-BOX by means of its serial number.

**Parameters:**

<Select> float

**Example:**

SOUR:EBOX:DEV:SElect 100112  
select the connected R&S EX-IQ-BOX with serial number  
'10112

**Manual operation:** See ["EX-IQ-BOX Device"](#) on page 66

---

**[:SOURce<hw>]:EBOX:DEVIce:SERial <serial>**

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

**Parameters:**

<serial> float

**Example:**

SOUR:EBOX:DEV:SER?  
query the R&S EX-IQ-BOX serial number.

**Manual operation:** See ["Hardware Info"](#) on page 66

## 9.2.2 Diagnostic Subsystem

The **DIAGnostic** subsystem contains the commands used for instrument diagnosis and servicing. SCPI does not define any **DIAGnostic** commands; the commands listed here are all device-specific. **DIAGnostic** commands are query commands which are not influenced by **\*RST**.

|                                                    |     |
|----------------------------------------------------|-----|
| <a href="#">:DIAGnostic:EBOX:CATalog?</a>          | 244 |
| <a href="#">:DIAGnostic:EBOX:CPRI:EXECute</a>      | 245 |
| <a href="#">:DIAGnostic:EBOX:CPRI:TEST?</a>        | 245 |
| <a href="#">:DIAGnostic:EBOX:CPRI:TEST:STORe</a>   | 245 |
| <a href="#">:DIAGnostic:EBOX:LVDS:BER?</a>         | 246 |
| <a href="#">:DIAGnostic:EBOX:LVDS:DCM?</a>         | 246 |
| <a href="#">:DIAGnostic:EBOX:LVDS:ERRors?</a>      | 246 |
| <a href="#">:DIAGnostic:EBOX:LVDS:NDATa?</a>       | 246 |
| <a href="#">:DIAGnostic:EBOX:LVDS:PLL?</a>         | 247 |
| <a href="#">:DIAGnostic:EBOX:LVDS:RCV?</a>         | 247 |
| <a href="#">:DIAGnostic:EBOX:LVDS:RX TX:SOURce</a> | 247 |
| <a href="#">:DIAGnostic:EBOX:LVDS:RX TX:STATe</a>  | 247 |
| <a href="#">:DIAGnostic:EBOX:POINt</a>             | 247 |
| <a href="#">:DIAGnostic:EBOX:POINt:VALue?</a>      | 248 |
| <a href="#">:DIAGnostic:EBOX:SElect</a>            | 248 |

---

**:DIAGnostic:EBOX:CATalog?**

The command queries the R&S EX-IQ-BOX instruments operated by R&S DiglConf. The query returns the serial numbers in a comma-separated string.

**Return values:**

<Catalog>                      string

**Example:**

DIAG:EBOX:CAT?

list the connected R&S EX-IQ-BOXes.

Response:

900002, 900010

R&S DiglConf currently operates with the R&S EX-IQ-BOXes

90002 and 90010

**Usage:**

Query only

---

**:DIAGnostic:EBOX:CPRI:EXECute**

The command starts the CPRI test for service purposes, see [:DIAGnostic:EBOX:CPRI:TEST?](#) on page 245 .

**Example:**

DIAG:EBOX:CPRI:EXEC?

executes the CPRI diagnostic test.

Response:

running, finished

**Usage:**

Event

---

**:DIAGnostic:EBOX:CPRI:TEST?**

The command checks the CPRI communication link for service purposes.

**Return values:**

<Test>                      0 | 1 | OFF | ON

\*RST:                      1

**Example:**

DIAG:EBOX:CPRI:TEST?

query the test result of the CPRI link.

Response: 0 = passed, 1 = failed

**Usage:**

Query only

---

**:DIAGnostic:EBOX:CPRI:TEST:STORe <Store>**

Saves the test report of the CPRI diagnostic test in a log file. This function is protected and used for service purposes.

**Setting parameters:**

<Store>                      string

**Example:**

MMEM:CDIR "d:/user/diagnostic"

set the default directory to d:/user/diagnostic

DIAG:EBOX:CPRI:TEST:STOR "CPRItest.log"

saves the test report in the default directory with file name  
CPRItest.log.

**Usage:**

Setting only



---

**:DIAGnostic:EBOX:LVDS:BER?**

The command checks the LVDS interface. This function is protected and used for service purposes.

**Return values:**

<ber> float

**Example:**

DIAG:EBOX:LVDS:BER?

query the results of the LVDS test.

Response: 0 = passed, 1 = failed

**Usage:**

Query only

---

**:DIAGnostic:EBOX:LVDS:DCM?**

Checks the LVDS DCM lock state. This function is protected and used for service purposes.

**Return values:**

<dcm> ON | OFF

\*RST: OFF

**Example:**

DIAG:EBOX:LVDS:DCM?

query the state DCM.

Response: 0 = locked, 1 = unlocked

**Usage:**

Query only

---

**:DIAGnostic:EBOX:LVDS:ERRors?**

The queries the number of errors in LVDS test. This function is protected and used for service purposes.

**Return values:**

<err> float

**Example:**

DIAG:EBOX:LVDS:ERR?

counts the errors occurred during LVDS test.

**Usage:**

Query only

---

**:DIAGnostic:EBOX:LVDS:NDATa?**

Zeroes the received bit for the LVDS test. This function is protected and used for service purposes.

**Return values:**

<dat> ON | OFF

\*RST: OFF

**Example:**

DIAG:EBOX:LVDS:NDAT?

**Usage:**

Query only

---

**:DIAGnostic:EBOX:LVDS:PLL?**

Checks the PLL lock state during LVDS test. This function is protected and used for service purposes.

**Return values:**

<pll> ON | OFF

**Example:**

DIAG:EBOX:LVDS:PLL?  
query the state of the PLL.

**Usage:**

Query only

---

**:DIAGnostic:EBOX:LVDS:RCV?**

The command checks the number of received bits.

**Return values:**

<received> float

**Example:**

DIAG:EBOX:LVDS:RCV?  
count the number of received bits.

**Usage:**

Query only

---

**:DIAGnostic:EBOX:LVDS:RX|TX:SOURce <source>**

Selects LVDS test source. This function is protected and used for service purposes.

**Parameters:**

<source> PRBS | COUNTER

**Example:**

DIAG:EBOX:LVDS:TX:SOUR PRBS  
test the TX channel with the PRBS signal pattern.

---

**:DIAGnostic:EBOX:LVDS:RX|TX:STATe <state>**

Starts the LVDS test. This function is protected and used for service purposes.

**Parameters:**

<state> 0 | 1 | OFF | ON  
\*RST: OFF

**Example:**

DIAG:EBOX:LVDS:TX:STAT ON  
start the LVDS test in the TX channel.

---

**:DIAGnostic:EBOX:POINT <point>**

Selects the diagnostic points. This function is protected and used for service purposes.

**Parameters:**

<point> UI | U2V5 | AVTT | AVCC\_PLL | AVCC\_MGT | U1V8 | U24V |  
GND | VIN | COM3V3 | AUX2V5 | DIV3V3 | CORE1V0 | VCO |  
GND1 | PPC\_VCC\_INT | PPC\_TEMP | PPC\_VCC\_AUX

**Example:**

DIAG:EBOX:POIN UI

**:DIAGnostic:EBOX:POINT:VALue?**

Queries the voltage value at the selected diagnostic point of the R&S EX-IQ-BOX.

**Return values:**

<val> string

**Example:**

DIAG:EBOX:POIN:VAL?  
query the voltage value at the diagnostic point.

**Usage:**

Query only

**:DIAGnostic:EBOX:SElect <Select>**

Select a currently connected R&S EX-IQ-BOX in the [chapter 6.1.6.1, "EX-IQ-BOX Device Manager"](#), on page 65 dialog by means of its serial number. This function is protected and used for service purposes.

**Parameters:**

<Select> float

**Example:**

DIAG:EBOX:SEL 100112  
select the connected R&S EX-IQ-BOX with serial number '10112'.

### 9.2.3 EBOX Subsystem

The **EBOX** subsystem describes all remote-control commands regarding the configuration of the R&S EX-IQ-BOX. Configuration parameters are set via the configuration software R&S DigIConf.

R&S DigIConf may handle up to four R&S EX-IQ-BOX devices simultaneously. Therefore, all commands regarding to the R&S EX-IQ-BOX start with [ :SOURce<hw>: ] in order to select a device.

The numeric suffix <hw> to **SOURce** distinguishes the selected R&S EX-IQ-BOX [ :SOURce<[1]|2|3|4>: ]....

- **SOURce[1]** = R&S EX-IQ-BOX 1  
If only one R&S EX-IQ-BOX is connected the keyword **SOURce** is optional and can be omitted.
- **SOURce2** = R&S EX-IQ-BOX 2 (up to four are possible simultaneously)  
If you work with more devices, the keyword is mandatory, i.e. the command must contain the keyword with suffix.

|                                                         |     |
|---------------------------------------------------------|-----|
| <code>[SOURce&lt;hw&gt;]:EBOX:ARB:CATalog?</code> ..... | 249 |
| <code>[SOURce&lt;hw&gt;]:EBOX:ARB:DELeTe</code> .....   | 249 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CATalog?</code> .....     | 249 |
| <code>[SOURce&lt;hw&gt;]:EBOX:COUNT</code> .....        | 250 |
| <code>[SOURce&lt;hw&gt;]:EBOX:ID?</code> .....          | 250 |
| <code>[SOURce&lt;hw&gt;]:EBOX:OPT</code> .....          | 250 |
| <code>[SOURce&lt;hw&gt;]:EBOX:SELeCt</code> .....       | 251 |
| <code>[SOURce&lt;hw&gt;]:EBOX:STATe?</code> .....       | 251 |

---

### `[SOURce<hw>]:EBOX:ARB:CATalog?`

The command queries the available waveform files in the specified default directory. Only files with the file extension `*.wav` will be listed.

#### Return values:

`<Catalog>`                      string

#### Example:

```
MMEM:CDIR "d:/user/waveform"
set the default directory to d:/user/waveform.
SOUR:EBOX:ARB:CAT?
list out all waveform files in the default directory.
Response:
wav1, wav2
the directory contains the configuration files wav1.wav and
wav2.wav.
```

**Usage:**                      Query only

---

### `[SOURce<hw>]:EBOX:ARB:DELeTe <Delete>`

The command removes a waveform file from the specified directory. Determine the file by adding directory, file name and extension of the file.

#### Setting parameters:

`<Delete>`                      `<file_name>`  
String parameter to specify the name and directory of the file to be removed.

#### Example:

```
SOUR:EBOX:ARB:DEL "D:/USER/wav1.wav"
delete the file wav1.wav in the USER directory on drive d: /.
```

**Usage:**                      Setting only

---

### `[SOURce<hw>]:EBOX:CATalog?`

Queries the R&S EX-IQ-BOXes operated by R&S DigIConf. The query returns the serial numbers in a comma-separated string.

#### Return values:

`<Catalog>`                      string

**Example:** SOUR:EBOX:CAT?  
list the connected R&S EX-IQ-BOXes.  
**Response:**  
Undefined, 900002, 900010  
R&S DiglConf currently operates with the R&S EX-IQ-BOXes  
90002 and 90010.

**Usage:** Query only

**[:SOURce<hw>]:EBOX:COUNT <Count>**

Queries the number of connected R&S EX-IQ-BOXes.

**Parameters:**

<Count> float  
Range: 0 to 4

**Example:** SOUR:EBOX:COUN?  
**Response:** "2"

**Manual operation:** See ["Block Diagram"](#) on page 56

**[:SOURce<hw>]:EBOX:ID?**

Queries the Id of the R&S EX-IQ-BOX. The Id is composed of *<part\_number>*, *<serial\_number>* and *<checksum>*.

**Return values:**

<Id> string

**Example:** EBOX:ID?  
**Response:** "1409.5505K04-100005-Av"

**Usage:** Query only

**Manual operation:** See ["Options"](#) on page 67

**[:SOURce<hw>]:EBOX:OPT <Opt>**

The command queries the options installed on the R&S EX-IQ-BOX. The query returns a list of options in a comma-separated string.

**Parameters:**

<Opt> string

**Example:** SOUR:EBOX:OPT?  
check the installed options.  
**Response:** EXBOX-B85, EXBOX-K10, EXBOX-K11,  
EXBOX-K90, EXBOX-K242, ...

**Manual operation:** See ["Options"](#) on page 67

**[[:SOURce<hw>]:EBOX:SELection <Select>**

Select a currently connected R&S EX-IQ-BOX by means of its serial number.

**Parameters:**

<Select> float

**Example:**

SOUR:EBOX:DEV:SELection 100112

select the connected R&S EX-IQ-BOX with serial number 10112.

**[[:SOURce<hw>]:EBOX:STATe?**

Queries the current state of the R&S EX-IQ-BOX. The state can only be activated with commands switching on a transmission protocol, e.g. EBOX:USER:STAT ON.

**Return values:**

<State> OFF | ON

\*RST: OFF

**Example:**

SOUR1:EBOX:STAT?

check whether a standard is active.

**Usage:**

Query only

## 9.2.4 INSTRUMENT Subsystem

The INSTRUMENT subsystem contains remote control commands to query the interface and identity of connected R&S instruments.

The numeric suffix INST<ch> distinguishes between the instruments connected to the R&S EX-IQ-BOX. If only one R&S instrument is connected the suffix INST[1] is optional and can be omitted.

|                                      |     |
|--------------------------------------|-----|
| [[:SOURce<hw>]:EBOX:INST<ch>:NAME?   | 251 |
| [[:SOURce<hw>]:EBOX:INST<ch>:PORT?   | 252 |
| [[:SOURce<hw>]:EBOX:INST<ch>:SERial? | 252 |
| [[:SOURce<hw>]:EBOX:INST<ch>:TYPE?   | 252 |

**[[:SOURce<hw>]:EBOX:INST<ch>:NAME?**

Queries type and serial number of an R&S instrument connected to the R&S EX-IQ-BOX.

**Return values:**

<Name> string

**Example:**

SOUR2:EBOX:INST1:NAME?

query the symbolic name of the connected instrument.

Response: AMU 200A (100201)

the second connected instrument is an R&S AMU200A with serial number 100201.

**Usage:**

Query only

**Manual operation:** See ["Connected Instrument"](#) on page 71

---

**[ :SOURce<hw>]:EBOX:INST<ch>:PORT?**

Queries the instrument's port the R&S EX-IQ-BOX is connected to. The response differs depending on the connected instrument type. In a two-path instrument the path is also given.

**Return values:**

<Port> string

**Example:**

SOUR2:EBOX:INST2:PORT?

query the digital interface of the instrument to which the R&S EX-IQ-BOX is connected.

Response: In, Out A

**Usage:** Query only

**Manual operation:** See ["Port"](#) on page 71

---

**[ :SOURce<hw>]:EBOX:INST<ch>:SERial?**

Queries serial number of the R&S instrument connected to the R&S EX-IQ-BOX.

**Return values:**

<Serial> string

**Example:**

SOUR1:EBOX:INST1:TYPE?

query the serial number of the instrument connected the R&S EX-IQ-BOX.

Response: 100201

the serial number of the first connected instrument is 100201.

**Usage:** Query only

**Manual operation:** See ["Serial Number"](#) on page 71

---

**[ :SOURce<hw>]:EBOX:INST<ch>:TYPE?**

Queries the type of an R&S instrument connected to the R&S EX-IQ-BOX.

**Return values:**

<Type> string

**Example:**

SOUR1:EBOX:INST1:TYPE?

query the type of the connected instrument.

Response: AMU 200A

the first connected instrument is an R&S AMU200A.

**Usage:** Query only

**Manual operation:** See ["Instrument Type"](#) on page 71

## 9.2.5 MMEMemory Subsystem

The MMEMemory 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 `MMEMemory:MSIS <msus>`.



The `C:` drive is a protected system drive. This drive should not be accessed. Reconstruction of the system partition will not be possible without loss of data..

### 9.2.5.1 File Naming Conventions

To enable files in different file systems to be used, the following file naming conventions should be observed.

The file name can be of any length and no distinction is made between uppercase and lowercase letters. The file and the optional file extension are separated by a dot. All letters and numbers are permitted (numbers are, however, not permitted at the beginning of the file name). Where possible, special characters should not be used. Use of the slashes "\" and "/" should be avoided since they are used in file paths. A number of names are reserved by the operating system, e.g. `CLOCK$`, `CON`, `AUX`, `COM1...COM4`, `LPT1...LPT3`, `NUL` and `PRN`.

In the R&S DigIConf all files in which lists and settings are stored are given a characteristic extension.

The extension is separated from the actual file name by a dot (see [chapter 9.2.5.2, "Extensions for User Files"](#), on page 254 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 `MMEMemory:MSIS` (default drive) and `MMEMemory:CDIR` (default directory) are used for the path and drive setting in the commands.

Before the instrument settings can be stored in a file, they have to be stored in an intermediate memory using common command `*SAV <number>`. The specified number is



subsequently used in the `MMEM:STOR:STATe<number>, <file>` command. Also, subsequently to loading a file with instrument settings with command `MMEM:LOAD:STAT<number>, <file>`, these settings have to be activated with the common command `*RCL <number>`.

#### Example:

In this example, the current instrument setting is always stored in the file `test1.savrcl` in the directory `user` on the internal hard disk.

```
*SAV 4
```

```
MMEM:STOR:STAT 4, "d:\user\test1.savrcl"
```

If the complete path including the drive letter is specified, the file is stored in the specified path.

```
MMEM:MSIS 'D:'*SAV 4
```

```
MMEM:STOR:STAT 4, "\user\test1.savrcl"
```

If the parameter only contains the path and file name, the default drive set with the `MMEM:MSIS` command is effective.

### 9.2.5.2 Extensions for User Files

The following table list all available file extensions for user files. The currently available files on the instrument depend on the installed options.

**Table 9-1: List of the automatically assigned file extensions in R&S DiglConf**

| Function/Digital Standard | List type | Contents                                                        | File suffix |
|---------------------------|-----------|-----------------------------------------------------------------|-------------|
| CPRI                      | Settings  | CPRI configuration, vendor data included<br>Instrument settings | *.cpri      |
|                           | Waveform  | Waveforms and multi segment waveforms                           | *.wv        |
| User Defined              | Settings  | User Defined Protocol configuration                             | *.iqbox     |
| Configuration Software    | Settings  | R&S DiglConf settings                                           | *.savrcl    |

### 9.2.5.3 Remote Control Commands

|                     |     |
|---------------------|-----|
| MMEMory:CATalog?    | 254 |
| MMEMory:CDIRectory  | 255 |
| MMEMory:DELeTe      | 255 |
| MMEMory:LOAD:STATe  | 255 |
| MMEMory:MDIRectory  | 256 |
| MMEMory:RDIRectory  | 256 |
| MMEMory:STORe:STATe | 256 |

#### MMEMory:CATalog?

Returns the content of the current or a specified directory.

**Return values:**

|           |                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <Catalog> | string<br>String parameter to specify the directory. If the directory is omitted, the command queries the content of the current directory, queried with <code>MMEM:CDIR</code> command.                                                                                                                                                                                          |
| <path>    | <used_memory>,<free_memory>,<file_name>,<file_entry>,...<br><b>&lt;used_memory&gt;</b><br>Total amount of storage currently used in the directory, in bytes.<br><b>&lt;free_memory&gt;</b><br>Total amount of storage available in the directory, in bytes.<br><b>&lt;file_entry&gt;</b><br>All files of the directory are listed with their file name, format and size in bytes. |

**Example:** `MMEM:CAT?`

**Usage:** Query only

**MMEMory:CDIRectory <Cdirectory>**

Changes the default directory for mass memory storage. The directory is used for all subsequent `MMEM` commands if no path is specified with them. It is also possible to change to a higher directory using two dots '..'.

**Setting parameters:**

|              |                  |
|--------------|------------------|
| <Cdirectory> | <directory_name> |
|--------------|------------------|

**Example:** `MMEM:CDIR 'var/user'*SAV 4`

**Usage:** Setting only

**MMEMory:DELeTe <Delete>**

Removes a file from the specified directory.

**Parameters:**

|          |                                                                                              |
|----------|----------------------------------------------------------------------------------------------|
| <Delete> | <file_name><br>String parameter to specify the name and directory of the file to be removed. |
|----------|----------------------------------------------------------------------------------------------|

**Example:** `MMEM:DEL "c:/temp/test"`

**MMEMory:LOAD:STATe <State>**

Loads the specified file stored under the specified name in an internal memory.

After the file has been loaded, the instrument setting must be activated using an `*RCL` command.

**Parameters:**

<sav\_rcl\_state\_number> Determines to the specific <number> to be used with the \*RCL command, e.g. \*RCL 4.

<file\_name> String parameter to specify the file name with extension \*.savrcl.

**Setting parameters:**

<State> string

**Example:** MMEM:STOR:STAT 4,"test.savrcl"

**Usage:** Setting only

**MMEMory:MDIRectory <Mdirectory>**

Creates a new subdirectory for mass memory storage in the specified directory. If no directory is specified, a subdirectory is created in the default directory. This command can also be used to create a directory tree.

**Setting parameters:**

<Mdirectory> string

**Example:** MMEM:MDIR "d:/test"

**Usage:** Setting only

**MMEMory:RDIRectory <Rdirectory>**

Removes an existing directory from the mass memory storage system. If no directory is specified, the subdirectory with the specified name is deleted in the default directory.

**Setting parameters:**

<Rdirectory> string  
String parameter to specify the directory to be deleted.

**Example:** MMEM:RDIR "d:/test"

**Usage:** Setting only

**MMEMory:STORe:STATe <State>**

Stores the current instrument setting in the specified file.

The instrument setting must first be stored in an internal memory with the same number using the common command \*SAV.

**Parameters:**

<sav\_rcl\_state\_number> Corresponds to the specific <number> defined with the \*SAV command, e.g. \*SAV 4.

<file\_name> String parameter to specify the file name with extension \*.savrcl.

**Setting parameters:**

<State> string  
 String parameter to specify the file name with extension  
 \*.savrc1.

**Example:** MMEM:STOR:STAT 4,"d:\user\test.savrc1"

**Usage:** Setting only

## 9.3 User Defined - Remote Control Commands

This chapter describes all remote-control commands for user defined applications, including their parameters and value ranges.

Based on the R&S DigIConf commands, the description is structured according to the SCPI subsystems. Within each chapter, the order is alphabetical.

As a special feature you can find most of the commands summarized in a set of commands. This is required for test setups of the R&S EX-IQ-BOX, model 1409.5505.02, when not controlled by R&S DigIConf.

A command set defines first the commands of the R&S instruments. See also [chapter 9.3.1, "Explanation to the Device Specific SCPI Syntax"](#), on page 257 for more details.

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

The command for R&S DigIConf is always listed as last command, thus directly with the explanation.

### 9.3.1 Explanation to the Device Specific SCPI Syntax

This chapter briefly describes the variants in SCPI notation, depending on the controlling device.

Basically, if you run an R&S EX-IQ-BOX, model 1409.5505.02 directly with an R&S instrument, you have to set the same parameters as if controlled by R&S DigIConf. Since the devices communicate directly with each other, however, the transmission direction must be determined within the command. I.e. there are separate commands defined for the transmission and the receiver mode.

The following example shows you the notation to use, according to the controlling device.

The <placeholder> represents the variants in notation.

**Example:**

```
<placeholder>:LOGic:TYPE
```

The command in this example selects the digital signaling system used for transmitting the baseband signal from or to the DUT.

**Table 9-2: Command Variants**

| SCPI                                              | used with ...         | Transmission path                |
|---------------------------------------------------|-----------------------|----------------------------------|
| [ :SOURce<hw>]:EBOX:USER:LOGic[:TYPE]             | R&S DigiConf          | determined by a separate command |
| [SOURce<[1]   2>:]BBIN:EXtErnal:LOGic[:TYPE]      | R&S Signal Generators | digital IQ IN (BBIN)             |
| [SOURce<[1]   2>:]IQ:OUTPut:EXtErnal:LOGic[:TYPE] | R&S Signal Generators | digital IQ OUT (IQ OUT)          |
| [SOURce:]RECeiver:LOGic[:TYPE]                    | R&S Signal Analyzer   | digital IQ IN (receiver)         |
| [SOURce:]TRANsmitter:LOGic[:TYPE]                 | R&S Signal Analyzer   | digital IQ OUT (transmitter)     |

### 9.3.2 User Defined - Main Control Commands

The **main controls** commands provide the selection of the transmission "Direction", and commands as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading previously defined settings.

|                                                     |     |
|-----------------------------------------------------|-----|
| [ :SOURce]:BBIN:EXtErnal:DIRection.....             | 258 |
| [ :SOURce<hw>]:IQ:OUTPut:EXtErnal:DIRection.....    | 258 |
| [ :SOURce<hw>]:EBOX:USER:DIRection.....             | 258 |
| [ :SOURce]:BBIN:EXtErnal:LOGic[:TYPE].....          | 259 |
| [ :SOURce<hw>]:IQ:OUTPut:EXtErnal:LOGic[:TYPE]..... | 259 |
| SOURce:TRANsmitter:LOGicType.....                   | 259 |
| SOURce:RECeiver:LOGicType.....                      | 259 |
| [ :SOURce<hw>]:EBOX:USER:LOGic[:TYPE].....          | 259 |
| [ :SOURce<hw>]:EBOX:USER:PRESet.....                | 260 |
| [ :SOURce]:RECeiver:SENDto.....                     | 260 |
| SOURce:TRANsmitter:SENDto.....                      | 260 |
| [ :SOURce<hw>]:EBOX:USER:STATE.....                 | 261 |

```
[ :SOURce]:BBIN:EXtErnal:DIRection <Direction>
```

```
[ :SOURce<hw>]:IQ:OUTPut:EXtErnal:DIRection <Direction>
```

```
[ :SOURce<hw>]:EBOX:USER:DIRection <Direction>
```

**Note:** This command applies to R&S Signal Generators and R&S DigiConf. Setting the direction of transmission for analyzers, refer to [ :SOURce]:RECeiver:SENDto on page 260 or SOURce:TRANsmitter:SENDto on page 260.

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 list.

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

- R&S signal analyzers  
Signal direction is selected in the "Select Type" field of the "EXIQ-Box Settings" dialog. Select "Transmitter/Receiver" in the drop down list, as described in [chapter 6.1.1.6, "Dialogs"](#), on page 57
- R&S signal generators  
The direction of signal transmission is determined by the connection at the interface, either DIGITAL IQ IN or OUT. The parameters are provided respectively in the "EX-IQ-BOX BBIN" and "EX-IQ-BOX BBOU" dialogs. Therefore, the "Direction" field is not needed.

Signal transmission is activated with "State".

**Parameters:**

<Direction> RECeiver | TRANsmitter

**RECeiver**

The connected R&S EX-IQ-BOX receives the signal from the DUT and forwards it to an R&S instrument.

**TRANsmitter (Output)**

The R&S EX-IQ-BOX receives data from an R&S instrument and sends it to the DUT.

The baseband signal is transmitted in Single Data Rate (SDR) mode from the DUT to the R&S EX-IQ-BOX or vice versa. The data transmission is triggered by the rising edge of the data clock.

**Example:**

EBOX:USER:DIR TRAN

set the R&S EX-IQ-BOX to transmit the data to the DUT.

**Manual operation:** See ["Direction"](#) on page 99

---

```
[ :SOURce]:BBIN:EXTernal:LOGic[:TYPE] <Type>
[:SOURce<hw>]:IQ:OUTPut:EXTernal:LOGic[:TYPE] <Type>
SOURce:TRANsmitter:LOGictype <Type>
SOURce:RECeiver:LOGictype <Type>
[:SOURce<hw>]:EBOX:USER:LOGic[:TYPE] <Type>
```

Selects the signaling system used from the DUT for the baseband signal.

**Note:**

**Avoid connector overload**

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

**Note: SCPI notation varies**

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

**Parameters:**

|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <Type>    | LVDS   LVTTTL   CMOS33   CMOS25   CMOS18   CMOS15   CMOS12, or LVDS   LVTTTL   CM33   CM25   CM18   CM15   CM12, respectively   SSI12   SI18<br>*RST: CMOS33                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| CMOS33... | Enter the respective string, if you run R&S DigIConf or R&S signal generators.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| CM33...   | Select the logic type as shown, when you remotely control R&S signal analyzers.<br><b>LVDS</b><br>The signal is transmitted by using the signaling system LVDS (Low Voltage Differential Signaling).<br><b>LVTTTL</b><br>The signal is transmitted in LVTTTL technology (Low Voltage Transistor Transistor Logic) with 3.3 V voltage level.<br><b>CMOSxx / CMxx</b><br>The signal is transmitted by using the CMOS technology (Complementary Metal Oxide Semiconductor technology).<br>xx represents the according voltage values.<br>Available level values: 3.3 V, 2.5 V, 1.8 V, 1.5 V, 1.2 V.<br>SSIxx (R&S instruments only)<br>The signal is transmitted by using the SSI technology (Serial Synchronuos Interface).<br><b>Note:</b><br>SSI signal are only supported by R&S signal generators and R&S signal analyzers. Due to the very specific application, it is listed here for completeness, but not described explicitly.<br>Voltage levels are 1.5 V and 1.8 V. |

**Manual operation:** See ["Logic Type"](#) on page 99

**[[:SOURce<hw>]:EBOX:USER:PRESet**

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

**Example:** SOUR1:EBOX:USER:PRES  
setup all User Defined parameters to the default value.

**Usage:** Event

**Manual operation:** See ["Set To Default"](#) on page 100

**[[:SOURce]:RECeiver:SENDto  
SOURce:TRANsmitter:SENDto**

The command determines the direction of signal transmission from the R&S EX-IQ-BOX to the DUT.

**Example:** SOUR:TRAN:SEND

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

**Manual operation:** See "Send to" on page 94

**[[:SOURce<hw>]:EBOX:USER:STATe <State>**

Activates signal transmission.

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

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

**Parameters:**

<State> OFF | ON  
\*RST: OFF

**Example:** EBOX:USER:STAT ON  
switch on signal data transmission.

**Manual operation:** See "State" on page 99

### 9.3.3 Settings Subsystem

The USER:SETTings subsystem contains the commands for loading and storing application settings in files.

|                                                |     |
|------------------------------------------------|-----|
| [[:SOURce<hw>]:EBOX:USER:SETTing:CATalog?..... | 261 |
| [[:SOURce<hw>]:EBOX:USER:SETTing:DELeTe.....   | 262 |
| [[:SOURce<hw>]:EBOX:USER:SETTing:LOAD.....     | 262 |
| [[:SOURce<hw>]:EBOX:USER:SETTing:STORe.....    | 262 |

**[[:SOURce<hw>]:EBOX:USER:SETTing:CATalog?**

Queries the available settings files in the specified directory. Settings files are used to store current application settings. Only files with the file extension \*.iqbox will be listed. Access to the files via remote is possible using the commands of the MEMM subsystem.

**Return values:**

<Catalog> string  
String parameter to select the directory where settings files are stored.

**Example:** MEMM:CDIR "d:\DigIConf\Settings\User"  
Set the default directory and path to  
d:\DigIConf\Settings\User.  
SOUR1:EBOX:USER:SETT:CAT?  
read out all settings files of the DigIConf\Settings\User  
directory on drive d:



**Usage:** Query only

---

**[[:SOURce<hw>]:EBOX:USER:SETTing:DELeTe <Delete>**

The command removes a settings file from the specified directory. Determine the file by adding directory, file name and extension of the file.

**Setting parameters:**

<Delete>                      <directory>, <file\_name>, <ext>  
Determine the file to be deleted by adding directory, file name and the file extension (\*.iqbox).

**Example:**                      SOUR1:EBOX:USER:SETT:DEL "d:  
                                     \DigIConf\Settings\User\converter\_test.iqbox"  
                                     delete the file converter\_test.iqbox.

**Usage:** Setting only

---

**[[:SOURce<hw>]:EBOX:USER:SETTing:LOAD <Load>**

The command loads a previously saved user defined configuration. Define directory and file name, R&S DigIConf automatically assigns the file extension \*.iqbox.

**Setting parameters:**

<Load>                        <directory>, <file\_name>  
String parameter to determine the target directory and the file-name for loading the settings file.

**Example:**                      SOUR1:EBOX:USER:SETT:LOAD "d:  
                                     \DigIConf\Settings\User\converter\_test"  
                                     load the settings file converter\_test.iqbox from the directory  
                                     d:\DigIConf\Settings\User.

**Usage:** Setting only

**Manual operation:** See ["Save/Recall"](#) on page 100

---

**[[:SOURce<hw>]:EBOX:USER:SETTing:STORe <Store>**

Saves the current signal configuration of user defined mode. Specify the directory and file name. R&S DigIConf automatically assigns the file extension \*.iqbox to user defined configuration files.

**Setting parameters:**

<Store>                        <directory>, <file\_name>  
String parameter to determine the target directory and the file-name for storing the settings file.

**Example:**                      SOUR1:EBOX:USER:SETT:STOR "d:  
                                     \DigIConf\Settings\User\converter\_test"  
                                     save the settings in the file converter\_test.iqbox in the  
                                     directory d:\DigIConf\Settings\User.

**Usage:** Setting only

**Manual operation:** See ["Save/Recall"](#) on page 100

### 9.3.4 Protocol Commands

This section contains the commands for setting the parameters of user defined transmission protocols.

|                                                                 |     |
|-----------------------------------------------------------------|-----|
| <a href="#">[:SOURce]:BBIN:EXternal:DRATe</a>                   | 263 |
| <a href="#">[:SOURce&lt;hw&gt;]:IQ:OUTPut:EXternal:DRATe</a>    | 263 |
| <a href="#">SOURce:TRANsmitter:DRATe</a>                        | 263 |
| <a href="#">SOURce:RECeiver:DRATe</a>                           | 263 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:DRATe</a>             | 263 |
| <a href="#">[:SOURce]:BBIN:EXternal:FORMat</a>                  | 264 |
| <a href="#">[:SOURce&lt;hw&gt;]:IQ:OUTPut:EXternal:FORMat</a>   | 264 |
| <a href="#">SOURce:TRANsmitter:FORMat</a>                       | 264 |
| <a href="#">SOURce:RECeiver:FORMat</a>                          | 264 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:FORMat</a>            | 264 |
| <a href="#">[:SOURce]:BBIN:EXternal:ILEaving</a>                | 264 |
| <a href="#">[:SOURce&lt;hw&gt;]:IQ:OUTPut:EXternal:ILEaving</a> | 264 |
| <a href="#">SOURce:TRANsmitter:ILEaving</a>                     | 264 |
| <a href="#">SOURce:RECeiver:ILEaving</a>                        | 265 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:ILEaving</a>          | 265 |
| <a href="#">[:SOURce]:BBIN:EXternal:SRATe?</a>                  | 265 |
| <a href="#">[:SOURce&lt;hw&gt;]:IQ:OUTPut:EXternal:SRATe?</a>   | 265 |
| <a href="#">SOURce:TRANsmitter:SRATe</a>                        | 265 |
| <a href="#">SOURce:RECeiver:SRATe</a>                           | 265 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SRATe?</a>            | 265 |

---

**[\[:SOURce\]:BBIN:EXternal:DRATe <Drate>](#)**

**[\[:SOURce<hw>\]:IQ:OUTPut:EXternal:DRATe <Drate>](#)**

**[SOURce:TRANsmitter:DRATe <Drate>](#)**

**[SOURce:RECeiver:DRATe <Drate>](#)**

**[\[:SOURce<hw>\]:EBOX:USER:DRATe <Drate>](#)**

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

**Parameters:**

&lt;Drate&gt; SDR | DDR

**SDR**

Transmits the baseband signal in **Single Data Rate** (SDR) mode from the DUT to the R&S EX-IQ-BOX or vice versa. The rising edge of the clock signal triggers data transmission.

**DDR**

Transmits the baseband signal in **Double Data Rate** (DDR) mode from the DUT to the R&S EX-IQ-BOX or vice versa. The rising and the falling edge of the clock signal trigger data transmission (double speed transfer).

\*RST: SDR

**Example:**

SOUR1:EBOX:USER:DRAT SDR  
sets the data rate mode to "Single".

**Manual operation:** See ["Data Rate"](#) on page 102

[[:SOURce]:BBIN:EXTernal:FORMat <Format>  
[:SOURce<hw>]:IQ:OUTPut:EXTernal:FORMat <Format>  
SOURce:TRANsmitter:FORMat <Format>  
SOURce:RECeiver:FORMat <Format>  
[:SOURce<hw>]:EBOX:USER:FORMat <Format>

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

**Parameters:**

&lt;Format&gt; SERIAL | PARALLEL

**SERIAL**

Transmits each sample serially, i.e. "bitwise" from the DUT to the R&S EX-IQ-BOX or vice versa. In serial mode, I and Q data are sent via the input and output pins IO and QO, respectively.

**PARALLEL**

Transmits parallel, i.e. "wordwise" from the DUT to the R&S EX-IQ-BOX or vice versa. The input and output pin assignment depends on the bits alignment and the bit order settings.

\*RST: PARALLEL

**Example:**

SOUR1:EBOX:USER:FORM SER  
sets the transmission protocol of the R&S EX-IQ-BOX to "serial".

**Manual operation:** See ["Format"](#) on page 101

[[:SOURce]:BBIN:EXTernal:ILEaving <leaving>  
[:SOURce<hw>]:IQ:OUTPut:EXTernal:ILEaving <leaving>  
SOURce:TRANsmitter:ILEaving

**SOURce:RECeiver:ILEaving**

[:SOURce&lt;hw&gt;]:EBOX:USER:ILEaving &lt;lleaving&gt;

Switches on interleaving and selects the interleaving mode.

Depending on the interleaving settings, the baseband signal is either sent simultaneously or in I/Q or Q/I order from the DUT to the R&S EX-IQ-BOX or vice versa.

**Parameters:**

&lt;lleaving&gt; OFF | IQ | QI

**OFF**

Transmits the baseband signal without not Interleaved on the I and Q data lines.

**IQ**

Transmits the baseband signal on the I data line starting with I data, i.e. "I/Q Interleaved".

**Serial transmission, SDR:** The strobe signal UI\_RES1 lasts for 2 clock cycles. The first clock cycle triggers the I data, the second the Q data.

**Serial transmission, DDR:** The strobe signal (UI\_Res1) lasts for 1 clock cycle. The rising edge triggers the I data, the falling edge triggers the Q data.

**Parallel transmission, SDR:** The I marker output at the Reserved1 pin UI\_RES1 of the user interface marks the I data.

**Parallel transmission, DDR:** The rising edge of the clock signal triggers the I data, the falling edge the Q data.

**QI**

Transmits the baseband signal on the I data line starting with Q data, i.e. "Q/I Interleaved". With interchanged order of the I and Q data the I/Q signal is transferred similarly as described under I/Q Interleaved.

\*RST: OFF

**Example:**

SOUR1:EBOX:USER:ILE IQ  
sets the interleaving mode to "IQ".

**Manual operation:** See "[Interleaving](#)" on page 104

[:SOURce]:BBIN:EXTeRnal:SRATe?

[:SOURce&lt;hw&gt;]:IQ:OUTPut:EXTeRnal:SRATe?

SOURce:TRANsmitter:SRATe

SOURce:RECeiver:SRATe

[:SOURce&lt;hw&gt;]:EBOX:USER:SRATe?

**Note:** This command refers to R&S DigIConf and R&S Signal Generators.

This command queries the current sample rate of the external digital baseband signal.

**Return values:**

&lt;Srate&gt; float

|                 |                                                                                                            |
|-----------------|------------------------------------------------------------------------------------------------------------|
| <b>Example:</b> | <code>SOUR1:EBOX:USER:SRAT?</code><br>queries the "sample rate" of the externally applied baseband signal. |
| <b>Usage:</b>   | Query only                                                                                                 |

### 9.3.5 Clock Subsystem

The `USER:CLOCK` subsystem contains the commands for configuration of the clock signal, and the corresponding output and input connectors.

|                                                                           |     |
|---------------------------------------------------------------------------|-----|
| <code>[SOURce]:BBIN:EXtErnal:CLOCK:PHASe</code> .....                     | 267 |
| <code>[SOURce&lt;hw&gt;]:IQ:OUTPut:EXtErnal:CLOCK:PHASe</code> .....      | 267 |
| <code>SOURce:TRANsmitter:CLOCK:PHASe</code> .....                         | 267 |
| <code>SOURce:RECEiver:CLOCK:PHASe</code> .....                            | 267 |
| <code>[SOURce&lt;hw&gt;]:EBOX:USER:CLOCK:PHASe</code> .....               | 267 |
| <code>[SOURce]:BBIN:EXtErnal:CLOCK:POLarity</code> .....                  | 267 |
| <code>[SOURce&lt;hw&gt;]:IQ:OUTPut:EXtErnal:CLOCK:POLarity</code> .....   | 267 |
| <code>SOURce:TRANsmitter:CLOCK:POLarity</code> .....                      | 267 |
| <code>SOURce:RECEiver:CLOCK:POLarity</code> .....                         | 267 |
| <code>[SOURce&lt;hw&gt;]:EBOX:USER:CLOCK:POLarity</code> .....            | 267 |
| <code>[SOURce]:BBIN:EXtErnal:CLOCK:RATE</code> .....                      | 267 |
| <code>[SOURce&lt;hw&gt;]:IQ:OUTPut:EXtErnal:CLOCK:RATE</code> .....       | 267 |
| <code>SOURce:TRANsmitter:CLOCK:RATE</code> .....                          | 267 |
| <code>SOURce:RECEiver:CLOCK:RATE</code> .....                             | 268 |
| <code>[SOURce&lt;hw&gt;]:EBOX:USER:CLOCK:RATE</code> .....                | 268 |
| <code>[SOURce&lt;hw&gt;]:EBOX:USER:CLOCK:REFERENCE:FREQuency</code> ..... | 269 |
| <code>[SOURce&lt;hw&gt;]:EBOX:USER:CLOCK:REFERENCE:VALue?</code> .....    | 269 |
| <code>[SOURce]:BBIN:EXtErnal:CLOCK:SKEW:IN</code> .....                   | 269 |
| <code>[SOURce&lt;hw&gt;]:IQ:OUTPut:EXtErnal:CLOCK:SKEW:IN</code> .....    | 269 |
| <code>SOURce:TRANsmitter:CLOCK:SKEW:IN</code> .....                       | 269 |
| <code>SOURce:RECEiver:CLOCK:SKEW:IN</code> .....                          | 269 |
| <code>[SOURce&lt;hw&gt;]:EBOX:USER:CLOCK:SKEW:IN</code> .....             | 269 |
| <code>[SOURce]:BBIN:EXtErnal:CLOCK:SKEW:OUT</code> .....                  | 270 |
| <code>[SOURce&lt;hw&gt;]:IQ:OUTPut:EXtErnal:CLOCK:SKEW:OUT</code> .....   | 270 |
| <code>SOURce:TRANsmitter:CLOCK:SKEW:OUT</code> .....                      | 270 |
| <code>SOURce:RECEiver:CLOCK:SKEW:OUT</code> .....                         | 270 |
| <code>[SOURce&lt;hw&gt;]:EBOX:USER:CLOCK:SKEW:OUT</code> .....            | 270 |
| <code>[SOURce]:BBIN:EXtErnal:CLOCK:SOURce</code> .....                    | 270 |
| <code>[SOURce&lt;hw&gt;]:IQ:OUTPut:EXtErnal:CLOCK:SOURce</code> .....     | 270 |
| <code>SOURce:TRANsmitter:CLOCK:SOURce</code> .....                        | 270 |
| <code>SOURce:RECEiver:CLOCK:SOURce</code> .....                           | 270 |
| <code>[SOURce&lt;hw&gt;]:EBOX:USER:CLOCK:SOURce</code> .....              | 270 |
| <code>[SOURce]:BBIN:EXtErnal:SCRatio</code> .....                         | 271 |
| <code>[SOURce&lt;hw&gt;]:IQ:OUTPut:EXtErnal:SCRatio</code> .....          | 271 |
| <code>SOURce:TRANsmitter:SCRatio</code> .....                             | 271 |
| <code>SOURce:RECEiver:SCRatio</code> .....                                | 271 |
| <code>[SOURce&lt;hw&gt;]:EBOX:USER:SCRatio</code> .....                   | 271 |

---

```
[ :SOURce]:BBIN:EXtErnal:CLOCK:PHASe <Phase>
[:SOURce<hw>]:IQ:OUTPut:EXtErnal:CLOCK:PHASe <Phase>
SOURce:TRANsmitter:CLOCK:PHASe <Phase>
SOURce:RECeiver:CLOCK:PHASe <Phase>
[:SOURce<hw>]:EBOX:USER:CLOCK:PHASe <Phase>
```

Sets a phase shift of the active clock edge in 90° steps related to the data bits.

**Note: SCPI notation varies**

The SCPI notation differs between the commands of R&S generators, R&S DigIConf and the R&S analyzers, as described below.

**Parameters:**

|                        |                                                                                                                         |
|------------------------|-------------------------------------------------------------------------------------------------------------------------|
| <Phase>                | 0   90   180   270, or P0   P90   P180   P270, respectively                                                             |
| *RST:                  | 0                                                                                                                       |
| 0   90   180   270     | Enter the value for the phase shift of the clock signal, if you remotely control R&S DigIConf or R&S signal generators. |
| P0   P90   P180   P270 | Enter the value with P, when you remotely control R&S signal analyzers.                                                 |

**Example:** SOUR1:EBOX:USER:CLOC:PHAS 180  
define a phase shift of 180 degree for the clock edge.

**Manual operation:** See "[Clock Phase](#)" on page 118

---

```
[ :SOURce]:BBIN:EXtErnal:CLOCK:POLArity <Polarity>
[:SOURce<hw>]:IQ:OUTPut:EXtErnal:CLOCK:POLArity <Polarity>
SOURce:TRANsmitter:CLOCK:POLArity <Polarity>
SOURce:RECeiver:CLOCK:POLArity <Polarity>
[:SOURce<hw>]:EBOX:USER:CLOCK:POLArity <Polarity>
```

Sets the clock polarity of the active clock edge for triggering the signal transmission.

**Note:** Setting the clock polarity negative is equivalent to setting the clock phase to 180°.

**Parameters:**

|                 |                                                 |
|-----------------|-------------------------------------------------|
| <Polarity>      | POSitive   NEGative                             |
| <b>Positive</b> | Activates the rising edge of the clock signal.  |
| <b>Negative</b> | Activates the falling edge of the clock signal. |
| *RST:           | POSitive                                        |

**Example:** SOUR1:EBOX:USER:CLOC:POL NEG  
sets negative polarity.

---

```
[ :SOURce]:BBIN:EXtErnal:CLOCK:RATE <Rate>
[:SOURce<hw>]:IQ:OUTPut:EXtErnal:CLOCK:RATE <Rate>
SOURce:TRANsmitter:CLOCK:RATE <Rate>
```

**SOURCE:RECEIVER:CLOCK:RATE <Rate>**

**[[:SOURCE<hw>]:EBOX:USER:CLOCK:RATE <Rate>**

Sets/queries the clock rate (frequency) for signal transmission between the R&S EX-IQ-BOX and the external device (DUT). Depending on the logic type and the clock source the clock rate range varies).

$$f_{CLK} = \frac{f_s \cdot WS \cdot INT}{DDR \cdot SCR}$$

**Fig. 9-1: User defined > Clock rate**

$f_{clk}$  = clock rate  
 $f_s$  = sample rate  
 WS = Word size  
 INT = Interleaving mode  
 DDR = double data rate  
 SCR = sample/clock rate ratio

|                                                                                                                                                               |                         | Value range                               |                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------------------------------------------|------------------------------------------|
| $f_s$ =                                                                                                                                                       | Sample rate             | 1 kHz ... 100 MHz                         |                                          |
| $f_{clk}$ ==                                                                                                                                                  | Clock rate              | LVTTL: 1 (25) kHz - 100 MHz <sup>*)</sup> | LVDS: 1 (25) kHz - 400 MHz <sup>*)</sup> |
| 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              |                                          |
| <sup>*)</sup> 1 kHz represents the internal clock source, fed in from the R&S Instrument, 25 kHz are given from the external reference at the user interface. |                         |                                           |                                          |

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

**Parameters:**

<Rate> float  
 Range: 1 kHz to 400 MHz  
 \*RST: 10 MHz

**Example:**

SOUR1:EBOX:USER:CLOC:RATE?  
 query the current frequency of the clock signal of the R&S EX-IQ-BOX.  
 SOUR1:EBOX:USER:CLOC:RATE 10MHZ  
 set the clock rate of the R&S EX-IQ-BOX to 10 MHz.

**Manual operation:** See "[Clock Rate](#)" on page 115

---

**[[:SOURce<hw>]:EBOX:USER:CLOCK:REFERENCE:FREQUENCY <Frequency>**

**Note:** This command applies to R&S DigIConf and is relevant for the internal clock source.

Defines the frequency value of the reference clock.

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

**Parameters:**

<Frequency>            5MHZ | 10MHZ | 13MHZ  
                              \*RST:        10 MHz

**Example:**

SOUR1:EBOX:USER:CLOCK:RATE 13MHZ  
 set the reference frequency to "13 MHz":

**Manual operation:** See ["Frequency"](#) on page 118

---

**[[:SOURce<hw>]:EBOX:USER:CLOCK:REFERENCE:VALUE?**

Queries the value of the clock signal at REF IN.

**Return values:**

<RefVal>                float

**Example:**

SOUR1:EBOX:USER:CLOCK:REF:VAL?  
 query the clock value.

**Usage:**                Query only

**Manual operation:** See ["Freq. Counter"](#) on page 119

---

**[[:SOURce]:BBIN:EXTERNAL:CLOCK:SKEW:IN <SkewIn>**

**[[:SOURce<hw>]:IQ:OUTPUT:EXTERNAL:CLOCK:SKEW:IN <SkewIn>**

**SOURce:TRANsmitter:CLOCK:SKEW:IN <SkewIn>**

**SOURce:RECeiver:CLOCK:SKEW:IN <SkewIn>**

**[[:SOURce<hw>]:EBOX:USER:CLOCK:SKEW:IN <SkewIn>**

Sets a time shift of the active clock edge related to the data bits. This feature is used to compensate an internal clock skew which is caused by differences of the clock and data line lengths.

**Parameters:**

<SkewIn>                float  
                              Range:        -100.0 ns to 100.0 ns  
                              \*RST:        0 ns

**Example:**

SOUR1:EBOX:USER:CLOCK:SKEW:IN 2ns  
 sets a time shift of 2 ns.

**Manual operation:** See ["Clock In Skew"](#) on page 118



---

```
[:SOURce]:BBIN:EXtErnal:CLOCK:SKEW:OUT <Skew>
[:SOURce<hw>]:IQ:OUTPut:EXtErnal:CLOCK:SKEW:OUT <Skew>
SOURce:TRANsmitter:CLOCK:SKEW:OUT <Skew>
SOURce:RECeiver:CLOCK:SKEW:OUT <Skew>
[:SOURce<hw>]:EBOX:USER:CLOCK:SKEW:OUT <Skew>
```

Sets a time shift of the active clock edge related to the data bits. This feature is used to compensate an external clock skew which is caused by differences of the clock and data line lengths.

**Parameters:**

<Skew> float  
 Range: -5 ns to 5 ns  
 \*RST: 0 ns

**Example:** SOUR1:EBOX:USER:CLOC:SKEW:OUT 2ns  
 sets a time shift of 2 ns.

**Manual operation:** See ["Clock Skew"](#) on page 118

---

```
[:SOURce]:BBIN:EXtErnal:CLOCK:SOURce <Source>
[:SOURce<hw>]:IQ:OUTPut:EXtErnal:CLOCK:SOURce <Source>
SOURce:TRANsmitter:CLOCK:SOURce <Source>
SOURce:RECeiver:CLOCK:SOURce <Source>
[:SOURce<hw>]:EBOX:USER:CLOCK:SOURce <Source>
```

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

**Parameters:**

<Source> INTERNAL | EXTERNAL | REF

**INTERNAL**

The BNC reference of the frequency input is used. The R&S EX-IQ-BOX synthesizes the clock and forwards it to the external device.

**Note:** When using the internal clock frequency, the reference output of the R&S instrument must be connected to the REF IN of the R&S EX-IQ-BOX at the rear panel. The connection can be kept during the entire operation even if an external clock reference is used.

**EXTERNAL**

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

\*RST: REF

**Example:** SOUR1:EBOX:USER:CLOC:SOUR EXT  
 select the "EXTERNAL" clock source.

**Manual operation:** See ["Clock Source"](#) on page 116

```
[ :SOURce]:BBIN:EXTernal:SCRatio <Scratio>
[ :SOURce<hw>]:IQ:OUTPut:EXTernal:SCRatio <Scratio>
SOURce:TRANsmitter:SCRatio <Source>
SOURce:RECeiver:SCRatio <Source>
[ :SOURce<hw>]:EBOX:USER:SCRatio <Scratio>
```

Sets the sample to clock rate ratio in parallel data transmission mode. The parameter characterizes the ratio of the sample rate to the clock rate.

**Note: SCPI notation varies**

The SCPI notation differs between the commands of R&S generators, R&S DigIConf and the R&S analyzers, as described below.

**Parameters:**

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>&lt;Scratio&gt;</b>  | SCR1   SCR4D5   SCR2D5   SCR1D5   SCR1D10  <br>SCR1D20, or 1   0.8   0.4   0.2   0.1   0.05, respectively<br><b>*RST:</b> SCR1                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>SCR1   SCR4D5...</b> | Enter the respective string, if you run R&S DigIConf or R&S signal generators.<br>SCR = <b>S</b> ample <b>C</b> lock rate <b>R</b> atio, and <b>D</b> represents the decimal point, according to the following values: SCR = 1, 4/5, 2/5, 1/5, 1/10, 1/20                                                                                                                                                                                                                                                                            |
| <b>1   0.8...</b>       | Enter the value numerically, when you remotely control R&S signal analyzers.<br><b>1, 4/5, 2/5, 1/5, 1/10, 1/20</b><br>Set a sample clock rate ratio.<br><b>For SCR &lt; 1:</b><br>Dummy samples are added.<br>The signal output SCR_VALID at the Reserved0 pin (UI_RESERVE_P0) of the user interface marks the validity of the data.<br><b>Note:</b> The values of the sample/clock rate depend on the parameter settings of "Word Size", "Interleaving" and "Data Rate" (see also [ :SOURce<hw>]:EBOX:USER:CLOCK:RATE on page 268. |

**Example:** SOUR1:EBOX:USER:SCR SCR4D5  
set the sample clock rate ratio to "4/5".

**Manual operation:** See "Sample / Clock Rate Ratio" on page 107

### 9.3.6 Data Subsystem

The USER:DATA subsystem contains the commands for configuration of the digital I/Q baseband signal.

|                                                       |     |
|-------------------------------------------------------|-----|
| [ :SOURce]:BBIN:EXTernal:DATA:ALIGNment.....          | 272 |
| [ :SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:ALIGNment..... | 272 |
| SOURce:TRANsmitter:DATA:ALIGNment.....                | 272 |
| SOURce:RECeiver:DATA:ALIGNment.....                   | 272 |

|                                                       |     |
|-------------------------------------------------------|-----|
| [SOURce<hw>]:EBOX:USER:DATA:ALIGnment.....            | 272 |
| [SOURce]:BBIN:EXtErnal:DATA:BORDer.....               | 273 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:BORDer.....      | 273 |
| SOURce:TRANsmitter:DATA:BORDer.....                   | 273 |
| SOURce:RECeiver:DATA:BORDer.....                      | 273 |
| [SOURce<hw>]:EBOX:USER:DATA:BORDer.....               | 273 |
| [SOURce]:BBIN:EXtErnal:DATA:NFORmat.....              | 273 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:NFORmat.....     | 273 |
| SOURce:TRANsmitter:DATA:NFORmat.....                  | 273 |
| SOURce:RECeiver:DATA:NFORmat.....                     | 273 |
| [SOURce<hw>]:EBOX:USER:DATA:NFORmat.....              | 273 |
| [SOURce]:BBIN:EXtErnal:DATA:POLarity:IQ.....          | 275 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:POLarity:IQ..... | 275 |
| SOURce:TRANsmitter:DATA:POLarity:IQ.....              | 275 |
| SOURce:RECeiver:DATA:POLarity:IQ.....                 | 275 |
| [SOURce<hw>]:EBOX:USER:DATA:POLarity:IQ.....          | 275 |
| [SOURce]:BBIN:EXtErnal:DATA:SIZE.....                 | 275 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:SIZE.....        | 275 |
| SOURce:TRANsmitter:DATA:SIZE.....                     | 275 |
| SOURce:RECeiver:DATA:SIZE.....                        | 275 |
| [SOURce<hw>]:EBOX:USER:DATA:SIZE.....                 | 275 |
| [SOURce]:BBIN:EXtErnal:DATA:SPOlarity.....            | 275 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:SPOlarity.....   | 275 |
| SOURce:TRANsmitter:DATA:SPOlarity.....                | 275 |
| SOURce:RECeiver:DATA:SPOlarity.....                   | 275 |
| [SOURce<hw>]:EBOX:USER:DATA:SPOlarity.....            | 275 |
| [SOURce]:BBIN:EXtErnal:DATA:SPOSition.....            | 276 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:SPOSition.....   | 276 |
| SOURce:TRANsmitter:DATA:SPOSition.....                | 276 |
| SOURce:RECeiver:DATA:SPOSition.....                   | 276 |
| [SOURce<hw>]:EBOX:USER:DATA:SPOSition.....            | 276 |
| [SOURce]:BBIN:EXtErnal:DATA:STYPe.....                | 276 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:STYPe.....       | 276 |
| SOURce:TRANsmitter:DATA:STYPe.....                    | 276 |
| SOURce:RECeiver:DATA:STYPe.....                       | 276 |
| [SOURce<hw>]:EBOX:USER:DATA:STYPe.....                | 276 |
| [SOURce]:BBIN:EXtErnal:DATA:TYPE.....                 | 277 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:TYPE.....        | 277 |
| SOURce:TRANsmitter:DATA:TYPE.....                     | 277 |
| SOURce:RECeiver:DATA:TYPE.....                        | 277 |
| [SOURce<hw>]:EBOX:USER:DATA:TYPE.....                 | 277 |

---

**[SOURce]:BBIN:EXtErnal:DATA:ALIGnment <Alignment>**  
**[SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:ALIGnment <Alignment>**  
**SOURce:TRANsmitter:DATA:ALIGnment <Alignment>**  
**SOURce:RECeiver:DATA:ALIGnment <Alignment>**  
**[SOURce<hw>]:EBOX:USER:DATA:ALIGnment <Alignment>**

**Note:** This command refers to parallel transmission mode.

Sets the alignment of the data bits on the data lines. Either the MSB or the LSB is mapped firmly to one data line. Depending on the word size the equivalent bit moves to the appropriate data line.

**Parameters:**

<Alignment>                      MSB | LSB

**MSB**

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

**LSB**

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

\*RST:                      LSB

**Example:**

SOUR1:EBOX:USER:DATA:ALIG LSB  
sets the word alignment to "LSB".

**Manual operation:**    See ["Word Alignment"](#) on page 109

[[:SOURce]:BBIN:EXTernal:DATA:BORDER <Border>

[[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:BORDER <Border>

SOURce:TRANsmitter:DATA:BORDER <Border>

SOURce:RECeiver:DATA:BORDER <Border>

[[:SOURce<hw>]:EBOX:USER:DATA:BORDER <Border>

Sets the order of the data bits. In "Parallel mode", either the LSB or the MSB is transmitted on the first used data line. In "Serial mode" either the LSB or the MSB is transmitted as first bit.

**Parameters:**

<Border>                              MSB | LSB

**MSB**

Transmits the MSB (**M**ost **S**ignificant **B**it) first.

**LSB**

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

\*RST:                              LSB

**Example:**

SOUR1:EBOX:USER:DATA:BORD MSB  
sets the data bit order to MSB.

**Manual operation:**    See ["Bit Order"](#) on page 110

[[:SOURce]:BBIN:EXTernal:DATA:NFORMAT <Nformat>

[[:SOURce<hw>]:IQ:OUTPut:EXTernal:DATA:NFORMAT <Nformat>

SOURce:TRANsmitter:DATA:NFORMAT <Nformat>

SOURce:RECeiver:DATA:NFORMAT <Nformat>

[[:SOURce<hw>]:EBOX:USER:DATA:NFORMAT <Nformat>

Selects the format of the transmitted data.

Allowed number range for word size n Bit:

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

**Table 9-3: User defined > Numeric format coding**

| z  | 2's Complement |   |   |   |  | Binary Offset |   |   |   |
|----|----------------|---|---|---|--|---------------|---|---|---|
| -8 | 1              | 0 | 0 | 0 |  | 0             | 0 | 0 | 0 |
| -7 | 1              | 0 | 0 | 1 |  | 0             | 0 | 0 | 1 |
| -6 | 1              | 0 | 1 | 0 |  | 0             | 0 | 1 | 0 |
| -5 | 1              | 0 | 1 | 1 |  | 0             | 0 | 1 | 1 |
| -4 | 1              | 1 | 0 | 0 |  | 0             | 1 | 0 | 0 |
| -3 | 1              | 1 | 0 | 1 |  | 0             | 1 | 0 | 1 |
| -2 | 1              | 1 | 1 | 0 |  | 0             | 1 | 1 | 0 |
| -1 | 1              | 1 | 1 | 1 |  | 0             | 1 | 1 | 1 |
| 0  | 0              | 0 | 0 | 0 |  | 1             | 0 | 0 | 0 |
| 1  | 0              | 0 | 0 | 1 |  | 1             | 0 | 0 | 1 |
| 2  | 0              | 0 | 1 | 0 |  | 1             | 0 | 1 | 0 |
| 3  | 0              | 0 | 1 | 1 |  | 1             | 0 | 1 | 1 |
| 4  | 0              | 1 | 0 | 0 |  | 1             | 1 | 0 | 0 |
| 5  | 0              | 1 | 0 | 1 |  | 1             | 1 | 0 | 1 |
| 6  | 0              | 1 | 1 | 0 |  | 1             | 1 | 1 | 0 |
| 7  | 0              | 1 | 1 | 1 |  | 1             | 1 | 1 | 1 |

#### Parameters:

<Nformat>

TCOMplement | OBINary

#### TCOMplement

Formats the value of the transmitted data in 2's complement.

The most significant bit has a value of  $-2^{n-1}$ , the bits of lesser significance follow as:

$$+2^{n-2} \dots +2^0$$

#### OBINary

Formats the value of the transmitted data in binary offset.

#### Example

Adds a binary offset of  $-2^{n-1}$  such that the final values are always positive.

$$n = 4 \rightarrow -8 \leq z < 8$$

\*RST: TCOMplement

#### Example:

SOUR1:EBOX:USER:DATA:NFOR TCOM

sets the numeric format to two's-complement.

**Manual operation:** See "Numeric Format" on page 112

---

```
[ :SOURce]:BBIN:EXtErnal:DATA:POLarity:IQ <lq>
[ :SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:POLarity:IQ <lq>
SOURce:TRANsmitter:DATA:POLarity:IQ <lq>
SOURce:RECeiver:DATA:POLarity:IQ <lq>
[ :SOURce<hw>]:EBOX:USER:DATA:POLarity:IQ <lq>
```

The command sets the polarity of the I and Q data lines of the R&S EX-IQ-BOX.

**Parameters:**

<lq>                      POSitive | NEGative

**POSitive**  
High level stands for a logic 1, low level for a logic 0.

**NEGative**  
High level stands for a logic 0, low level for a logic 1.

\*RST:                  POSitive

**Example:**

```
SOUR1:EBOX:USER:DATA:POL:IQ NEG
set the inversion of the I and Q data signal.
```

---

```
[ :SOURce]:BBIN:EXtErnal:DATA:SIZE <Size>
[ :SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:SIZE <Size>
SOURce:TRANsmitter:DATA:SIZE <Size>
SOURce:RECeiver:DATA:SIZE <Size>
[ :SOURce<hw>]:EBOX:USER:DATA:SIZE <Size>
```

Sets the word size resolution of a sample. If the word size is set to a value n, the I word uses these n bits and the Q word uses n bits. The R&S EX-IQ-BOX supports word sizes from 4 to 18 bits.

**Parameters:**

<Size>                      float

Range:                  4 to 18

\*RST:                  16

Default unit: Bit

**Example:**

```
SOUR1:EBOX:USER:DATA:SIZE 8
sets the word size resolution to 8 bit.
```

**Manual operation:** See ["Word Size"](#) on page 109

---

```
[ :SOURce]:BBIN:EXtErnal:DATA:SPOLarity <Spolarity>
[ :SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:SPOLarity <Spolarity>
SOURce:TRANsmitter:DATA:SPOLarity <Spolarity>
SOURce:RECeiver:DATA:SPOLarity <Spolarity>
[ :SOURce<hw>]:EBOX:USER:DATA:SPOLarity <Spolarity>
```

Determines the polarity of the strobe marker signal. During a serial data transmission every data sample is marked by the strobe marker signal. The strobe marker is output at the UI\_GP5 of the user interface..

**Note:** Clock Phase or Clock Skew settings do not affect the strobe marker signal.

**Parameters:**

&lt;Spolarity&gt; POSitive | NEGative

**POSitive**

Sets the strobe polarity to high level.

**NEGative**

Sets the strobe polarity to low level.

\*RST: POSitive

**Example:**

SOUR1:EBOX:USER:DATA:SPOL NEG  
 inverts of the strobe marker signal.

**Manual operation:** See "Strobe Polarity" on page 113

[[:SOURce]:BBIN:EXtErnal:DATA:SPOSition <Sposition>  
 [[:SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:SPOSition <Sposition>  
 SOURce:TRANsmitter:DATA:SPOSition <Sposition>  
 SOURce:RECeiver:DATA:SPOSition <Sposition>  
 [[:SOURce<hw>]:EBOX:USER:DATA:SPOSition <Sposition>

**Note:** This command refers to serial data transmission.

Sets the sample position of the strobe marker output. The strobe marker is output at the UI\_GP5 of the user interface.

**Parameters:**

<Sposition> float  
 Range: 0 to word size-1  
 \*RST: 0

**Example:**

SOUR1:EBOX:USER:DATA:SPOS 10  
 sets the strobe marker output to sample position 10.

**Manual operation:** See "Strobe Position" on page 114

[[:SOURce]:BBIN:EXtErnal:DATA:STYPe <Stype>  
 [[:SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:STYPe <Stype>  
 SOURce:TRANsmitter:DATA:STYPe <Stype>  
 SOURce:RECeiver:DATA:STYPe <Stype>  
 [[:SOURce<hw>]:EBOX:USER:DATA:STYPe <Stype>

Selects the signal mode of the transmission. The digital I and Q signals are either transmitted separately or the I and Q samples are assembled to a carrier signal and shifted to an intermediate frequency (IF).

**Note:** Currently the signal type is firmly set to "IQ" and read only. IQ transmits the digital I and Q signal components separately.

Signal type "IF" is intended for future use.

**Parameters:**

&lt;Stype&gt; IQ | IF

**IQ**

Transmits the digital I and Q signals separately.

\*RST: IQ

**Example:**

SOUR1:EBOX:USER:DATA:STYP?

queries the set signal type.

**Manual operation:** See "Signal Type" on page 108

[:SOURce]:BBIN:EXtErnal:DATA:TYPE &lt;Type&gt;

[:SOURce&lt;hw&gt;]:IQ:OUTPut:EXtErnal:DATA:TYPE &lt;Type&gt;

SOURce:TRANsmitter:DATA:TYPE

SOURce:RECeiver:DATA:TYPE

[:SOURce&lt;hw&gt;]:EBOX:USER:DATA:TYPE &lt;Type&gt;

Selects the signal data type.

Data type "PFSamples" is intended for future use.

**Parameters:**

&lt;Type&gt; SAMPLEs | PFSamples

**SAMPLEs**

Sets signal type to samples.

\*RST: SAMPLEs

**Example:**

EBOX:USER:DATA:TYPE?

queries the set data type.

### 9.3.7 Test Subsystem

The `USER:TEST` subsystem provides commands for testing the user interface between the R&S EX-IQ-BOX and the DUT.

|                                                |     |
|------------------------------------------------|-----|
| [:SOURce<hw>]:EBOX:USER:TEST:RX:BER?           | 277 |
| [:SOURce<hw>]:EBOX:USER:TEST:RX:SIGNAL         | 278 |
| [:SOURce<hw>]:EBOX:USER:TEST:RX:STATE          | 278 |
| [:SOURce<hw>]:EBOX:USER:TEST:RX:WORDS?         | 279 |
| [:SOURce<hw>]:EBOX:USER:TEST:TX:SIGNAL         | 279 |
| [:SOURce<hw>]:EBOX:USER:TEST:TX:SINE:AMPLitude | 280 |
| [:SOURce<hw>]:EBOX:USER:TEST:TX:SINE:FREQuency | 281 |
| [:SOURce<hw>]:EBOX:USER:TEST:TX:STATE          | 281 |

[:SOURce&lt;hw&gt;]:EBOX:USER:TEST:RX:BER?

Queries the bit error rate. The function consecutively counts the number of discrepancies that occur during the test. The BER result is the ratio, which is calculated by dividing the number of error bits by the total number of bits.



**Return values:**

<Ber> float  
 \*RST: 0

**Example:**

SOUR1:EBOX:USER:DIR REC  
 sets "Receiver" mode.  
 SOUR1:EBOX:USER:TEST:RX:STAT ON  
 activates Rx test.  
 SOUR1:EBOX:USER:TEST:RX:BER?  
 checks the bit error rate.

**Usage:** Query only

**Manual operation:** See "Rx BER" on page 124

**[[:SOURce<hw>]:EBOX:USER:TEST:RX:SIGNAL <Signal>**

Selects the incoming test signal for testing. The test receiver analyzes both PRBS 16 or counter test signals.

**Parameters:**

<Signal> PRBS | COUNTER  
**PRBS**  
 Selects a PRBS 16 (Pseudo Random Binary Sequence) sequence for testing.  
**COUNTER**  
 Selects a counter test signal.  
 Range: PRBS to COUN  
 \*RST: PRBS

**Example:**

SOUR1:EBOX:USER:DIR REIC  
 SOUR1:EBOX:USER:TEST:RX:SIGN COUN  
 sets to "Receiver" and selects a counter signal for testing.

**Manual operation:** See "Test Signal" on page 123

**[[:SOURce<hw>]:EBOX:USER:TEST:RX:STATE <State>**

Activates the test receiver.

The R&S EX-IQ-BOX expects a test signal at the user interface. First, the test receiver synchronizes to the last received data word, and then generates a test sequence and compares each generated sample with the corresponding received sample.

**Parameters:**

<State> OFF | ON  
 \*RST: OFF

**Example:**

SOUR1:EBOX:USER:DIR REC  
 .  
 SOUR1:EBOX:USER:TEST:RX:STAT ON  
 sets the "Receiver" mode and activates Rx test.

**Manual operation:** See "Rx Test" on page 123

---

**[ :SOURce<hw>]:EBOX:USER:TEST:RX:WORDS?**

Queries the total number of received bits. This functions consecutively counts the number of received bits, compares them with the sent data and determines the error rate.

**Return values:**

<Words> float

**Example:**

```
SOUR1:EBOX:USER:DIR REC
sets to "Receiver" mode.
SOUR1:EBOX:USER:TEST:RX:STAT ON
activates Rx test.
SOUR1:EBOX:USER:TEST:RX:WORD?
checks the number of received bits.
```

**Usage:** Query only

**Manual operation:** See " Rx Received Bits" on page 124

---

**[ :SOURce<hw>]:EBOX:USER:TEST:TX:SIGNAL <Signal>**

Selects a test signal of the test generator.

The R&S EX-IQ-BOX internally generates either a sine, PRBS or counter signal for testing, defined as follows:

- PRBS

The PRBS 16 sequence is defined by the generator polynomial  $G(x) = 1 + x^2 + x^3 + x^5 + x^{16}$ .

The functional implementation of the **PRBS** generation defined by the following linear feedback shift register (**LFSR**):

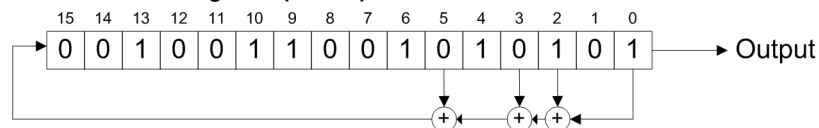


**Fig. 9-2: User defined > Test PRBS linear feedback shift register (LFSR)**

- Sine

The sine signal follows the formula,

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

**Fig. 9-3: User defined > sine signal formula**

$n$  = discrete time index

$f$  = frequency of the test sine signal

$f_s$  = sampling frequency, based on the "protocol", "data" and "clock" settings.

with the real component :

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

and the imaginary component:

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

#### Parameters:

<Signal>

PRBS | COUNTER | SINE

#### PRBS

Generates a PRBS 16 (Pseudo Random Binary Sequence) sequence. The output of this sequence complies to the "Protocol", "Data" and "Clock" settings of the R&S EX-IQ-BOX.

E.g. if the word size of the I / Q sample is 7 bits, the R&S EX-IQ-BOX sends the PRBS 16 sequence in 7-bit parts.

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

#### COUNTER

Generates a counter test signal. The counter size is based on the word size, set in the "Data" tab. Each output sample increases the counter by 1.

#### SINE

Provides a sine signal for testing, determined as shown by the formula above.

Range: PRBS to SINE

\*RST: PRBS

#### Example:

```
SOUR1:EBOX:USER:DIR TRAN
```

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

sets to "Transmitter" and selects a counter signal for testing.

**Manual operation:** See ["Test Signal"](#) on page 121

**[[:SOURce<hw>]:EBOX:USER:TEST:TX:SINE:AMPLitude <Amplitude>**

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

#### Parameters:

<Amplitude>

float

Range: -100 to 0

Increment: 1 dBFS

#### Example:

```
SOUR1:EBOX:USER:DIR TRAN
```

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

sets to "Transmitter" and "-50 dBFS" amplitude of the sine test signal.

**Manual operation:** See ["Amplitude"](#) on page 123

**[[:SOURce<hw>]:EBOX:USER:TEST:TX:SINE:FREQuency <Frequency>**

Sets the frequency of the sine test signal. The frequency is limited to "0.4  $f_s$ ", and the sampling frequency " $f_s$ " depends on the clock, data rate and the interleaving mode settings.

**Parameters:**

<Frequency> float  
 Range: -4 MHz to 4 MHz  
 Increment: 1 kHz

**Example:**

SOUR1:EBOX:USER:DIR TRAN  
 SOUR1:EBOX:USER:TEST:TX:SINE:FREQ 100KHZ  
 sets to "Transmitter" and the signal frequency "100 kHz".

**Manual operation:** See ["Frequency"](#) on page 123

**[[:SOURce<hw>]:EBOX:USER:TEST:TX:STATe <State>**

Switches the test generator on or off. While the test generator is switched on, the test signal replaces the I/Q data source coming from "DIG IQ IN".

**Parameters:**

<State> OFF | ON  
 \*RST: OFF

**Example:**

SOUR1:EBOX:USER:DIR TRAN  
 SOUR1:EBOX:USER:TEST:TX:STAT ON  
 sets "Transmitter" and switches on the test generator.

**Manual operation:** See ["Tx Test"](#) on page 121

### 9.3.8 Trigger Subsystem

The USER:TRIGger subsystem contains the commands for configuring a trigger signal when the R&S EX-IQ-BOX is working in transmitter mode.

|                                               |     |
|-----------------------------------------------|-----|
| [[:SOURce<hw>]:EBOX:USER:TRIGger:ARM.....     | 281 |
| [[:SOURce<hw>]:EBOX:USER:TRIGger:CSTat?.....  | 282 |
| [[:SOURce<hw>]:EBOX:USER:TRIGger:DElay.....   | 282 |
| [[:SOURce<hw>]:EBOX:USER:TRIGger:REStart..... | 282 |
| [[:SOURce<hw>]:EBOX:USER:TRIGger:SOURce.....  | 282 |
| [[:SOURce<hw>]:EBOX:USER:TRIGger:STATe?.....  | 283 |

**[[:SOURce<hw>]:EBOX:USER:TRIGger:ARM**

Stops the current signal output. It continues either automatically or synchronized, according to the used trigger source.

**Example:**

EBOX:USER:TRIG:ARM  
 stops signal output.

**Usage:** Event

**Manual operation:** See "[Arm](#)" on page 120

#### **[ :SOURce<hw>]:EBOX:USER:TRIGger:CSTat?**

Queries the current trigger status.

**Return values:**

<Status> string

**Example:** EBOX:USER:TRIG:CSTAT?  
Response: Idle, i.e. triggering is waiting for a trigger event.

**Usage:** Query only

#### **[ :SOURce<hw>]:EBOX:USER:TRIGger:DELay <Delay>**

Specifies a time delay after the trigger event. Trigger delay is defined in clock cycles

**Parameters:**

<Delay> float

**Example:** EBOX:USER:TRIG:DEL 5  
Signal output starts 5 clock cycles after the trigger event.

**Manual operation:** See "[Trigger Delay](#)" on page 120

#### **[ :SOURce<hw>]:EBOX:USER:TRIGger:REStart**

Starts triggering again.

**Example:** EBOX:USER:TRIG:REST  
restarts triggering.

**Usage:** Event

#### **[ :SOURce<hw>]:EBOX:USER:TRIGger:SOURce <Source>**

Selects the trigger source. The trigger signal starts the signal output at the user interface.

**Parameters:**

<Source> AUTO | SYNC

**AUTO**

Outputs the signal immediately.

**SYNC**

Synchronizes signal output with an incoming trigger signal, i.e. the DUT triggers data output to the R&S EX-IQ-BOX. The trigger signal is applied at the SYNC IN pin of the user interface.

\*RST: AUTO

**Example:** EBOX:USER:TRIG:SOUR SYNC  
uses a trigger signal from the DUT to synchronize signal output.

**Manual operation:** See ["Trigger Source"](#) on page 119

---

#### **[ :SOURce<hw>]:EBOX:USER:TRIGger:STATe?**

Queries the trigger status.

##### **Return values:**

<State> STOP | RUN

##### **Example:**

EBOX:USER:TRIG:STAT?

Response: STOP, i.e. triggering is stopped.

##### **Usage:**

Query only

**Manual operation:** See ["Status"](#) on page 120

### 9.3.9 SSI Subsystem

The `USER:SSI` subsystem contains the commands for configuring the signal transmission for SSI (serial synchronous interface) signals.

|                                                                       |     |
|-----------------------------------------------------------------------|-----|
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:CMDData:RX TX</a>       | 283 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:CMSize</a>              | 284 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:GAIN:FSElect</a>        | 284 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:GAIN:STATe</a>          | 284 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:LFSYnc</a>              | 284 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:SIZE</a>                | 284 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:SPI:CLOCK:FREQuency</a> | 285 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:SPI:CLOCK:PHASe</a>     | 285 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:SPI:CSElect</a>         | 285 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:SPI:FSElect</a>         | 285 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:SPI:RBYTe?</a>          | 286 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:USER:SSI:SPI:WBYTe</a>           | 286 |

---

#### **[ :SOURce<hw>]:EBOX:USER:SSI:CMDData:RX|TX <CMDData>**

In transmitter mode, the command defines the number of the C&M bit word as defined in the size parameter, see [\[ :SOURce<hw>\]:EBOX:USER:SSI:CMSize](#). In receiver mode, you can query the number.

##### **Parameters:**

<CMDData> string  
 Range: 0 to 32  
 Increment: 1

##### **Example:**

EBOX:USER:SSI:CMSIZE "8"

sets the word size to eight bit.

EBOX:USER:SSI:CMD:TX "#HA5,8"

EBOX:USER:SSI:CMD:RX?

**Manual operation:** See ["C&M Data"](#) on page 125

---

**[[:SOURce<hw>]:EBOX:USER:SSI:CMSize <CMSize>**

Defines the number of the Control & Management bits, following the I/Q data word. The size is defined from 0 up to 32 bits.

**Parameters:**

<CMSize> float  
Range: 0 to 32  
Increment: 1

**Example:** EBOX:USER:SSI:CM:SIZE 8  
sets 12 bit for control information.

**Manual operation:** See ["C&M Size"](#) on page 124

---

**[[:SOURce<hw>]:EBOX:USER:SSI:GAIN:FSElect <FSelect>**

Defines a binary file containing a gain table.

**Parameters:**

<FSelect> string

**Example:** EBOX:USER:SSI:GAIN:FSEL "gainFile.hex"

**Manual operation:** See ["Gain File"](#) on page 125

---

**[[:SOURce<hw>]:EBOX:USER:SSI:GAIN:STATE <State>**

Activates the automatic gain handling.

**Parameters:**

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

**Example:** EBOX:USER:SSI:GAIN:STAT ON

**Manual operation:** See ["Enable Automatic Gain"](#) on page 125

---

**[[:SOURce<hw>]:EBOX:USER:SSI:LFSYnc <Lfsync>****Parameters:**

<Lfsync> 0 | 1 | OFF | ON  
\*RST: 0

**Manual operation:** See ["Late Frame Sync"](#) on page 125

---

**[[:SOURce<hw>]:EBOX:USER:SSI:SIZE <Size>**

Defines the word size an I or Q data word in bits.

**Parameters:**

<Size> float  
Range: 4 to 24

**Example:** `EBOX:USER:SSI:SIZE 12`  
sets the word size resolution to 12 bit.

**Manual operation:** See ["Word Size"](#) on page 124

**[[:SOURce<hw>]:EBOX:USER:SSI:SPI:CLOCK:FREQuency <Frequency>**

Selects the system clock frequency.

**Parameters:**

<Frequency> 1MHZ | 2.5MHZ | 5MHZ | 8.333MHZ | 12.5MHZ | 25MHZ  
\*RST: 1MHZ

**Example:** `EBOX:USER:SSI:SPI:CLOC:FREQ 12.5MHz`

**Manual operation:** See ["Clock Frequency"](#) on page 125

**[[:SOURce<hw>]:EBOX:USER:SSI:SPI:CLOCK:PHASe <Phase>**

Selects the phase of the clock signal. Either 0 or 180 degree are possible.

**Parameters:**

<Phase> 0 | 180  
\*RST: 0

**Example:** `EBOX:USER:SSI:SPI:CLOC:PHAS 180`  
shifts the phase of the clock signal by 180 degree.

**Manual operation:** See ["Clock Phase"](#) on page 125

**[[:SOURce<hw>]:EBOX:USER:SSI:SPI:CSElect <CSelect>**

Selects the SSI-SPI chip.

**Parameters:**

<CSelect> 0 | 1 | OFF | ON  
\*RST: 0

**Example:** `EBOX:USER:SSI:SPI:CSEL ON`

**Manual operation:** See ["Chip Select"](#) on page 126

**[[:SOURce<hw>]:EBOX:USER:SSI:SPI:FSElect <FSelect>**

Selects a SSI:SPI file.

**Parameters:**

<FSelect> string

**Example:** `EBOX:USER:SSI:SPI:FSEL "spidata"`

**Manual operation:** See ["Select File"](#) on page 126



---

**[ :SOURce<hw> ]:EBOX:USER:SSI:SPI:RBYTe?**

Queries the SSI:SPI byte.

**Return values:**

<RByte>                      integer

**Example:**                      EBOX:USER:SSI:SPI:RBYT?

**Usage:**                      Query only

**Manual operation:**    See ["Read Byte \(hex\)"](#) on page 126

---

**[ :SOURce<hw> ]:EBOX:USER:SSI:SPI:WBYTe <WByte>**

**Parameters:**

<WByte>                      integer

**Manual operation:**    See ["Write Byte \(hex\)"](#) on page 126

---

## 9.4 CPRI Remote Control Commands

This chapter describes all remote-control commands for the standardized protocol CPRI, including their parameters and value ranges. The parameters are set in the configuration software R&S DigIConf.

In remote control operation, R&S DigIConf itself is operated remotely by means of remote-control commands. For background information about the SCPI command structure and basic information on operating R&S DigIConf via remote control, refer to [chapter 8, "Remote Control Basics"](#), on page 213.

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 & Management settings
- Hardware information
- L1 analysis information
- Main settings
- Recorder settings
- Diagnostics
- Downlink/Uplink settings (Tx/Rx)
- Vendor Data



Find a list of all commands for the R&S EX-IQ-BOX at the end of the manual.

---

The following description lists the remote-control commands in alphabetical order, structured by function.

### 9.4.1 CPRI ARB Subsystem

The ARB subsystem contains all remote control commands that are relevant for loading a waveform file in the waveform memory of the R&S EX-IQ-BOX. To get a list of available waveform files, see [\[:SOURce<hw>\]:EBOX:ARB:CATalog?](#) on page 249.

The numeric suffix to ARB<ch> distinguishes the channel of the waveform memory (ARB1 . . . 4).

|                                                                       |     |
|-----------------------------------------------------------------------|-----|
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB:OPTion?</a>             | 287 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB:PEAK?</a>               | 287 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB:PRESet</a>              | 288 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB:RELoad</a>              | 288 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB:RMS?</a>                | 288 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB:SAMPles:TOTal?</a>      | 288 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB&lt;ch&gt;:CONFLICT?</a> | 289 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB&lt;ch&gt;:FILE</a>      | 289 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB&lt;ch&gt;:SAMPles?</a>  | 289 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB&lt;ch&gt;:SRATe?</a>    | 290 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:ARB&lt;ch&gt;:STATe</a>     | 290 |

---

#### **[\[:SOURce<hw>\]:EBOX:CPRI:ARB:OPTion?](#)**

Queries the options installed on the R&S EX-IQ-BOX. The query returns a list of options in a comma-separated string.

##### **Return values:**

<opt>                      string

##### **Example:**

```
EBOX:CPRI:ARB:OPT?
check the installed options.
Response: EXBOX-B85, EXBOX-K10, EXBOX-K11,
EXBOX-K90, EXBOX-K242, ...
```

**Usage:**                      Query only

---

#### **[\[:SOURce<hw>\]:EBOX:CPRI:ARB:PEAK?](#)**

Queries the signal level in terms of a peak envelope power value (PEP). The unit of the peak envelope power is dBFS (Full Scale ratio).

##### **Return values:**

<peak>                      float

##### **Example:**

```
EBOX:CPRI:ARB:PEAK?
queries the peak envelope power of the signal.
```

**Usage:**                      Query only

**Manual operation:**      See ["PEP dBFS"](#) on page 207

---

**[[:SOURce<hw>]:EBOX:CPRI:ARB:PRESet**

The command sets the waveform memory to default, i.e. it erases the ARB table (all loaded waveform files and settings).

**Example:** SOUR1:EBOX:CPRI:ARB:PRESet  
clears the ARB table.

**Usage:** Event

**Manual operation:** See "Reset" on page 207

---

**[[:SOURce<hw>]:EBOX:CPRI:ARB:RELoad**

Refreshes all currently loaded waveform files.

**Example:** SOUR1:EBOX:CPRI:ARB:RELoad  
update assigned files in the waveform memory.

**Usage:** Event

**Manual operation:** See "Reload" on page 207

---

**[[:SOURce<hw>]:EBOX:CPRI:ARB:RMS?**

Queries the signal level in terms of an rms value. The unit of the power is dBFS (Full Scale ratio).

**Return values:**  
<rms> float

**Example:** EBOX:CPRI:ARB:RMS?  
queries the rms value of the signal.

**Usage:** Query only

**Manual operation:** See "Level dBFS" on page 207

---

**[[:SOURce<hw>]:EBOX:CPRI:ARB:SAMPles:TOTal?**

Queries the number of samples including all active waveform files.

**Return values:**  
<Total> float  
Increment: 1.0e-6  
\*RST: 0

**Example:** SOUR1:EBOX:CPRI:ARB:SAMP:TOT?  
check the entire number of samples.  
Response: 0.154 MSamples

**Usage:** Query only

**Manual operation:** See "Samples" on page 206

**[ :SOURce<hw>]:EBOX:CPRI:ARB<ch>:CONFLICT?**

The command queries whether an option conflict has occurred. A conflict arises, if a waveform requires an option, that is not installed on the R&S EX-IQ-BOX, or is not enabled.

**Return values:**

<Oconflict>            OFF | ON  
                          \*RST:        OFF

**Example:**

SOUR1:EBOX:CPRI:ARB:CONF?  
 check if there is an option conflict.  
 Response: 0 if OK, 1 if not OK

**Usage:**                Query only

**Manual operation:**   See ["Options Conflict"](#) on page 207

**[ :SOURce<hw>]:EBOX:CPRI:ARB<ch>:FILE <File>**

The command selects a stored waveform file. Enter directory and file name with the file extension \*.wv for waveform files.

**Parameters:**

<File>                    <path>, <file\_name>.<ext>  
 String parameter containing the directory, where the waveform file is located, the file name, and the file extension \*.wv for waveform files.

**Example:**

SOUR1:EBOX:CPRI:ARB2:FILE  
 "..\\DigIConf\\Waveforms\\p4DQPSK7.wv"  
 load the file "waveform" into the second ARB waveform memory.

**Manual operation:**   See ["File"](#) on page 205

**[ :SOURce<hw>]:EBOX:CPRI:ARB<ch>:SAMPLES?**

The command queries the number of samples the loaded signal is composed of.

**Return values:**

<Samples>                integer  
                          Increment: 1  
                          \*RST:        0

**Example:**

SOUR1:EBOX:CPRI:ARB1:SAMPL?  
 query the samples of the signal loaded in ARB1 waveform memory.  
 Response: 122.88  
 the current sample rate is 122.88 Mbit/s

**Usage:**                Query only

**[[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:SRATe?**

The command queries the sample rate of the signal, loaded from the waveform memory. The sample rate represents the number of samples per second that are used for digitizing.

**Return values:**

<Srate> integer  
Increment: 1  
\*RST: 0

**Example:**

SOUR1:EBOX:CPRI:ARB1:SRAT?  
query the sample rate of the signal loaded in ARB1 waveform memory.  
Response: 122.88  
the current sample rate is 122.88 Mbit/s

**Usage:** Query only

**Manual operation:** See "Sample Rate /MHz" on page 206

**[[:SOURce<hw>]:EBOX:CPRI:ARB<ch>:STATe <State>**

The command switches on the transmission of the test data.

**Parameters:**

<State> ON | OFF  
\*RST: OFF

**Example:**

SOUR1:EBOX:CPRI:ARB1:STAT ON  
activate waveform loaded in ARB1.

**Manual operation:** See "State" on page 207

## 9.4.2 CPRI Control & Management Subsystem

The CPRI Control & Management (C&M) command subsystem comprises all remote-control commands related to the process of exchanging control information between RE (Radio Equipment) and REC (Radio Equipment Control) in base station systems. CPRI supports two different protocols for C&M data, the slower variation HDLC (High-Level Data Link Control) and the fast Ethernet.

|                                                |     |
|------------------------------------------------|-----|
| [[:SOURce<hw>]:EBOX:CPRI:CM:ETH:ACTIve?.....   | 291 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:BAUDrate..... | 291 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:ETH:BRATe?.....    | 291 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:ETH:COMMand.....   | 292 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:ETH:EXECute.....   | 292 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:ETH:PPTR.....      | 292 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:ETH:PTR?.....      | 293 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:ETH:STATe.....     | 293 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:ACTIve?.....  | 293 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:BRATe.....    | 294 |
| [[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:COMMand.....  | 294 |

|                                                                     |     |
|---------------------------------------------------------------------|-----|
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:CM:HDLC:EXECute.....</a>  | 295 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:CM:HDLC:MODE.....</a>     | 295 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:CM:HDLC:RFRames?.....</a> | 295 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:CM:HDLC:RST.....</a>      | 296 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:CM:HDLC:RX?.....</a>      | 296 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:CM:HDLC:SFRames?.....</a> | 296 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:CM:HDLC:SOURce.....</a>   | 296 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:CM:HDLC:STATe.....</a>    | 297 |

### **[\[:SOURce<hw>\]:EBOX:CPRI:CM:ETH:ACTive?](#)**

The command queries whether the interface is active.

#### **Return values:**

<Active>                      OFF | ON  
                                  \*RST:        OFF

#### **Example:**

SOUR1:EBOX:CPRI:CM:ETH:ACT?  
 check the activity of the Ethernet interface.  
 Response: 0  
 the interface is not active.

**Usage:**                      Query only

**Manual operation:**    See "[Ethernet Active](#)" on page 199

### **[\[:SOURce<hw>\]:EBOX:CPRI:CM:HDLC:BAUDRate <Baudrate>](#)**

Determines the number of bits to be transferred per second via the serial interface RS232.

Available baudrates are: 300 | 600 | 1200 | 2400 | 4800 | 9600 | 14400 | 19200 | 28800  
 | 38400 | 56000 | 57600 | 115200 | 128000 | 256000 bps.

#### **Parameters:**

<Baudrate>                      float

#### **Example:**

EBOX:CPRI:CM:HDLC:BAUD 2400  
 sets 2400 bits per second transmission rate.

**Manual operation:**    See "[RS232 Settings](#)" on page 197

### **[\[:SOURce<hw>\]:EBOX:CPRI:CM:ETH:BRATe?](#)**

The command queries the resulting bit rate of fast C&M data exchange. This bit rate depends on the CPRI line bit rate and the Ethernet pointer.

#### **Return values:**

<Rate>                              float  
                                  Increment: 0.01  
                                  \*RST:        42240000

**Example:** SOUR1:EBOX:CPRI:CM:ETH:BRAT?  
 query the current bit rate of fast C&M.  
 Response: 122.88  
 the current bit rate is 122.88 Mbit/s.

**Usage:** Query only

**Manual operation:** See ["Bit Rate"](#) on page 199

**[SOURce<hw>]:EBOX:CPRI:CM:ETH:COMManD <Command>**

This command enters a control command in fast C&M interactive mode.

**Parameters:**

<Command> string

**Example:** SOUR1:EBOX:CPRI:CM:ETH:COMM "test cmd"  
 transmit the test command for fast C&M control to the control panel.  
 SOUR1:EBOX:CPRI:CM:ETH:EXEC  
 execute the test command.

**Manual operation:** See ["Input Window, Command line, Execute"](#) on page 200

**[SOURce<hw>]:EBOX:CPRI:CM:ETH:EXECute**

The command sends the C&M data in fast C&M mode.

**Example:** SOUR1:EBOX:CPRI:CM:ETH:EXEC  
 executes the control command, or command sequence of fast C&M data.

**Usage:** Event

**Manual operation:** See ["Input Window, Command line, Execute"](#) on page 200

**[SOURce<hw>]:EBOX:CPRI:CM:ETH:PPTR <Ptr>**

This command sets the CPRI Ethernet pointer. This setting determines the Fast C&M bit rate, since this pointer represents the boundary between vendor data and Fast C&M Data in the CPRI control block.

**Parameters:**

<Ptr> 20...63  
 Range: 20 to 63  
 Increment: 1  
 \*RST: 20

**Example:** SOUR1:EBOX:CPRI:CM:ETH:PPTR 25  
 set the ethernet pointer to 25.

**Manual operation:** See ["Pref. Eth. Pointer"](#) on page 198

**[ :SOURce<hw>]:EBOX:CPRI:CM:ETH:PTR?**

The command queries the resulting Ethernet pointer after the link setup, i.e. the position after the handshake between the R&S EXBOX-B85 and the DUT.

**Return values:**

<Pptr> float  
 Range: 20 to 63  
 Increment: 1  
 \*RST: 20

**Example:**

SOUR1:EBOX:CPRI:CM:ETH:PTR?  
 check the position of the ethernet pointer after link setup.  
 Response: 45  
 the resulting pointer is at position 45.

**Usage:** Query only

**Manual operation:** See ["Ethernet Pointer"](#) on page 167

**[ :SOURce<hw>]:EBOX:CPRI:CM:ETH:STATe <State>**

The command activates the C&M data exchange via the Ethernet interface.

**Parameters:**

<State> OFF | ON  
 \*RST: OFF

**Example:**

SOUR1:EBOX:CPRI:CM:ETH:STAT ON  
 switches on fast C&M.

**Manual operation:** See ["State"](#) on page 198

**[ :SOURce<hw>]:EBOX:CPRI:CM:HDLC:ACTive?**

The command queries whether the interface is active.

**Return values:**

<Active> OFF | ON  
 \*RST: OFF

**Example:**

SOUR1:EBOX:CPRI:CM:HDLC:ACT?  
 checks the activity of the HDLC interface.  
 Response: 0  
 the interface is not active.

**Usage:** Query only

**Manual operation:** See ["HDLC Active"](#) on page 196



**[ :SOURce<hw>]:EBOX:CPRI:CM:HDLC:BRATe <Rate>**

The command sets the bit rate for transmission of the control data in slow C&M mode (HDLC).

**Note:** The maximum HDLC rate for slow C&M depends on the CPRI Line Bit Rate. The following table shows the available HDLC bit rates for the corresponding CPRI bit rates.

| CPRI Line Bit Rate                | 2x (1228.8 Mbit/s) | 4x(2457.6 Mbit/s)         | 5x (3072.0 Mbit/s)                |
|-----------------------------------|--------------------|---------------------------|-----------------------------------|
| Possible HDLC Bit Rates in kbit/s | 240<br>480<br>960  | 240<br>480<br>960<br>1920 | 240<br>480<br>960<br>1920<br>2400 |

**Parameters:**

<Rate> 240 | 480 | 960 | 1920 | 2400  
 Range: 240000 to 2400000  
 Increment: 1  
 \*RST: 240000  
 Default unit: kbit/s

**Example:** SOUR1:EBOX:CPRI:CM:HDLC:BRAT 480  
 select a bit rate of 480 kbit/s for slow C&M transmission.

**Manual operation:** See ["Bit Rate"](#) on page 195

**[ :SOURce<hw>]:EBOX:CPRI:CM:HDLC:COMMand <Command>**

Enters a control command in slow C&M interactive mode.

Note that the command may perform a number of symbols that is divisible by 2. Odd values □□ are not accepted.

This command applies to HDLC C&M data source "Terminal", see [\[ :SOURce<hw>\]:EBOX:CPRI:CM:HDLC:SOURce](#). In direct mode, that is control data received via the RS-232-C interface, this command is not effective (CPRI REC Test mode).

**Parameters:**

<Command> string

**Example:** SOUR1:EBOX:CPRI:CM:HDLC:COMM "test cmd"  
 transmits the test command for slow C&M control to the control panel.  
 SOUR1:EBOX:CPRI:CM:HDLC:EXEC  
 executes the test command.

**Manual operation:** See ["Terminal"](#) on page 197

**[SOURce<hw>]:EBOX:CPRI:CM:HDLC:EXECute**

The command sends the entered slow C&M data.

This command applies to slow C&M source "Terminal". In direct mode, i.e. with data coming via the RS-232 interface, the controls are not active (CPRI REC Test mode).

**Example:** SOUR1:EBOX:CPRI:CM:HDLC:EXEC  
executes the control command of slow C&M data.

**Usage:** Event

**Manual operation:** See "Terminal" on page 197

**[SOURce<hw>]:EBOX:CPRI:CM:HDLC:MODE <Mode>**

The command selects the mode for HDLC C&M data transmission.

**Parameters:**

<Mode> DIRect | ECODing

**DIRect**

The R&S EX-IQ-BOX transmits the data directly to the DUT, i.e. without internal encoding or decoding.

This mode applies to HDLC source "RS-232-C Connector".

**ECODing**

The R&S EX-IQ-BOX either encodes the plain text data before transmission to the DUT, or it decodes and then displays the incoming data.

This mode applies to HDLC source "Terminal".

\*RST: ECODing

**Example:** SOUR1:EBOX:CPRI:CM:HDLC:MODE DIR  
send the data without internal encodin/decoding.

**Manual operation:** See "Mode" on page 195

**[SOURce<hw>]:EBOX:CPRI:CM:HDLC:RFRames?**

The command queries the number of received HDLC frames.

**Return values:**

<Rframes> float  
Increment: 1  
\*RST: 0

**Example:** SOUR1:EBOX:CPRI:CM:HDLC:RFR?  
query the number of received HDLC frames.

**Usage:** Query only

**Manual operation:** See "Frames Received" on page 197

---

**[[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:RST**

Resets the Rx/Tx data.

**Example:** EBOX:CPRI:CM:HDLC:RST

**Usage:** Event

**Manual operation:** See ["Terminal"](#) on page 197

---

**[[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:RX?**

Queries the received control & management data (HDLC).

**Return values:**

<Rx> string

**Example:** EBOX:CPRI:CM:HDLC:RX?

**Usage:** Query only

**Manual operation:** See ["Terminal"](#) on page 197

---

**[[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:SFRames?**

The command queries the number of sent HDLC frames.

**Return values:**

<Sframes> float  
Increment: 1  
\*RST: 0

**Example:** SOUR1:EBOX:CPRI:CM:HDLC:SFR?  
query the number of sent HDLC frames.

**Usage:** Query only

**Manual operation:** See ["Frames Sent"](#) on page 196

---

**[[:SOURce<hw>]:EBOX:CPRI:CM:HDLC:SOURce <Source>**

The command selects the source of the HDLC C&M data.

**Parameters:**

&lt;Source&gt;

TERMinal

**TERMinal|RS232**

Use the integrated terminal of R&S DigIConf for C&M data input or output.

This method applies to the CPRI RE test mode.

**RS232**

Use the RS-232-C connector for C&M data input or output.

You can use the RS-232-C interface in the CPRI RE and the CPRI REC test mode.

\*RST:       TERMinal

**Example:**

SOUR1:EBOX:CPRI:CM:HDLC:SOUR TERM

Enter the C&M data via the the terminal of R&S DigIConf.

**Manual operation:** See ["Source"](#) on page 195

**[SOURce<hw>]:EBOX:CPRI:CM:HDLC:STATe <State>**

The command activates and deactivates the C&M data exchange by means of HDLC protocol (slow C&M).

**Parameters:**

&lt;State&gt;

OFF | ON

\*RST:       OFF

**Example:**

SOUR1:EBOX:CPRI:CM:HDLC:STAT ON

switch on slow C&M.

**Manual operation:** See ["State"](#) on page 195

### 9.4.3 CPRI Hardware Subsystem

The hardware (HW: ) command subsystem encloses remote-control commands for setting hardware parameters, including the assignment to the interfaces, special settings of the link, status information and reference clock settings.

The numeric suffix to GPIO<dir> distinguishes the transmission direction of the connected GPIO Interfaces.

|                                                                           |     |
|---------------------------------------------------------------------------|-----|
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:ALARm?</a>                   | 298 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:BBRevision?</a>              | 298 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:CMODE?</a>                   | 299 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:CORE?</a>                    | 299 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:EBRevision?</a>              | 300 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:FBVersion?</a>               | 300 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:FCVersion?</a>               | 300 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:GPIO:MFWidth:BFRame</a>      | 300 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:GPIO:MFWidth:HFRame</a>      | 301 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:GPIO:MFWidth:NFRame</a>      | 301 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:HW:GPIO&lt;ch&gt;:DIRection</a> | 301 |

|                                                         |     |
|---------------------------------------------------------|-----|
| [SOURce<hw>]:EBOX:CPRI:HW:GPIO<ch>:SIGnal.....          | 302 |
| [SOURce<hw>]:EBOX:CPRI:HW:HSSS:INPut.....               | 303 |
| [SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP1[:STATe]..... | 304 |
| [SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP2[:STATe]..... | 304 |
| [SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SMA[:STATe].....  | 305 |
| [SOURce<hw>]:EBOX:CPRI:HW:LBRate.....                   | 305 |
| [SOURce<hw>]:EBOX:CPRI:HW:LOF?.....                     | 306 |
| [SOURce<hw>]:EBOX:CPRI:HW:LOS?.....                     | 306 |
| [SOURce<hw>]:EBOX:CPRI:HW:PROTocol.....                 | 306 |
| [SOURce<hw>]:EBOX:CPRI:HW:R21T?.....                    | 307 |
| [SOURce<hw>]:EBOX:CPRI:HW:RCLock:CRLocked?.....         | 307 |
| [SOURce<hw>]:EBOX:CPRI:HW:RCLock:CSLocked?.....         | 307 |
| [SOURce<hw>]:EBOX:CPRI:HW:RCLock:ROLocked?.....         | 308 |
| [SOURce<hw>]:EBOX:CPRI:HW:RCLock:SOURce.....            | 308 |
| [SOURce<hw>]:EBOX:CPRI:HW:SEED:RECeived?.....           | 309 |
| [SOURce<hw>]:EBOX:CPRI:HW:SEED:SCRambling.....          | 309 |
| [SOURce<hw>]:EBOX:CPRI:HW:SMA:DOSWing.....              | 310 |
| [SOURce<hw>]:EBOX:CPRI:HW:SMA:RXEGain.....              | 310 |
| [SOURce<hw>]:EBOX:CPRI:HW:T14T.....                     | 311 |
| [SOURce<hw>]:EBOX:CPRI:HW:TIMing?.....                  | 311 |
| [SOURce<hw>]:EBOX:CPRI:HW:TOFFset.....                  | 311 |

---

#### [SOURce<hw>]:EBOX:CPRI:HW:ALARm?

This command queries, if any alarm is detected on the CPRI communication link, i.e. it acts on behalf of all warnings.

##### Return values:

<Alarm>                    0 | 1  
                              \*RST:        0

##### Example:

SOUR1:EBOX:CPRI:HW:ALAR?  
 check if any link alarm is detected.  
 Response: 0  
 no error occurred.

**Usage:**                    Query only

**Manual operation:**    See "[Link Status](#)" on page 152

---

#### [SOURce<hw>]:EBOX:CPRI:HW:BBRevision?

This command queries the revision number of the connected CPRI breakout board.

##### Return values:

<Bbrevision>                string

##### Example:

SOUR1:EBOX:CPRI:HW:BBR?  
 query the revision number of the connected breakout board.  
 Response: 4  
 the internal CPRI breakout board has revision 4.

**Usage:**                    Query only

**Manual operation:** See ["Breakout Board Revision"](#) on page 155

---

#### **[ :SOURce<hw>]:EBOX:CPRI:HW:CMODE?**

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

##### **Return values:**

<Cmode> string

##### **Master**

The R&S EX-IQ-BOX is working in CPRI RE Test mode.

##### **Slave**

The R&S EX-IQ-BOX is working in CPRI REC Test mode.

##### **Example:**

SOUR1:EBOX:CPRI:HW:CMOD?

query the role of the R&S EX-IQ-BOX in the CPRI communication link.

Response: Slave

the R&S EX-IQ-BOX operates as slave, i.e. in CPRI REC Test mode.

**Usage:** Query only

**Manual operation:** See ["CPRI Mode"](#) on page 168

---

#### **[ :SOURce<hw>]:EBOX:CPRI:HW:CORE?**

Queries the current state of the CPRI core.

##### **Return values:**

<Cstatus> string

##### **Link is up**

The CPRI core works in normal operating mode.

##### **Reset**

It is at the starting point of establishing the link.

##### **L1 Synchronization**

Attempt of L1 synchronization.

##### **Setup protocol version**

Protocol version setup.

##### **Setup C&M parameter**

C&M parameter setup.

##### **Passive mode**

Only I/Q data are active, C&M is not used.

##### **Example:**

SOUR1:EBOX:CPRI:HW:CORE?

check the current mode of the CPRI core.

Response: Link is up

the CPRI communication link operates in normal mode.

**Usage:** Query only

**Manual operation:** See ["Core Mode"](#) on page 168

---

**[[:SOURce<hw>]:EBOX:CPRI:HW:EBRevision?**

Queries the revision number of the R&S EX-IQ-BOX's internal board.

**Return values:**

<Ebrevision>                      string

**Example:**

SOUR1:EBOX:CPRI:HW:EBR?

query the revision number of the internal EX-IQ-BOX board.

Response: 123

the internal R&S EX-IQ-BOX board has revision 123.

**Usage:**                              Query only

**Manual operation:** See ["R&S EX-IQ-BOX Board Revision"](#) on page 154

---

**[[:SOURce<hw>]:EBOX:CPRI:HW:FBVersion?**

Queries the version of the FPGA (Field Programmable Gate Array) basic design.

**Return values:**

<Fbversion>                      string

**Example:**

SOUR1:EBOX:CPRI:HW:FBV?

check the version of the FPGA basic design.

Response: 02.01.123

the CPRI FPGA has revision 02.01.123.

**Usage:**                              Query only

**Manual operation:** See ["FPGA Base Version"](#) on page 154

---

**[[:SOURce<hw>]:EBOX:CPRI:HW:FCVersion?**

Queries the version of the FPGA (Field Programmable Gate Array) CPRI design.

**Return values:**

<Fcversion>                      string

**Example:**

SOUR1:EBOX:CPRI:HW:FCV?

query the version of the CPRI FPGA.

Response: CPRI 01.01.001

the CPRI FPGA has revision 01.01.001.

**Usage:**                              Query only

**Manual operation:** See ["FPGA CPRI Version"](#) on page 154

---

**[[:SOURce<hw>]:EBOX:CPRI:HW:GPIO:MFWidth:BFRame <Width>**

Sets the frame width of the basic frame marker output signal in clock periods.

**Parameters:**

<Width> float  
Range: 1 to 65535

**Example:**

EBOX:CPRI:HW:GPIO:MFW:BFR 5  
increases the basic frame marker output signal to 5 clock periods.

**Manual operation:** See ["Basic ; Hyper ; Node B"](#) on page 163

**[ :SOURce<hw> ]:EBOX:CPRI:HW:GPIO:MFWWidth:HFRame <Width>**

Sets the frame width of the hyper frame marker output signal in clock periods.

**Parameters:**

<Width> float  
Range: 1 to 65535

**Example:**

EBOX:CPRI:HW:GPIO:MFW:BFR 2  
increases the basic frame marker output signal to 2 clock periods.

**Manual operation:** See ["Basic ; Hyper ; Node B"](#) on page 163

**[ :SOURce<hw> ]:EBOX:CPRI:HW:GPIO:MFWWidth:NFRame <Width>**

Sets the frame width of the node B frame marker output signal in clock periods.

**Parameters:**

<Width> float  
Range: 1 to 65535

**Example:**

EBOX:CPRI:HW:GPIO:MFW:BFR 10  
increases the basic frame marker output signal to 10 clock periods.

**Manual operation:** See ["Basic ; Hyper ; Node B"](#) on page 163

**[ :SOURce<hw> ]:EBOX:CPRI:HW:GPIO<ch>:DIRrection <Direction>**

Determines the transmission direction at the connected GPIO interfaces. You can individually activate each of the three interfaces separately.

The numeric suffix to GPIO<ch> distinguishes between the available GPIO interfaces.



**Parameters:**

&lt;Direction&gt;

OFF | OUTPut | INPut

Deactivate the GPIO interface.

**OFF**

Deactivates the GPIO interface.

**OUTPut**

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

**INPut**

Selects the appropriate GPIO interface as input, which means you receive a signal from the external device, e.g. for trigger purpose.

\*RST: OFF

**Example:**

```
SOUR1:EBOX:CPRI:HW:GPIO1:DIR OUTP
outputs the control signal at GPIO port 1.
```

**Manual operation:** See "[Direction GPIO 1-3](#)" on page 162

---

**[ :SOURce<hw> ] :EBOX:CPRI:HW:GPIO<ch>:SIGnal <Signal>**

The command determines the type of the control signal. You can define separate signals for each of the three interfaces.

The numeric suffix GPIO<ch> distinguishes between the GPIO interfaces 1, 2, 3 and 4.

**Parameters:**

&lt;Signal&gt;

CLOW | CHIGH | DLBFrame | DLHFrame | DLNFrame |  
ULBFrame | ULHFrame | ULNFrame | TMClock | RCLock | EXT1 |  
EXT2 | EXT3 | NOnE

GPIO output settings

In output mode, you can assign the following signals to the GPIO interface.

**CLOW|CHIGH**

Sets the control signal to constant level high or low.

**DLBFrame|ULBFrame**

Takes the information in the CPRI basic frame for control. According to the WCDMA clock rate, the CPRI protocol synchronizes its basic frame with 3.84 MHz.

**DLHFrame|ULHFrame**

Uses the CPRI hyper frame clock for control. The hyper frame clock rate is 15 kHz.

**DLNFrame|ULNFrame**

Uses the information in the CPRI Node B frame for control. CPRI updates the B node every 10 ms, i.e. you can control the DUT with a clock rate of 100 Hz.

**TMClock**

Uses the CPRI signal processing clock, e.g. 61.44 MHz at 2x line rate. This clock is used for timing measurements like response time, latency, etc..

**RCLock**

Uses the CPRI signal processing clock, e.g. 61.44 MHz at 2x line rate. This clock is used for timing measurements like response time, latency, etc..

**EXT1|EXT2|EXT3**

In input mode, each of the three GPIO ports provide also an external trigger signal.

**NOnE**

Deactivates the GPIO interface.

\*RST: NOnE

**Example:**

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

use the information in the CPRI Node B frame for control.

**Manual operation:** See "Signal GPIO 1-3" on page 162

---

**[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:INPut <Input>**

The command determines the interface for signal input. Only one interface can be active at the same time.

Basically the R&S EX-IQ-BOX receives a CPRI signal via one of the optical interfaces SFP1, or SFP2.

**Parameters:**

&lt;Input&gt;

SFP1 | SFP2 | SMA | LOOPback | NONE

**SFP1**

Selects the SFP1 (**S**mall **F**orm-factor **P**luggable) interface, at which the R&S EX-IQ-BOX is connected to the DUT to receive the signal.

**SFP2**

Selects the SFP2 (**S**mall **F**orm-factor **P**luggable) interface, at which the R&S EX-IQ-BOX is connected to the DUT to receive the signal.

**SMA**

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

**LOOPback**

Assigns the internal loopback, if the signal is routed back internally.

**NONE**

Deactivates the input, if no connection is established.

\*RST: SFP1

**Example:**

SOUR1:EBOX:CPRI:HW:HSSS:INP SFP1  
assigns SFP1 for signal input.

**Manual operation:**

See ["Input \(1409.7208.02\) ; Input/Output \(1409.7208.04\)"](#) on page 160

---

**[ :SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP1[:STATe] <State>**

Determines the SFP1 (**S**mall **F**orm-factor **P**luggable) interface for signal output, i.e. aligns the transmitter type of the DUT. You can activate more than one interface for the signal output simultaneously, e.g. set SFP1 for signal transmission to the DUT, and SMA for signal monitoring.

**Parameters:**

&lt;State&gt;

OFF | ON

\*RST: ON

**Example:**

SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SFP1 ON  
activates the SFP1 interface for signal output.

**Manual operation:**

See ["Outputs"](#) on page 160

---

**[ :SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP2[:STATe] <State>**

Determines the SFP2 (**S**mall **F**orm-factor **P**luggable) interface for signal output, i.e. aligns the transmitter type of the DUT. You can activate more than one interface for the signal output simultaneously, e.g. set SFP2 for signal transmission to the DUT, and SMA for signal monitoring.

The numeric suffix to SFP distinguishes between the available SFP interfaces.

**Parameters:**

<State> OFF | ON  
 \*RST: OFF

**Example:**

SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SFP2 ON  
 activates the SFP2 interface for signal output.

**Manual operation:** See ["Outputs"](#) on page 160

**[[:SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SMA[:STATe] <State>**

Determines the SMA (SubMiniatur version A) interface for signal output, i.e. aligns the transmitter type of the DUT. You can activate more than one interface for the signal output simultaneously, e.g. set SFP1 for signal transmission to the DUT, and SMA for signal monitoring.

**Parameters:**

<State> OFF | ON  
 \*RST: OFF

**Example:**

SOUR1:EBOX:CPRI:HW:HSSS:OUTP:SMA ON  
 activates the interface for signal output.

**Manual operation:** See ["Outputs"](#) on page 160

**[[:SOURce<hw>]:EBOX:CPRI:HW:LBRate <Lbrate>**

Selects the line bit rate for the communication link.

The available line speed depends on the CPRI breakout board version, see ["CPRI Line Bit Rate"](#) on page 157

**Parameters:**

<Lbrate> LR2X | LR4X | LR5X | LRAuto | LR1X | LR8X | LR10X | LR16X  
**LR1X**  
 1x614.4 Mbit/s  
**LR2X**  
 2x1228.8 Mbit/s  
**LR4X**  
 4x2457.6 Mbit/s  
**LR5X**  
 5x3072.0 Mbit/s  
**LR8X**  
 5x4915.2 Mbit/s  
**LR10X**  
 5x6144.0 Mbit/s  
**LR16X**  
 5x9830.4 Mbit/s  
 \*RST: LR2X

**Example:** SOUR1:EBOX:CPRI:HW:LBR LR2X  
sets the line bit rate 2x1228.8 Mbit/s.

**Manual operation:** See ["CPRI Line Bit Rate"](#) on page 157

#### **[SOURce<hw>]:EBOX:CPRI:HW:LOF?**

Queries the CPRI frame delimiter K28.5.

##### **Return values:**

<Lof> 0 | 1  
\*RST: 0

**Example:** SOUR1:EBOX:CPRI:HW:LOF?  
check if the frame delimiter K28.5 is detected.  
Response: 1 (0 = no error)  
the K28.5 frame delimiter is not found.

**Usage:** Query only

**Manual operation:** See ["LOF \(Loss of Frame\)"](#) on page 168

#### **[SOURce<hw>]:EBOX:CPRI:HW:LOS?**

The command queries data synchronization.

##### **Return values:**

<Los> 0 | 1  
\*RST: 0

**Example:** SOUR1:EBOX:CPRI:HW:LOS?  
check if data is synchronized.  
Response: 1 (0 = no error)  
data lost their synchronization.

**Usage:** Query only

**Manual operation:** See ["LOS \(Loss of Signal\)"](#) on page 168

#### **[SOURce<hw>]:EBOX:CPRI:HW:PROTocol <Protocol>**

Determines the CPRI protocol version. The protocol version depends on the selected line bit rate. See ["Protocol Version"](#) on page 158 for an overview.

##### **Parameters:**

<Protocol> V1 | V2

**Example:** EBOX:CPRI:HW:PROT V2  
Selects CPRI version 2.0.

**Manual operation:** See ["Protocol Version"](#) on page 158

---

**[ :SOURce<hw> ]:EBOX:CPRI:HW:R21T?**

Displays the cable delay.

**Return values:**

<r21> float

**Example:** EBOX:CPRI:HW:R21T?  
Response: '-117 ns'

**Usage:** Query only

**Manual operation:** See "[R21](#)" on page 157

---

**[ :SOURce<hw> ]:EBOX:CPRI:HW:RCLock:CRLocked?**

This command queries, if clock recovery is unlocked. Clock recovery must be locked in CPRI REC test mode.

**Return values:**

<Reclocked> 0 | 1

**ON**

**The clock recovery is locked.**

**OFF**

The clock recovery is unlocked.

\*RST: 1

**Example:** SOUR1:EBOX:CPRI:HW:RCL:CR?  
check if clock recovery is locked.  
Response: 1  
clock recovery is locked.

**Usage:** Query only

**Manual operation:** See "[Clock Recovery Locked](#)" on page 155

---

**[ :SOURce<hw> ]:EBOX:CPRI:HW:RCLock:CSLocked?**

This command queries, if the main PLL of the R&S EX-IQ-BOX is unlocked. This state is fundamental and must be locked in every operating mode of the R&S EX-IQ-BOX.

**Return values:**

<Slocked> OFF | ON

**ON**

**The PLL is locked.**

**OFF**

The PLL is unlocked.

\*RST: 1

**Example:** SOUR1:EBOX:CPRI:HW:RCL:CSL?  
check if the PLL of the R&S EX-IQ-BOX is locked.  
Response: 0  
the PLL is unlocked.

**Usage:** Query only

**Manual operation:** See ["Clock Synthesis Locked"](#) on page 155

#### **[[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:ROLocked?**

This command checks, if the reference clock output is available.

A second synthesizer generates a 10 MHz reference clock selectable at one of the GPIO interface connectors. The status LED turns blue, if the clock output is available.

#### **Return values:**

<Reflocked> 0 | 1  
\*RST: 1

**Example:** SOUR1:EBOX:CPRI:HW:RCL:ROL?  
check if the reference clock output is available.  
Response: 1  
clock output is not available.

**Usage:** Query only

**Manual operation:** See ["10MHz Reference Output Locked"](#) on page 155

#### **[[:SOURce<hw>]:EBOX:CPRI:HW:RCLock:SOURce <Source>**

Selects the reference signal source. In test mode CPRI RE, the R&S EX-IQ-BOX is synchronized either external or internally. Test mode CPRI REC uses the reference clock embedded in the CPRI link.

The reference clock is extracted from the CPRI link. This selection is mandatory in a CPRI REC test setup, since the R&S EX-IQ-BOX operates in CPRI slave mode.

Applies to a CPRI REC test mode.

**Parameters:**

&lt;Source&gt;

RIN | INTernal | CRECcovery

**RIN**

CPRI RE test setup with a connected R&amp;S instrument.

The R&S EX-IQ-BOX synchronizes the CPRI communication link with the reference signal provided by an R&S instrument. The 10 MHz signal is fed to the BNC connector REF IN on the back of the R&S EX-IQ-BOX.

**INTernal**

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

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

**CRECcovery**

CPRI REC test mode.

The reference clock is extracted from the CPRI link. This selection is mandatory in a CPRI REC test setup, since the R&S EX-IQ-BOX operates in CPRI slave mode.

\*RST: RIN

**Example:**

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

set the internal clock source for reference.

**Manual operation:** See "Source" on page 155**[ :SOURce<hw> ]:EBOX:CPRI:HW:SEED:RECeived?**

Queries the scrambling seed used by the connected transmitter.

**Return values:**

&lt;Received&gt;

string

**Example:**

EBOX:CPRI:HW:SEED:REC?

Response: '3ffffffff'

**Usage:**

Query only

**Manual operation:** See "Received Seed" on page 158**[ :SOURce<hw> ]:EBOX:CPRI:HW:SEED:SCRambling <Scrambling>**

Specifies the scrambling seed. This parameter applies to CPRI protocol version 2.0

**Parameters:**

&lt;Scrambling&gt;

integer

Range: depends on other settings to depends on other settings

**Example:**

EBOX:CPRI:HW:SEED:SCR #H3FFFFFFFF

**Manual operation:** See "Scrambling Seed" on page 158



**[[:SOURce<hw>]:EBOX:CPRI:HW:SMA:DOSWing <Doswing>**

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

**Parameters:**

<Doswing> float  
 Range: 0.1 to 1.6  
 Increment: 0.1  
 \*RST: 0.8

**Example:** SOUR1:EBOX:CPRI:HW:SMA:DOSW 1.0  
 sets 1.0 Vpp differential output voltage of the CML.

**Manual operation:** See ["Differential Output Swing"](#) on page 159

**[[:SOURce<hw>]:EBOX:CPRI:HW:SMA:RXEGain <Rxegain>**

The command sets the input gain of the equalizer. This equalizer is an active high-pass filter, that equalizes the low-pass behaviour of the transmission medium, such as e.g. the FR4 backplane. The gain, expressed in dB, relates to the frequency of 2 GHz.

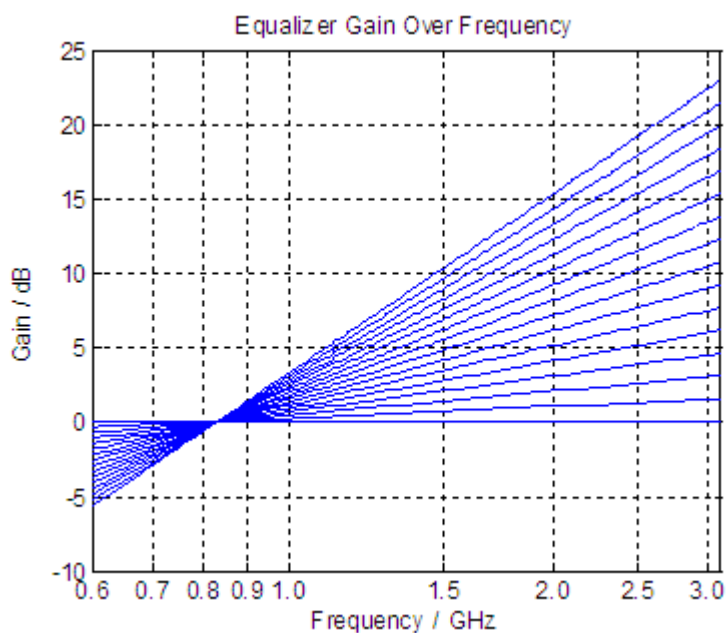


**Fig. 9-4: CPRI - equalizer gain over frequency**

**Parameters:**

<Rxegain> float  
 Range: 0 to 15  
 Increment: 1  
 \*RST: 0  
 Default unit: dB

**Example:** SOUR1:EBOX:CPRI:HW:SMA:RXEG 10  
sets the equalizer gain to 10 dB.

**Manual operation:** See ["Rx Equalizer Gain"](#) on page 159

**[ :SOURce<hw>]:EBOX:CPRI:HW:T14T <time>**

Sets the frame timing difference between the output signal at R1 and the input signal at R4.

Depending on the CPRI test mode you can specify either T14 or TOffset. The other parameter is calculated accordingly.

**Parameters:**

<time> float

**Example:** EBOX:CPRI:HW:T14T 180  
sets T14=180 ns

**Manual operation:** See ["T14"](#) on page 157

**[ :SOURce<hw>]:EBOX:CPRI:HW:TIMing?**

The command queries, if the R21 timing calculation is invalid (CPRI requirement 21).

**Return values:**

<Timing> 0 | 1  
\*RST: 0

**Example:** SOUR1:EBOX:CPRI:HW:TIM?  
check if timing calculation is correct.  
Response: 1 (0 = no error)  
the R21 timing calculation is invalid.

**Usage:** Query only

**[ :SOURce<hw>]:EBOX:CPRI:HW:TOFFset <offset>**

Sets the frame timing offset between the input signal at R2 and the output signal at R3.

Depending on the CPRI test mode you can specify either T14 or TOffset. The other parameter is calculated accordingly.

**Parameters:**

<offset> float

**Example:** EBOX:CPRI:HW:TOFF 10  
sets 10 ns timing offset

**Manual operation:** See ["TOffset"](#) on page 157

### 9.4.4 CPRI L1 Analysis Subsystem

The L1 analysis (L1 : ) command subsystem contains the remote-control commands for querying the link status.

|                                                                         |     |
|-------------------------------------------------------------------------|-----|
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:HDLC:BRATe?</a> .....      | 312 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:RX:LOCaL:LOF?</a> .....    | 312 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:RX:LOCaL:LOS?</a> .....    | 312 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:RX:LOCaL:RAI?</a> .....    | 313 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:RX:REMote:LOF?</a> .....   | 313 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:RX:REMote:LOS?</a> .....   | 313 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:RX:REMote:RAI?</a> .....   | 314 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:RX:REMote:RESet?</a> ..... | 314 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:RX:REMote:SAP?</a> .....   | 314 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:L1:VERSIon?</a> .....         | 315 |

---

#### **[\[:SOURce<hw>\]:EBOX:CPRI:L1:HDLC:BRATe?](#)**

Queries the HDLC bit rate value during link setup.

##### **Return values:**

<rate> float

##### **Example:**

EBOX:CPRI:L1:HDLC:BRAT?

Response: 4800

##### **Usage:**

Query only

**Manual operation:** See "[HDLC Rate](#)" on page 166

---

#### **[\[:SOURce<hw>\]:EBOX:CPRI:L1:RX:LOCaL:LOF?](#)**

Queries whether the received signal is synchronized correctly at the CPRI breakout board, i.e. LOF (Loss of Frame).

##### **Return values:**

<lof> 0 | 1 | OFF | ON

##### **Example:**

SOUR1:EBOX:CPRI:L1:RX:LOC:LOF?

queris if received data is synchronized.

Response: 1 (error), data lost synchronization.

##### **Usage:**

Query only

**Manual operation:** See "[Local Alarms](#)" on page 168

---

#### **[\[:SOURce<hw>\]:EBOX:CPRI:L1:RX:LOCaL:LOS?](#)**

Queries whether LOS (Loss of Signal) has occurred in the received signal at the CPRI breakout board.

##### **Return values:**

<lo> 0 | 1 | OFF | ON

**Example:** SOUR1:EBOX:CPRI:L1:RX:LOC:LOS?  
check if loss of signal happened.  
Response: 0 (no error)

**Usage:** Query only

**Manual operation:** See "[Local Alarms](#)" on page 168

#### **[SOURce<hw>]:EBOX:CPRI:L1:RX:LOCAl:RAI?**

Queries the RAI (**R**emote **A**rm **I**ndication) state at the CPRI breakout board, i.e. if any remote part of the end-to-end link has failed.

**Return values:**

<rai> 0 | 1 | OFF | ON

**Example:** SOUR1:EBOX:CPRI:L1:RX:LOC: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

**Manual operation:** See "[Local Alarms](#)" on page 168

#### **[SOURce<hw>]:EBOX:CPRI:L1:RX:REMote:LOF?**

Queries whether the received signal is synchronized correctly at the DUT, that means without LOF (**L**oss of **F**rame).

**Return values:**

<lof> 0 | 1 | OFF | ON

**Example:** SOUR1:EBOX:CPRI:L1:RX:REM:LOF?  
queries if the received data is synchronized.  
Response: 1 (error), data lost synchronization.

**Usage:** Query only

**Manual operation:** See "[Remote Alarms](#)" on page 169

#### **[SOURce<hw>]:EBOX:CPRI:L1:RX:REMote:LOS?**

Queries whether LOS (**L**oss of **S**ignal) has occurred in the received signal at the DUT.

**Return values:**

<los> 0 | 1 | OFF | ON

**Example:** SOUR1:EBOX:CPRI:L1:RX:REM:LOS?  
check if loss of signal happened.  
Response: 0 (no error)

**Usage:** Query only

**Manual operation:** See "[Remote Alarms](#)" on page 169

---

**[[:SOURce<hw>]:EBOX:CPRI:L1:RX:REMOte:RAI?**

Queries the RAI (Remote Arm Indication) state at the DUT, i.e. if any remote part of the end-to-end link has failed.

**Return values:**

<rai> 0 | 1 | OFF | ON

**Example:**

SOUR1:EBOX:CPRI:L1:RX:REM: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

**Manual operation:** See "Remote Alarms" on page 169

---

**[[:SOURce<hw>]:EBOX:CPRI:L1:RX:REMOte:RESet?**

Queries whether the DUT is in reset state.

**Return values:**

<reset> 0 | 1 | OFF | ON

**1**

CPRI RE test mode: Confirms that a reset was performed.

**CPRI REC test mode:** Confirms a reset request.

**0**

**CPRI RE test mode:** No reset was performed.

**CPRI REC test mode:** No reset is requested.

**Example:**

SOUR1:EBOX:CPRI:L1:RX:REM:RES?

check the reset state of the DUT.

**Usage:**

Query only

**Manual operation:** See "Remote Alarms" on page 169

---

**[[:SOURce<hw>]:EBOX:CPRI:L1:RX:REMOte:SAP?**

Queries whether the data communication failed (SDI Service Access Point Defect Indication).

**Return values:**

<sap> 0 | 1 | OFF | ON

**Example:**

SOUR1:EBOX:CPRI:L1:RX:REM:SAP?

check the data communication.

Response: **1** (error)

data communication failed.

**Usage:**

Query only

**Manual operation:** See "Remote Alarms" on page 169

**[ :SOURce<hw>]:EBOX:CPRI:L1:VERSion?**

Queries the CPRI L1 inband protocol version.

**Return values:**

<ver>                      string

**Example:**                      EBOX:CPRI:L1:VERS?

Response: 2

**Usage:**                      Query only

**Manual operation:**    See ["Protocol Version"](#) on page 165

### 9.4.5 CPRI Main Control Commands

The **main controls** commands provide the selection of the "CPRI test mode", and commands as "State" for activating, "Set to Default" for preset and "Save/Recall" for storing or loading previously defined settings.

|                                                              |     |
|--------------------------------------------------------------|-----|
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:MODE</a> .....     | 315 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:PRESet</a> .....   | 315 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:STATe</a> .....    | 316 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:VERSion?</a> ..... | 316 |

**[ :SOURce<hw>]:EBOX:CPRI:MODE <Mode>**

Selects the CPRI test mode. The R&S EX-IQ-BOX simulates either the baseband module or the RF module to test the appropriate counterpart.

**Parameters:**

<Mode>                      RETest | RECTest

**RETest**

The R&S EX-IQ-BOX works as RF module for testing the baseband module (**R**adio **E**quipment).

**RECTest**

The R&S EX-IQ-BOX emulates the baseband module for testing the RF module (**R**adio **E**quipment **C**ontrol).

\*RST:                      RETest

**Example:**                      SOUR1:EBOX:CPRI:MODE RECT

activate CPRI REC test mode.

**Manual operation:**    See ["Mode"](#) on page 152

**[ :SOURce<hw>]:EBOX:CPRI:PRESet**

Sets all parameters to default. Refer to [chapter A.3.2, "CPRI Default Settings"](#), on page 372, with an overview of the most important default settings.

**Example:**                      SOUR1:EBOX:CPRI:PRES

set to CPRI default.

**Usage:** Event

**Manual operation:** See "Set To Default / Preset" on page 152

---

**[ :SOURce<hw> ]:EBOX:CPRI:STATe <State>**

Activates the CPRI standardized protocol. The corresponding FPGA (Field Programmable Array) is loaded automatically into the R&S EX-IQ-BOX.

**Parameters:**

<State> OFF | ON  
\*RST: OFF

**Example:** SOUR1:EBOX:CPRI:STAT ON  
activates CPRI protocol transmission.

**Manual operation:** See "State" on page 152

---

**[ :SOURce<hw> ]:EBOX:CPRI:VERSion?**

Queries the version of currently used CPRI standard protocol version.

**Return values:**

<Version> V4\_2 | V5\_0

**Example:** EBOX:CPRI:VERS?  
Response: 'V5\_0'

**Usage:** Query only

## 9.4.6 CPRI Recorder Subsystem

The CPRI:RECOder subsystem contains all remote-control commands that are relevant for recording an I/Q signal and storing the recorded data in a waveform file.

|                                                                 |     |
|-----------------------------------------------------------------|-----|
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:ABORt.....                | 317 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:DATA:SOURce.....          | 317 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:DATA:SOURce:CATalog?..... | 317 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:DATA:SRATe?.....          | 317 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:EXECute.....              | 318 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:FILE:CREate.....          | 318 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:FILE:SELect.....          | 318 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:RLENgth.....              | 319 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:RTIME?.....               | 319 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:STATe?.....               | 319 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:STATus?.....              | 320 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:TRIGger:POSition.....     | 320 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:TRIGger:SOURce.....       | 321 |
| [ :SOURce<hw> ]:EBOX:CPRI:RECOder<ch>:VIEW.....                 | 321 |

**[ :SOURce<hw>]:EBOX:CPRI:RECOder<ch>:ABORt**

Stops and cancels the recording. You can abort the recording at any time and restart again.

**Example:** SOUR1:EBOX:CPRI:REC:ABOR  
stops recording.

**Usage:** Event

**Manual operation:** See "Abort / Discard" on page 211

**[ :SOURce<hw>]:EBOX:CPRI:RECOder<ch>:DATA:SOURce <Source>**

Selects the signal source of the signal to be recorded. All RX signals are available. In order to record a signal, the signal must be selected in the respective RX dialog. Either the uplink signal in CPRI RE test mode, or the downlink signal of the CPRI REC testmode are possible. Assign the signal "DIG OUT 2 IQ / Recorder" or "Recorder" under [ :SOURce<hw>]:EBOX:CPRI:RX:SIGNal<ch>:OUTPut on page 331. Switch on signal state, see [ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:STATe on page 352.

**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.

**Manual operation:** See "Data Source" on page 209

**[ :SOURce<hw>]:EBOX:CPRI:RECOder<ch>:DATA:SOURce:CATalog?**

Returns a list of data sources, i.e. output signals in the current, or specified directory.

**Return values:**

<Srcs> string

**Example:** SOUR1:EBOX:CPRI:REC:DATA:SOUR:CAT?  
read out all waveform files of the current directory.

**Usage:** Query only

**Manual operation:** See "Data Source" on page 209

**[ :SOURce<hw>]:EBOX:CPRI:RECOder<ch>:DATA:SRATe?**

Queries the sample rate of the recorded signal.

**Return values:**

<Srate> float  
\*RST: 3840000  
Default unit: Hz



**Example:** SOUR1:EBOX:CPRI:REC:DATA:SRAT?  
query the sample rate value of the selected signal.

**Usage:** Query only

**Manual operation:** See "Sample Rate" on page 210

#### **[SOURce<hw>]:EBOX:CPRI:RECOder<ch>:EXECute**

Starts the recording.

**Example:** SOUR1:EBOX:CPRI:REC:EXEC  
starts recording of the currently selected signal.

**Usage:** Event

**Manual operation:** See "Record" on page 211

#### **[SOURce<hw>]:EBOX:CPRI:RECOder<ch>:FILE:CREate**

This command creates a file and stores the recorded data.

**Note:** R&S DigiConf stores the recorded data in the waveform file format with the predefined file extension \*.wv. By default, waveform files are stored in the directory **%Program Files%/Rohde-Schwarz/DigiConf/Settings**, unless another directory is selected. File name and the directory are user-selectable.

##### **Parameters:**

<path>, <filename> String parameter to specify directory, path and filename.

**Example:** SOUR1:EBOX:CPRI:REC:FILE:CRE  
save the recorded data in a file

**Usage:** Event

**Manual operation:** See "Save to File" on page 211

#### **[SOURce<hw>]:EBOX:CPRI:RECOder<ch>:FILE:SElect <Select>**

Saves the the recorded data in a file. Filename and directory are specified within the command.

If no file of the specified name exists, it is created. The file extension may be omitted. R&S DigiConf stores the recorded I/Q data streams in the R&S WinIQSim2 waveform file format with the predefined file extension \*.wv.

##### **Setting parameters:**

<Select> <path>, <file\_name>  
String parameter to select directory, path and file name.

**Example:** SOUR1:EBOX:CPRI:REC:FILE:SEL "D:  
\\3GPP\_CPRIRE.wv"  
select the recorded file 3GPP\_CPRIRE.wv from D:\ directory.

**Usage:** Setting only

**Manual operation:** See ["Save"](#) on page 211

---

**[ :SOURce<hw>]:EBOX:CPRI:RECOder<ch>:RLENgth <Length>**

Sets the data length to be recorded in samples.

**Parameters:**

<Length> integer  
 Specifies the number of samples to be recorded.  
 Range: 1 to 128000000  
 Increment: 1  
 \*RST: 100 Samples

**Example:** SOUR1:EBOX:CPRI:REC:RLENgth 1024  
 record 1024 samples of the signal.

**Manual operation:** See ["Recording Length"](#) on page 209

---

**[ :SOURce<hw>]:EBOX:CPRI:RECOder<ch>:RTIME?**

Queries the recording time. The recording time results from the recording length and the sample rate.

**Return values:**

<Duration> float  
 Range: 0 to 2147483647 s  
 Increment: 0.000001  
 \*RST: 0  
 Default unit: s

**Example:** SOUR1:EBOX:CPRI:REC:RTIM?  
 returns the time needed for recording.

**Usage:** Query only

**Manual operation:** See ["Recording Time"](#) on page 210

---

**[ :SOURce<hw>]:EBOX:CPRI:RECOder<ch>:STATe?**

This command queries whether the selected data source signal is active or not. If inactive, the recorder cannot be started.

**Return values:**

<State> 0 | 1  
 \*RST: OFF

**Example:** SOUR1:EBOX:CPRI:REC:STAT?  
 Response: 0 (inactive)

**Usage:** Query only

**[ :SOURce<hw>]:EBOX:CPRI:RECOder<ch>:STATus?****Return values:**

&lt;Status&gt;

IDLE | FRUN | READy | WTRigger | TRIGgered | DONE

Returns the state of the recording process.

**IDLE**

Recording is inactive. Configure the recorder in that state.

The recorder remains in "Idle" state until you start with `Execute`.**FRUN**

The recorder records the signal continuously in a ring memory.

These data are required for pre-trigger analyzes.

**READy**

Recording has passed through the ring memory once at least, i.e. it has described the memory completely. At this point the data is valid and R&amp;S DigIConf activates the trigger signal automatically.

**WTRigger**

The recorder continues recording until the trigger event occurs.

Then the process switches to the next state.

If trigger source "Software" is used, the trigger event occurs immediately.

**TRIGgered**

After the trigger event, only the remaining samples after the trigger position are recorded (post-trigger data).

**DONE**

If all post-trigger data are recorded, the recording is completed and the recorder stops. The data is available in the memory.

\*RST: IDLE

**Example:**`SOUR1:EBOX:CPRI:REC:STAT?`

Response: WTR, i.e. the process is waiting for a trigger event.

**Usage:**

Query only

**Manual operation:**See "[Recorder Status Diagram](#)" on page 210**[ :SOURce<hw>]:EBOX:CPRI:RECOder<ch>:TRIGger:POSition <Position>**

Determine the position of the trigger event on the waveform. The position provides to realize a pre-trigger recording, as well as a post-trigger recording. The value is set in the samples from 0 to Recording Length-1.

- Post-trigger, i.e. position 0 at the beginning of the waveform enables to evaluate the signal after the trigger event.
- Pre Trigger, with the trigger position at the end of the waveform, provides the evaluation of the signal before the trigger event.

**Parameters:**

<Position> integer  
 Specify a numeric value.  
 Range: 0 to 99  
 Increment: 1  
 \*RST: 0

**Example:**

SOUR1:EBOX:CPRI:REC:TRIG:POS 2  
 set trigger position 2.

**Manual operation:** See "[Trigger Position](#)" on page 209

**[[:SOURce<hw>]:EBOX:CPRI:RECOder<ch>:TRIGger:SOURce <Source>**

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

**Parameters:**

<Source> SOFTWARE | EXT1 | EXT2 | EXT3 | TXBF | TXHF | TXNF | RXBF | RXHF | RXNF | SYNC

**SOFTWARE**

Software trigger starts the recording immediately after the record is switched on. No other event is necessary.

**EXT1...3**

Starts recording with an external trigger event.

External trigger events are generated by the hardware and fed at the GENERAL PURPOSE IO interface.

**TXBF|TXHF|TXNF|RXBF|RXHF|RXNF**

Starts recording with an external trigger event. These trigger events come within the CPRI communication link.

Available trigger events are:

CPRI DL/UL Basic Frame: TXBF | RXBF

CPRI DL/UL Hyper Frame: TXHF | RXHF

CPRI DL/UL NodeB Frame: TXNF | RXNF

**SYNC**

Starts recording after a specific sync pattern is received.

\*RST: SOFTWARE

**Example:**

SOUR1:EBOX:CPRI:REC:TRIG:SOUR EXT2  
 start recording with an external trigger event, fed at the 2nd GPIO interface.

**Manual operation:** See "[Trigger Source](#)" on page 209

**[[:SOURce<hw>]:EBOX:CPRI:RECOder<ch>:VIEW**

Calls the viewer program ARB toolbox, to view the currently loaded IQ data stream.

**Example:** EBOX:CPRI:REC:VIEW "d:  
 \user\temp\qpsk\_dirac\_3\_84Hz"  
 calls the ARB toolbox to view the IQ content of the file.

**Usage:** Event

**Manual operation:** See "View" on page 212

### 9.4.7 CPRI Settings Subsystem

With the commands of the `SETTing` subsystem, you can save settings of a CPRI application, or recall previously saved configurations. It covers all commands for file handling.

|                                                                      |     |
|----------------------------------------------------------------------|-----|
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:SETTing:CATalog?</a> ..... | 322 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:SETTing:DELeTe</a> .....   | 322 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:SETTing:LOAD</a> .....     | 323 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:SETTing:STORE</a> .....    | 323 |

---

#### **`[:SOURce<hw>]:EBOX:CPRI:SETTing:CATalog?`**

The command queries the available settings files in the specified directory. Settings files are used to store current application settings. Only files with the file extension \*.cpri will be listed.

Access to the files via remote is possible using the commands of the `MEMM` subsystem.

#### **Return values:**

<Catalog> string  
 String parameter to select the directory where settings files are stored.

**Example:** MEMM:CDIR "d:\DigIConf\Settings\CPRI"  
 Set the default directory and path to  
 d:\DigIConf\Settings\CPRI.  
 SOUR1:EBOX:CPRI:SETT:CAT?  
 read out all settings files of the \DigIConf\Settings\CPRI  
 directory on drive d:

**Usage:** Query only

**Manual operation:** See "Save / Recall" on page 152

---

#### **`[:SOURce<hw>]:EBOX:CPRI:SETTing:DELeTe <Delete>`**

The command removes a settings file from the specified directory.

#### **Setting parameters:**

<Delete> <directory>, <file\_name>, <ext>  
 Determine the file to be deleted by adding directory, file name and the file extension (\*.cpri).

**Example:** SOUR1:EBOX:CPRI:SETT:DEL "d:  
 \DigIConf\Settings\CPRI\RETest.cpri"  
 delete the file RETest.cpri.

**Usage:** Setting only

#### **[SOURce<hw>]:EBOX:CPRI:SETTing:LOAD <Load>**

The command loads a previously saved CPRI configuration. Define directory and file name, R&S DigIConf automatically assigns the file extension \*.cpri.

##### **Setting parameters:**

<Load> <directory>, <file\_name>  
 String parameter to determine the target directory and the file-name for loading the settings file.

**Example:** SOUR1:EBOX:CPRI:SETT:LOAD "D:  
 /USER/CPRISettings/RETest"  
 load the CPRI settings file RETest.cpri from the directory  
 d:\USER\CPRISettings.

**Usage:** Setting only

**Manual operation:** See ["Save / Recall"](#) on page 152

#### **[SOURce<hw>]:EBOX:CPRI:SETTing:STORe <Store>**

Saves the current CPRI signal configuration. Specify the directory and file name. R&S DigIConf automatically assigns the file extension \*.cpri to CPRI configuration files.

##### **Setting parameters:**

<Store> <directory>, <file\_name>  
 String parameter to determine the target directory and the file-name for storing the settings file.

**Example:** SOUR1:EBOX:CPRI:SETT:STOR "D:  
 /USER/CPRISettings/RETest"  
 save the currently defined CPRI settings in the file  
 RETest.cpri in the directory d:\USER\CPRISettings.

**Usage:** Setting only

**Manual operation:** See ["Save / Recall"](#) on page 152

### **9.4.8 CPRI Test & Diagnostics Subsystem**

The TEST: & Diagnostics subsystem contains the remote-control commands to get information on the SFP transceiver connection and RX alarms. You also find the commands for executing a low level BER test in this panel.

The numeric suffix to `SFP<st>` distinguishes the SFP interfaces (SFP1,SFP2).

|                                                                           |     |
|---------------------------------------------------------------------------|-----|
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:BER:RX:RATE?</code>               | 324 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:BER:RX:STATE</code>               | 324 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:BER:RX:WORDS?</code>              | 325 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:BER:TX:STATE</code>               | 325 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:PRBS:RST</code>                        | 325 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:RX:LOF?</code>                    | 325 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:RX:LOS?</code>                    | 326 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:RX:RAI?</code>                    | 326 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:RX:RESet?</code>                  | 326 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:RX:SDI?</code>                    | 327 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:SFP&lt;st&gt;:INFO?</code>        | 327 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:SFP&lt;st&gt;:LOS?</code>         | 327 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:SFP&lt;st&gt;:TX:DIsabled?</code> | 328 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:SFP&lt;st&gt;:TX:FAULT?</code>    | 328 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:TX:REReset</code>                 | 328 |
| <code>[SOURce&lt;hw&gt;]:EBOX:CPRI:TEST:TX:SDI</code>                     | 329 |

#### **`[SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:RATE?`**

The command queries the number of bit errors. This function consecutively counts the number of discrepancies that occur during the test. The BER result is the ratio, which is calculated by dividing the number of error bits by the total number of bits.

##### **Return values:**

`<Rate>` float  
 Range: 0 to 1.000  
 Increment: 0.01  
 \*RST: 0

##### **Example:**

`SOUR1:EBOX:CPRI:TEST:BER:RX:RATE?`  
 query the number of bit errors.  
 Response: 2  
 2 bit errors occurred during low level BER test.

**Usage:** Query only

**Manual operation:** See "[Rx BER](#)" on page 193

#### **`[SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:STATE <State>`**

Switches on the test receiver.

##### **Parameters:**

`<State>` ON | OFF  
 \*RST: OFF

##### **Example:**

`SOUR1:EBOX:CPRI:TEST:BER:RX:STAT ON`  
 switch on test receiver.

**[ :SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:WORDS?**

The command queries the number of received IQ words during low level BER RX test. Low level BER test consecutively counts the number of received words in order to compare them with the sent data and to determine the error rate.

**Return values:**

<Words>                    integer  
                               Increment: 1  
                               \*RST: 0

**Example:**

SOUR1:EBOX:CPRI:TEST:BER:RX:WORD?  
 query the number of received IQ words.  
 Response: 10005  
 R&S DiglConf received 10005 words during low level BER test.

**Usage:**                    Query only

**Manual operation:**    See "[Rx Received Bits](#)" on page 193

**[ :SOURce<hw>]:EBOX:CPRI:TEST:BER:TX:STATe <Execute>**

The command starts the transmission of the test data.

**Parameters:**

<Execute>                ON | OFF  
                               \*RST:        OFF

**Example:**

SOUR1:EBOX:CPRI:TEST:BER:TX:STAT ON  
 start PRBS TX test.

**[ :SOURce<hw>]:EBOX:CPRI:PRBS:RST**

Resets the PRBS test.

**Usage:**                    Event

**Manual operation:**    See "[Reset](#)" on page 193

**[ :SOURce<hw>]:EBOX:CPRI:TEST:RX:LOF?**

Queries whether the received signal is synchronized correctly, i.e. LOF (Loss of Frame).

**Return values:**

<Lof>                    0 | 1  
                               \*RST:        0

**Example:**

SOUR1:EBOX:CPRI:TEST:RX:LOF?  
 check if received data is synchronized.  
 Response: 1 (error), data lost synchronization.

**Usage:**                    Query only

**Manual operation:**    See "[Flags](#)" on page 166



---

**[[:SOURce<hw>]:EBOX:CPRI:TEST:RX:LOS?**

The command queries a **Loss of Signal (LOS)**.

**Return values:**

<Los>                    0 | 1  
\*RST:                0

**Example:**

SOUR1:EBOX:CPRI:TEST:RX:LOS?  
check if loss of signal happened.  
Response: 0 (no error)

**Usage:**                Query only

**Manual operation:**   See "Flags" on page 166

---

**[[:SOURce<hw>]:EBOX:CPRI:TEST:RX:RAI?**

The command queries the RAI (**R**emote **A**rm **I**ndication) state, i.e. if any remote part of the end-to-end link has failed.

**Return values:**

<Rai>                    0 | 1  
\*RST:                0

**Example:**

SOUR1:EBOX:CPRI:TEST:RX:RAI?  
check if a remote part of the end-to-end link has failed.  
Response: 0 if OK, 1 if not OK

**Usage:**                Query only

**Manual operation:**   See "Flags" on page 166

---

**[[:SOURce<hw>]:EBOX:CPRI:TEST:RX:RESet?**

Checks the reset state of the DUT.

**Return values:**

<Reset>                0 | 1  
**1**  
CPRI RE test mode: Confirms that a reset was performed.  
**CPRI REC test mode:** Confirms a reset request.  
**0**  
CPRI RE test mode: No reset was performed.  
CPRI REC test mode: No reset is requested.  
\*RST:                0

**Example:**

SOUR1:EBOX:CPRI:TEST:RX:RES?  
check the reset state of the DUT.

**Usage:**                Query only

**Manual operation:**   See "Flags" on page 166

---

**[[:SOURce<hw>]:EBOX:CPRI:TEST:RX:SDI?**

The command queries if the data communication failed (SDI **S**ervice Access Point **D**efect **I**ndication).

**Return values:**

<Sdi>                    0 | 1  
                           \*RST:        0

**Example:**

SOUR1:EBOX:CPRI:TEST:RX:SDI?  
 check the data communication.  
 Response: **1** (error)  
 data communication failed.

**Usage:**                Query only

**Manual operation:** See "[Flags](#)" on page 166

---

**[[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:INFO?**

The command provides information on all SFP module parameters.

**Return values:**

<Info>                   string

**Example:**

SOUR1:EBOX:CPRI:TEST:SFP:INFO?  
 query all parameters of the SFP1 module.  
 Response: 'Vendor:R&S, Part number:  
 90567, 'Connector:LC, 'Bit Rate:  
 2400kbit/s, 'Wave Length:1024,...'.

**Usage:**                Query only

**Manual operation:** See "[SFP Diagnostics](#)" on page 204

---

**[[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:LOS?**

Queries whether data communication via the SFP module failed and the signal was lost.

**Return values:**

<Sloss>                   0 | 1  
                           \*RST:        0

**Example:**

SOUR1:EBOX:CPRI:TEST:SFP1:LOS?  
 check whether the data was transferred correctly through the  
 SFP1 module, or whether the signal was lost.  
 Response: 0 if OK, 1 if not OK

**Usage:**                Query only

**Manual operation:** See "[SFP LEDs](#)" on page 204

**[[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:TX:DISabled?**

Queries whether the interface of the breakout board and the SFP transmission line are disabled.

**Return values:**

<Disabled>            0 | 1  
                          \*RST:        0

**Example:**

SOUR1:EBOX:CPRI:TEST:SFP:TX:DIS?  
 check the interface between the breakout board and the SFP transmission line.  
 Response: 1 if active 0 if inactive.

**Usage:**                Query only

**Manual operation:**   See "SFP LEDs" on page 204

**[[:SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:TX:FAULT?**

Queries the error states at the SFP interfaces. If a SFP is disconnected, R&S DiglConf responses with 0 (error).

**Return values:**

<Fault>                0 | 1  
                          \*RST:        0

**Example:**

SOUR1:EBOX:CPRI:TEST:SFP:TX:FAUL?  
 check if a transmission error occurred.  
 Response: 0 if OK, 1 if not OK

**Usage:**                Query only

**Manual operation:**   See "SFP LEDs" on page 204

**[[:SOURce<hw>]:EBOX:CPRI:TEST:TX:REReset <Rereset>**

The command sets or clears the bit on the downlink connection which requests the RE to reset.

**Note:** This function applies to CPRI RE test mode. In this mode, the R&S EX-IQ-BOX acts as a CPRI REC (master). As defined in the CPRI standard specification, the CPRI REC provides the generation of Layer 1 messages. In this section, you can simulate some events. Use this function to see how the DUT responds to these events.

**Parameters:**

<Rereset>              ON | OFF  
                          \*RST:        0

**Example:**

SOUR1:EBOX:CPRI:TEST:TX:RER ON  
 request the RE to reset.

**Manual operation:**   See "RE Reset" on page 170

**[[:SOURce<hw>]:EBOX:CPRI:TEST:TX:SDI <Sdi>**

Activates the SDI (**S**ervice **A**ccess **P**oint **D**efect **I**ndication) defect indicator. This function intentionally provokes an SDI event, in order to examine whether the DUT evaluates it. In realtime applications, the function detects whether an SAP (**S**ervice **A**ccess **P**oint) is defective or not working properly.

**Note:** The command applies to CPRI RE test mode. In this mode, the R&S EX-IQ-BOX acts as a CPRI REC (master). As defined in the CPRI standard specification, the CPRI REC provides the generation of Layer 1 messages. In this section, you can simulate some events. Use this function to see how the DUT responds to these events.

**Parameters:**

<Sdi>                      0 | 1  
                               \*RST:        0

**Example:**                SOUR1:EBOX:CPRI:TEST:TX:SDI ON  
                               activate transmitter SAP Defect Indication.

**Manual operation:**    See "SDI" on page 169

#### 9.4.9 CPRI TX/RX - Downlink/Uplink Subsystem

The {TX|RX} subsystem comprises the remote control commands related to the CPRI Uplink and Downlink.

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



**Terms used in the description and familiar synonyms**

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

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

- In **CPRI RE** test mode, the R&S EX-IQ-BOX works in the DL (downlink) as a transmitter (TX) and in the UL (uplink) as a receiver (RX).

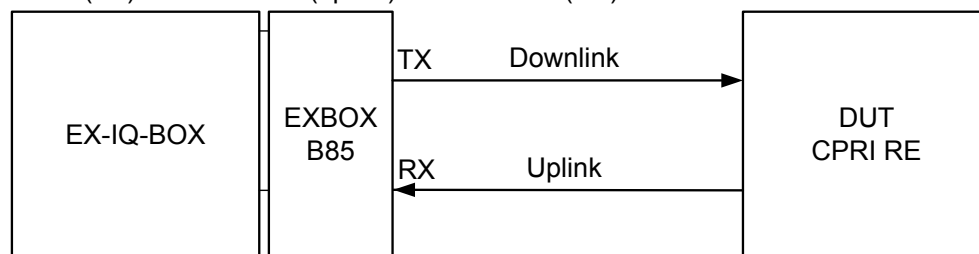


**Fig. 9-5: CPRI RE test - schematic representation**

- In **CPRI REC** test mode, the R&S EX-IQ-BOX works in the DL as a receiver (RX) and in the UL as a transmitter (TX).

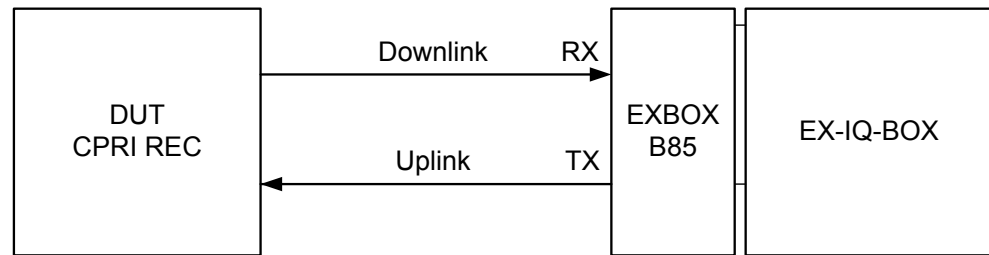


**Fig. 9-6: CPRI REC test - schematic representation**

The downlink and uplink settings are similar; they both define the signals I/Q data and their distribution inside the CPRI basic frame container (AxC allocation).

The following description of a remote-command applies to both directions of transmission. {TX|RX} depicted in curly brackets in the command syntax, distinguishes the transmission direction.

The numeric suffix <ch> to SIGNAL distinguishes the selected signal. Up to 24 signals can be addressed. The signals are indexed in ascending order according to their position in the list.



<ch> exclusively addresses the position of the signal in the list. It does not select a signal with an index in the signal name.

|                                                                  |     |
|------------------------------------------------------------------|-----|
| [SOURce<hw>]:EBOX:CPRI:RX:SIGNAL<ch>:OUTPut.....                 | 331 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:TRIGGer:ARM.....                    | 332 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:TRIGGer:SOURce.....                 | 332 |
| [SOURce<hw>]:EBOX:CPRI:SFRame<st>:DATA.....                      | 332 |
| [SOURce<hw>]:EBOX:CPRI:TX:SIGNAL<ch>:SOURce.....                 | 332 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:APPLy.....                          | 333 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC:COUNT?.....                     | 333 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:BADDress.....              | 334 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:CONFLICT?.....             | 334 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:PSRC?.....                 | 334 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:SIZE?.....                 | 335 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:SOURce?.....               | 335 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:WADDress.....              | 336 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXCStatus?.....                     | 336 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:DRATe:ASSigned?.....                | 336 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:DRATe:AVAIlable?.....               | 337 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:INTerleaving.....                   | 337 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL:APPend.....                  | 337 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL:COUNT?.....                  | 338 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:ARB:CONFLICT?.....       | 338 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:ARB:FILE?.....           | 338 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:ALLocation.....      | 339 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:COUNT:ASSign?.....   | 339 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:COUNT:NEEDed?.....   | 340 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:DRATe:ASSigned?..... | 341 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:DRATe:NEEDed?.....   | 341 |

|                                                                 |     |
|-----------------------------------------------------------------|-----|
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:DRATe:STATus?       | 341 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:LIST?               | 342 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:COPY                    | 342 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:CRESt                   | 342 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:DELeTe                  | 343 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:GAIN                    | 343 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:GROUp<user0>:PATTeRn               | 344 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SOURce:GROUp:CALC                  | 344 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SOURce<ch>:GROUp:COUNT             | 344 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SOURce<ch>:GROUp<user0>:REPetition | 345 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SOURce<ch>:GROUp<user0>:STATe      | 345 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:IQResolution            | 345 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:NAME                    | 346 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:NFORmat                 | 346 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:OSAMpling               | 348 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:PLENgtH                 | 348 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:RMS?                    | 348 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:SRATe                   | 349 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:STANdard                | 350 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:STATe                   | 352 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:WARning?                           | 352 |

#### [SOURce<hw>]:EBOX:CPRI:RX:SIGNAL<ch>:OUTPut <Output>

Determines the output interface, to transmit the received baseband signal from the DUT to an R&S instrument and/or to the built-in I/Q recorder. That is, if you work in the **RE Test Uplink** or the **REC Test Downlink** mode.

The R&S EX-IQ-BOX extracts the I/Q baseband signal of the CPRI protocol, and forwards it to an R&S instrument. Simultaneously, you can also record the signal with the I/Q recorder.

#### Parameters:

<Output>

IQOutput | REcorder | SYNC | PRBS

#### **IQOutput**

Selects the DIG IQ IN 2 interface of the R&S EX-IQ-BOX for signal output.

#### **REcorder**

Selects the built-in I/Q recorder as the destination for the received signal.

#### **SYNC**

Checks one AxC inside the CPRI frame against a static synchronization pattern.

#### **PRBS**

Activates the BER test to measure the bit error rate of the CPRI link.

\*RST:        IQO

#### Example:

SOUR1:EBOX:CPRI:RX:SIGN:OUTP IQO  
assigns the digital interface to signal output.

**Manual operation:** See ["Signal Output"](#) on page 174

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:TRIGger:ARM**

Stops the current signal transmission. It continues either automatically or synchronized, according to the used start condition.

**Manual operation:** See ["Run"](#) on page 189

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:TRIGger:SOURce <Trigger>**

Defines the start condition for the scheduler, for data transmission and analysis.

**Parameters:**

<Trigger>                      SOFTware | EXT1 | EXT2 | EXT3 | TXBF | TXHF | TXNF | RXBF |  
RXHF | RXNF | SYNC

**Manual operation:** See ["Start Condition"](#) on page 188

---

**[ :SOURce<hw>]:EBOX:CPRI:SFRame<st>:DATA <StaticFrameData>**

Fills the complete CPRI frame with a static pattern for debugging purposes. This pattern is transmitted as it is, without scaling, rounding or interleaving.

**Parameters:**

<StaticFrameData>    integer

**Example:**                      [ :SOURce<hw>]:EBOX:CPRI:SFRame<st>:DATA  
"102010110000"

**Manual operation:** See ["Frame Data"](#) on page 176

---

**[ :SOURce<hw>]:EBOX:CPRI:TX:SIGNAL<ch>:SOURce <Source>**

Determines the signal source for signal transmission to the DUT. That is, if you work in the **RE Test Downlink** or the **REC Test Uplink** mode.

The signal comes either from an R&S instrument via the Digital I/Q Interface of the R&S EX-IQ-BOX, or the signal is generated internally or by means of the waveform memory in the R&S EX-IQ-BOX.

The R&S EX-IQ-BOX converts the I/Q format of the signal into the CPRI protocol format. Embedded with additional control information, the link transfers the data to the DUT.

**Parameters:**

&lt;Source&gt;

PATTern | IQIN | ARB1 | ARB2 | ARB3 | ARB4 | STATic | PRBS

**PATTern**

Uses the internal pattern generator as signal source.

**IQIN**

An R&amp;S instrument applies a digital baseband signal at DIQ IQ IN 1 connector of the R&amp;S EX-IQ-BOX.

**ARB1...4**

Selects one of the waveform memories with a loaded I/Q signal.

**Notes:**

This feature requires, that the R&amp;S EX-IQ-BOX is equipped with the appropriate waveform memory option.

A conflict arises, if no signal is loaded in the memory, or is not activated.

The Multi Waveform options support simultaneous playback of up to four signals. For information on the available options refer to [chapter 3.2.2.3, "Waveform Memory, Multi Waveform Playback and Recording Memory"](#), on page 23.**STATic**

Fills the complete CPRI frame with a static pattern for debugging purposes. This pattern is transmitted as it is, without scaling, rounding or interleaving.

**PRBS**

Generates a PRBS pattern.

\*RST: IQIN

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN:SOUR ARB1

selects the signal of the first waveform memory as signal source.

**Manual operation:** See ["Physical Source"](#) on page 173

---

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:APPLY**

Assigns the downlink/uplink settings in order to become effective.

**Example:**

SOUR1:EBOX:CPRI:TX:APPL

accept the settings.

**Usage:**

Event

**Manual operation:** See ["Arm"](#) on page 189

---

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:AXC:COUNT?**

Queries the number of used AxCs.



**Return values:**

<Count> integer  
 Range: 1 to 24  
 Increment: 1  
 \*RST: 1

**Example:**

SOUR1:EBOX:CPRI:TX:AXC0:SOUR?  
 check the number of used AxCs.  
 Response: 18  
 18 AxCs are currently in use.

**Usage:**

Query only

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:BADDress <Baddress>**

The position of the AxC within the CPRI basic frame is defined by word address and bit address. This command queries or defines the bit address, i.e. the starting bit inside the word, see [ :SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:WADDress on page 336.

**Parameters:**

<Baddress> float  
 Range: 0 to 38  
 Increment: 2  
 \*RST: 0

**Example:**

SOUR1:EBOX:CPRI:TX:AXC0:BADD 0  
 set the starting bit to "0".

**Manual operation:** See "AxC Table" on page 188

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:CONFLict?**

A conflict arises, when AxCs overlap. The command queries the status of overlapping.

**Return values:**

<Conflict> OFF | ON  
 No overlapping occurred.  
 AxCs overlapped.  
 \*RST: 0

**Example:**

SOUR1:EBOX:CPRI:TX:AXC3:CONF?  
 check if AxC3 overlaps with a previous one.  
 Response: 0 if OK, 1 if not OK

**Usage:**

Query only

**Manual operation:** See "AxC Table" on page 188

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:PSRC?**

Queries the physical signal source.

**Return values:**

<src> PATTern | IQIN | IQOutput | ARB1 | ARB2 | ARB3 | ARB4 |  
RECOder | STATic | SYNC | PRBS

**Example:**

EBOX:CPRI:TX:AXC0:PSRC?

Response: "PATT"

**Usage:**

Query only

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:SIZE?**

Queries the size of the AxC in bits. The size depends on the selected signal source.

With the exception of signals from the signal source Sync Pattern, the size is calculated using the following formula:

$$AxC\_size_{axc}[bit] = I / Q Resolution_{signal} \cdot 2$$

For Sync Pattern signals, calculate the source with the formula:

$$AxC\_size_{axc}[bit] = Pattern Length_{signal}$$

**Return values:**

<Size> integer  
Range: 2 to 40  
Increment: 1  
\*RST: 32

**Example:**

SOUR1:EBOX:CPRI:TX:AXC1:SIZE?

check the AxC size.

Response: 32

the length of AxC1 is 32 bit.

**Usage:**

Query only

**Manual operation:** See ["AxC Table"](#) on page 188

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:SOURce?**

Queries the signal name the AxC is assigned to.

**Note:** This command applies to downlink.

**Return values:**

<Source> string

**Example:**

SOUR1:EBOX:CPRI:TX:AXC0:SOUR?

check the signal allocated in AxC 0.

Response: signal\_1

signal\_1 is assigned to the first AxC.

**Usage:**

Query only

**Manual operation:** See ["AxC Table"](#) on page 188

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:WADDress <Waddress>**

The position of the AxC within the CPRI basic frame is defined by word address and bit address. This command queries or defines the word address, i.e. with which word the AxC starts, while the bit address specifies the bit index inside the word, see [ :SOURce<hw>]:EBOX:CPRI:TX|RX:AXC<ch0>:BADDress on page 334.

**Parameters:**

<Waddress> integer  
 Range: 0 to 38  
 Increment: 1  
 \*RST: 1

**Example:** SOUR1:EBOX:CPRI:TX:AXC0:WADD 15  
 start at word address 20 with the signal in the first AxC.

**Manual operation:** See "AxC Table" on page 188

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:AXCStatus?**

The command queries the status of all AxCs.

**Note:** This command applies to downlink.

**Return values:**

<Axcstatus> 0 | 1  
 \*RST: 0

**Example:** SOUR1:EBOX:CPRI:RX:AXCS?  
 check the status of all AxCs in receiver mode.  
 Response: 1 if active 0 if not active.

**Usage:** Query only

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:DRATe:ASSigned?**

Queries the assigned I/Q data rate of all active signals. This parameter depends on the size of each assigned AxC and is calculated with the formula:

The assigned data rate is calculated with the formula:

$$Data\ Rate_{assigned} [Mbit / s] = \sum AxC\_size_{axc} \cdot 3.84 [MHz]$$

**Return values:**

<Assigned> float  
 Increment: 0.01  
 \*RST: 0

**Example:** SOUR1:EBOX:CPRI:TX:DRAT:ASS?  
 query the data rate of all active signals.  
 Response: 491.52 Mbit/s  
 the entire data rate of the active signals is 491.52' Mbit/s.

**Usage:** Query only

**Manual operation:** See ["Assigned Data Rate \(AxC\)"](#) on page 187

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:DRATe:AVAIlable?**

Queries the available data rate for the I/Q data in the AxC container.

The data rate is calculated with the formula:

$$\begin{aligned} \text{Data Rate}_{\text{available}} [\text{Mbit/s}] &= \text{Data Word Count} \cdot \text{Word Length} [\text{bit}] \cdot 3.84 [\text{MHz}] \\ &= 15 \cdot \text{Word Length} [\text{bit}] \cdot 3.84 [\text{MHz}] \end{aligned}$$

**Note:** The word length depends on the line bit rate, refer also to ["CPRI Basic Frame Graph"](#) on page 186.

**Return values:**

<Available> float  
Increment: 1000  
\*RST: 921600000

**Example:** SOUR1:EBOX:CPRI:TX:DRAT:AVA?  
query the available I/Q data rate.  
Response: 921.60 Mbit/s  
the CPRI basic frame provides a data rate of 921.6 Mbit/s for I/Q.

**Usage:** Query only

**Manual operation:** See ["Available Data Rate \(I/Q\)"](#) on page 187

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:INTERleaving <Interleaving>**

Activates I/Q data interleaving.

**Parameters:**

<Interleaving> 0 | 1 | OFF | ON  
\*RST: OFF

**Example:** EBOX:CPRI:TX:INT ON  
activates interleaving.

**Manual operation:** See ["I/Q Data Interleaving"](#) on page 187

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal:APPend**

Adds a new signal to the list. R&S DigiConf attaches a signal with default parameter values, a predetermined name and a name index following the last list entry.

**Example:** SOUR1:EBOX:CPRI:TX:SIGN2:APP  
adds a new signal as second list item to the signal list.

**Usage:** Event

**Manual operation:** See ["Append"](#) on page 173

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL:COUNT?**

This command queries the number of active signals.

**Note:** This command applies to downlink.

**Return values:**

<Count> integer  
 Range: 1 to 24  
 Increment: 1  
 \*RST: 1

**Example:**

SOUR1:EBOX:CPRI:TX:SIGNAL:COUNT?  
 check the number of used signals.  
 Response: 3  
 3 signals are currently in use.

**Usage:** Query only

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:ARB:CONFLICT?**

The command queries the status of a signal loaded from a waveform memory. A conflict arises, if a waveform memory is selected as signal source and no signal is loaded in the memory, or is not activated.

**Note:** This command applies to downlink.

**Return values:**

<Conflict> 0 | 1 | OFF | ON  
 \*RST: 0

**Example:**

SOUR1:EBOX:CPRI:TX:SIGNAL:ARB:CONFLICT?  
 check if the signal in the waveform memory is loaded and activated.  
 Response: 1 if active 0 if ARB is off.

**Usage:** Query only

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:ARB:FILE?**

Queries the loaded waveform file from a waveform memory signal source.

**Notes:**

This parameter is relevant when operating with ARB. I.e., if you load a file and select the signal source ARB, R&S DigiConf indicates the file name. For standard communication signals, the field is hidden.

R&S DigiConf loads waveforms calculated by simulation software such as Matlab or R&S WinIQSIM2 into the memory of the R&S EX-IQ-BOX. With the aid of the CPRI breakout board, the R&S EX-IQ-BOX then embeds the signal into the CPRI protocol.

**Return values:**

<File> string

**Example:** SOUR1:EBOX:CPRI:TX:SIGN:ARB:FILE?  
 query the currently loaded wave file.  
 Response: p4DQPSK7\_68M\_OV4\_2016Samples.wv

**Usage:** Query only

**Manual operation:** See "Wave file" on page 176

**[SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:ALLocation <Allocation>**

Defines how to allocate the AxCs to the signal. R&S DigIConf automatically assigns the AxCs to a signal, and this parameter specifies the method.

**Parameters:**

<Allocation> PACKed | FLEXible

**PACKed**

The AxCs allocate a continuous area inside the CPRI basic frame. Word address and offset address of the first AxC define the starting position. If possible, the following AxCs are placed successively. The signal AxCs are automatically laid in a free area of the CPRI frame. If there is not enough free space, the signal AxCs are placed at the beginning of the base frame, i.e. at the position of word 1.

**FLEXible**

Manually assign the position of the AxCs by word address and offset address.

**Tip:** Use this setting, to embed each sample of a signal individually within the CPRI basic frame.

Range: 1 to 4

\*RST: PACKed

**Example:** SOUR1:EBOX:CPRI:TX:SIGN:AXC:ALL FLEX  
 selects *flexible* to manually assign the AxC position.

**Manual operation:** See "AxC Allocation" on page 180

**[SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:COUNT:ASSign?**

Queries the assigned number of AxCs and the assigned data rate. The assigned data rate depends on the signal group settings, i.e. on the repetition rate and the number of active AxCs per group.

The assigned data rate is calculated with the formula:

$$\text{Data Rate}_{\text{assigned}} [\text{Mbit/s}] = 3.84 [\text{MHz}] \times 2 \times \text{I/Q Resolution} (\sum(\text{AxC\_on\_count}_{\text{grp}} \times \text{Repetition}_{\text{grp}}) / \sum(\text{Repetition}_{\text{grp}}))$$

**Note:** In case of "Sync Pattern" signals, the assigned data rate depends on the pattern length and the sample rate. It is calculated by the sample rate as shown:

$$\text{Data Rate}_{\text{assigned}} = \text{Sample Rate} \times \text{Pattern Length}$$

**Return values:**

<Assign> integer  
 Range: 1 to 24  
 Increment: 1  
 \*RST: 1

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN2:AXC:COUN:ASS?  
 check the data rate and the AxCs assigned to the second signal.  
 Response: 3 / 368.40 Mbit/s  
 this signal requires 3 AxCs and a data rate of 368.4 Mbit/s.  
 To checkup, ask whether the allocated values fit to the required values:  
 SOUR1:EBOX:CPRI:TX:SIGN2:AXC:DRAT:STAT?  
 Response: 0 if OK, 1 if not OK  
 Refer also to [:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:DRATe:STATus? on page 341.

**Usage:** Query only

**Manual operation:** See "(Assigned)" on page 181

**[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:AXC:COUNt:NEEDed?**

Queries the needed number of AxCs and the required data rate.

Depending on the sample rate, a signal needs one or more AxCs to carry its I/Q data. If possible, R&S DigIConf automatically assigns the number of needed AxCs to the signal.

**Note:** The maximum number of AxCs for all signals is 24.

The needed number of AxCs is calculated with the formula:

$$\text{AxCs}_{\text{needed}} = \text{ceil}(\text{Sample Rate} \times \text{Oversampling} / 3.84 [\text{MHz}])$$

The data rate is calculated with the formula:

$$\text{Data Rate}_{\text{needed}} [\text{Mbit/s}] = \text{Sample Rate} \times \text{Oversampling} \times 2 \times \text{I/Q Resolution}$$

**Note:** For signal source "Pattern" the needed number of AxCs is 1.

**Return values:**

<Needed> integer  
 Range: 1 to 24  
 Increment: 1  
 \*RST: 1

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN2:AXC:COUN:NEED?  
 check the data rate and the AxCs needed from the second signal.  
 Response: 3 / 358.40 Mbit/s  
 this signal requires '3' AxCs and a data rate of '358.4' Mbit/s'.  
 To checkup, ask whether the needed values fit to the assigned values:  
 SOUR1:EBOX:CPRI:TX:SIGN2:AXC:DRAT:STAT?  
 Response: 0 if OK, 1 if not OK

**Usage:** Query only

**Manual operation:** See "AxC(s) / Data Rate" on page 180

---

**[ :SOURce<hw> ]:EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:DRATe:ASSigned?**

Queries the data rate assigned to the signal.

The assigned data rate depends on the signal group settings, i.e. on the repetition rate and the number of active AxCs per group.

The assigned data rate is calculated with the formula:

$$\text{Data Rate}_{\text{assigned}} [\text{Mbit/s}] = 3.84 [\text{MHz}] \times 2 \times \text{I/Q Resolution} \left( \frac{\sum (\text{AxC\_on\_count}_{\text{grp}} \times \text{Repetition}_{\text{grp}})}{\sum (\text{Repetition}_{\text{grp}})} \right)$$

Note:

In case of "Sync Pattern" signals, the assigned data rate depends on the pattern length and the sample rate. It is calculated by the sample rate as shown:

**Return values:**

<Assigned> float  
 Increment: 10000  
 \*RST: 122880000

**Example:** SOUR1:EBOX:CPRI:TX:SIGNAL:AXC:DRAT:ASS?  
 check the data rate of the first signal.  
 Response: 122.88 Mbit/s  
 this signal is transmitted with 122.88 Mbit/s data rate.

**Usage:** Query only

---

**[ :SOURce<hw> ]:EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:DRATe:NEEDed?**

Queries the data rate required from the signal.

This command applies to downlink.

**Return values:**

<Needed> float  
 Increment: 10000  
 \*RST: 122880000

**Example:** SOUR1:EBOX:CPRI:TX:SIGNAL:AXC:DRAT:NEED?  
 check the data rate the first signal needs.  
 Response: 122.88 Mbit/s  
 this signal uses 122.88 Mbit/s data rate.

**Usage:** Query only

---

**[ :SOURce<hw> ]:EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:DRATe:STATus?**

Queries whether the assigned data rate fits to the required data rate.



**Deviations in data rates!** Refer to the example under ["Example to CPRI Groups Concept"](#) on page 189, on what to do if the values do not fit.

**Return values:**

<Status> OFF | ON

The needed and the assigned data rates values are the same. No error occurs.

The needed and the assigned data rate values differ. Signal transmission cannot be performed. To fix the problem, proceed as described in ["Example to CPRI Groups Concept"](#) on page 189.

\*RST: 1

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN:AXC:DRAT:STAT?

checks if the assigned values fit to the values required from the signal.

Response: 0 if OK, 1 if not OK

**Usage:** Query only

**Manual operation:** See ["Status LED"](#) on page 181

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:AXC:LIST?**

**Note:** This command applies to downlink.

**Return values:**

<List> string

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN2:AXC:LIST?

query the AxCs assigned to the second signal.

Response: AXC3, AXC4, AXC5 this signal uses 3 AxCs.

**Usage:** Query only

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:COPY**

Creates a copy of a signal selected with the index <ch>. The function copies the parameter values and assigns the same name with suffix for distinction. The new signal is added at the end of the list, i.e. the index of the copied signal is incremented by 1 after the last signal.

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN3:COPY

copies the third signal from the list of downlink signals.

**Usage:** Event

**Manual operation:** See ["Copy + Append"](#) on page 173

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:CRESt <Crest>**

Sets the crest factor. This parameter is required for the correct indication of the RMS Level value, see [\[ :SOURce<hw>\]:EBOX:CPRI:TX|RX:SIGNAL<ch>:RMS?](#) on page 348.

The rms level is calculated with the formula:

$$\text{RMS [dB]} = \text{Peak [dB]} - \text{Crest Factor [dB]} + \text{Gain [dB]}$$

The crest factor must correspond to the input signal. Enter the value, e.g. a connected baseband generator provides.

**Note:** Crest factor applies to external signals, i.e. to digital standards or to user defined signals. If the R&S EX-IQ-BOX is working with an internal signal, that is generated by a pattern or a waveform file, the parameter is already known must not be entered manually.

**Parameters:**

<Crest> float  
 Range: 0 to 30  
 Increment: 0.01  
 \*RST: 0  
 Default unit: dB

**Example:** SOUR1:EBOX:CPRI:TX:SIGN:CRES 10dB  
 set the 10 dB crest factor.

**Manual operation:** See "Crest Factor" on page 180

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:DELeTe**

Removes a signal from the list. The function removes the corresponding AxCs from the list of used AxCs. The signal is selected by the index <ch>.

**Example:** SOUR1:EBOX:CPRI:TX:SIGN2:DEL  
 removes the second signal from the list of downlink signals.

**Usage:** Event

**Manual operation:** See "Delete" on page 173

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:GAIN <Gain>**

Sets a gain value for the I/Q signal. Positive values lead to a digital signal amplification, and negative values correspond to a digital signal attenuation. A gain value of 0 dB results in an unchanged level of the I/Q signal. By default, the value is set to 0 dB.

**Parameters:**

<Gain> float  
 Range: -40 to 6  
 Increment: 0.01  
 \*RST: 0  
 Default unit: dB

**Example:** SOUR1:EBOX:CPRI:TX:SIGN:GAIN -20  
 set -20 dB gain.

**Manual operation:** See "Gain" on page 179

---

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:GROup<user0>:PATTern <pattern>**

Queries the binary data pattern of an AxC and responses in binary format.

Enter the required pattern with the command, respecting the syntax as follows:

"#B0101010101010101,16"

#B = binary representation

0101010101010101 = pattern

16 = pattern length

See also the example below for a complete command.

By default, all data pattern is set to zero. You can basically set up to 40 bits, but the currently possible number depends on the signal length that is specified in ["Pattern Length"](#) on page 177.

**Parameters:**

<pattern> integer

**Example:**

EBOX:CPRI:TX:GRO:PATT "#B0101010101010101,16"  
insert the pattern for the first signal, and assign the signal to AxC1  
in the first group of the AxC allocation table,

**Manual operation:** See ["Groups Table"](#) on page 183

---

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:SOURce:GROup:CALC**

Calculates the scheduling sequences of the groups.

**Usage:** Event

**Manual operation:** See ["Auto"](#) on page 182

---

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:SOURce<ch>:GROup:COUNT <Count>**

Determines the number of groups for a signal. The grouping enables to achieve arbitrary sample rates that are not necessarily integer multiples of the CPRI basic frame rate. Each group defines an AxC configuration for a certain time, i.e. repetitions. Thus you can change the AxC assignment over time by using more than one group with different settings.

**Parameters:**

<Count> integer  
Range: 1 to 4  
Increment: 1  
\*RST: 1

**Example:**

EBOX:CPRI:TX:SOUR:GRO:COUN 2  
specify 2 groups for distribution of the first signal in the CPRI  
frame.

**Manual operation:** See ["Number of Groups"](#) on page 182

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SOURce<ch>:GROup<user0>:REPetition**  
**<Repetition>**

Selects the AxC group and specifies the number of repetitions of the signal, that means how many CPRI basic frames follow the current group setting.

The numeric suffix `GROUP<user0>` distinguishes the selected group. Up to 4 groups can be specified. These are "G #0" to "G #3".

**Note:** AxC status and AxC pattern depend on the used signal sources. Status refers to externally used sources and pattern indicates the coding of the AxCs with internal signal source.

**Parameters:**

**<Repetition>** integer  
 Range: 1 to 20000  
 Increment: 1  
 \*RST: 1

**Example:** `EBOX:CPRI:TX:SOUR:GRO:REP 3`  
 repeats the signal of Group1 3 times.

**Manual operation:** See ["Groups Table"](#) on page 183

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SOURce<ch>:GROup<user0>:STATe <state>**

Activates the respective AxC. By default, all AxCs are activated.

**Parameters:**

**<state>** 0 | 1 | OFF | ON  
 \*RST: ON

**Example:** `EBOX:CPRI:TX:SOUR:GRO:STAT ON`  
 activates AxC1 in the first group of the AxC allocation table.

**Manual operation:** See ["Groups Table"](#) on page 183

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:IQResolution <Iqresolution>**

Sets the I/Q resolution in bits. The resolution is valid for both, the I and the Q values. I.e., if you set the resolution to 16 bits, the sample rate is 32 bits wide, composed of 16-bit I and 16-bit Q.

**Parameters:**

**<Iqresolution>** float  
 Range: 4 to 18  
 Increment: 1  
 \*RST: 16

**Example:** `SOUR1:EBOX:CPRI:TX:SIGN:IQR 16`  
 sets 16 bits I/Q resolution.

**Manual operation:** See ["I/Q Resolution"](#) on page 179

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:NAME <Name>**

This command enters or changes the signal name.

**Parameters:**

<Name>                      string

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN4:NAME "sig\_3gpp"  
assign the signal name sig\_3gpp to the fourth signal of the list in transmitter mode.

**Manual operation:** See "Signal Name" on page 173

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:NFORMAT <Nformat>**

Selects a numeric representation for data transmission.

Allowed number range for word size n Bit:

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

**Table 9-4: User defined > Numeric format coding**

| z  | 2's Complement |   |   |   |  | Binary Offset |   |   |   |
|----|----------------|---|---|---|--|---------------|---|---|---|
| -8 | 1              | 0 | 0 | 0 |  | 0             | 0 | 0 | 0 |
| -7 | 1              | 0 | 0 | 1 |  | 0             | 0 | 0 | 1 |
| -6 | 1              | 0 | 1 | 0 |  | 0             | 0 | 1 | 0 |
| -5 | 1              | 0 | 1 | 1 |  | 0             | 0 | 1 | 1 |
| -4 | 1              | 1 | 0 | 0 |  | 0             | 1 | 0 | 0 |
| -3 | 1              | 1 | 0 | 1 |  | 0             | 1 | 0 | 1 |
| -2 | 1              | 1 | 1 | 0 |  | 0             | 1 | 1 | 0 |
| -1 | 1              | 1 | 1 | 1 |  | 0             | 1 | 1 | 1 |
| 0  | 0              | 0 | 0 | 0 |  | 1             | 0 | 0 | 0 |
| 1  | 0              | 0 | 0 | 1 |  | 1             | 0 | 0 | 1 |
| 2  | 0              | 0 | 1 | 0 |  | 1             | 0 | 1 | 0 |
| 3  | 0              | 0 | 1 | 1 |  | 1             | 0 | 1 | 1 |
| 4  | 0              | 1 | 0 | 0 |  | 1             | 1 | 0 | 0 |
| 5  | 0              | 1 | 0 | 1 |  | 1             | 1 | 0 | 1 |
| 6  | 0              | 1 | 1 | 0 |  | 1             | 1 | 1 | 0 |
| 7  | 0              | 1 | 1 | 1 |  | 1             | 1 | 1 | 1 |

**9E2 encoding format** is used in mobile base stations to extend the dynamic range of I and Q, while reducing the needed amount of bits.

The coding is 9E2 with 9 bits mantissa and 2 bits exponent, that are shared from I and Q, as shown in the figure.

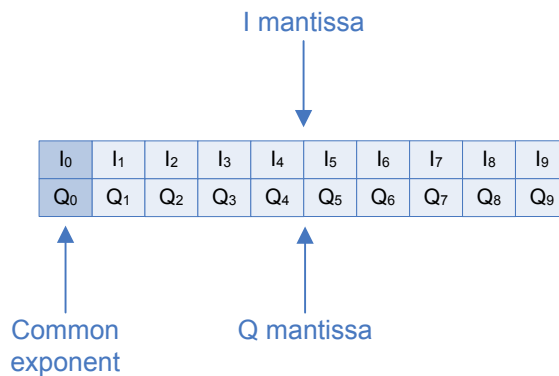


**Fig. 9-7: 2's complement 9E2**

The I and Q samples of the 2's complement 9E2 are calculated with the formulas:

I sample 10 bits = 9 bits mantissa + 1 bit, i.e. bit\_0 exponent

$$I = \left( \left( \sum_{i=0}^7 2^i \cdot I_{i+1} \right) - 2^8 \cdot I_9 \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

Q sample 10 bits: 9 bits Q mantissa + 1 bit, i.e. bit\_1 exponent

$$Q = \left( \left( \sum_{i=0}^7 2^i \cdot Q_{i+1} \right) - 2^8 \cdot Q_9 \right) \cdot 2^{(2 \cdot Q_0 + I_0)}$$

**Parameters:**

<Nformat>

COMplement | C9E2 | BOFFset

**COMplement**

Formats the signal in two's-complement.

The most significant bit has a value of  $-2^{n-1}$ , the bits of lesser significance follow as:

$+2^{n-2} \dots + 2^0$

**C9E2**

Formats the signal in two's-complement variant 9E2.

**BOFFset**

Formats the signal in binary offset.

Adds a binary offset of  $-2^{n-1}$  such that the final values are always positive.

**Example**

Adds a binary offset of  $-2^{n-1}$  such that the final values are always positive.

\*RST:       COMplement

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN2:NFOR COMP

set the numeric format of the second signal to 2's complement 2.

**Manual operation:** See "Numeric format" on page 177

---

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:OSAMpling <Osampling>**

Determine the oversampling factor.

**Note:** Oversampling 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 considered and therefore not relevant.

**Parameters:**

<Osampling>                      integer  
                                          Range:        1 to 4  
                                          Increment: 1  
                                          \*RST:        1

**Example:**                      SOUR1:EBOX:CPRI:TX:SIGN:OSAM 2  
                                          sets oversampling factor 2.

**Manual operation:**    See "[Oversampling](#)" on page 177

---

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:PLENth <Plength>**

Defines the length of the pattern used by the internal pattern generator.

**Note:** The parameter applies to the physical source PATtern.

**Parameters:**

<Plength>                      float  
                                          Range:        2 to 40  
                                          Increment: 2  
                                          \*RST:        16

**Example:**                      SOUR1:EBOX:CPRI:TX:SIGN:PLEN 4  
                                          sets the pattern length 4.

**Manual operation:**    See "[Pattern Length](#)" on page 177

---

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:RMS?**

Queries the rms level of the signal. The signal level is expressed in terms of an rms value. It always refers to both signal components (SQR(I<sup>2</sup>+Q<sup>2</sup>)).

In order to get the RMS value correctly, the crest factor of the signal must be specified, see [[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:CRESt on page 342.

The rms level is calculated with the formula:

$$\text{RMS [dB]} = \text{Peak [dB]} - \text{Crest Factor [dB]} + \text{Gain [dB]}$$

**Note:** The RMS level refers to external signals, i.e. to digital standards or to user defined signals. If the R&S EX-IQ-BOX is working with an internal signal, that is generated by a pattern or a waveform file, the parameter is already known must not be entered manually.

**Return values:**

<Rms> float  
 Range: -40 to 6  
 Increment: 0.01  
 \*RST: 0

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN:RMS?  
 query the crest factor.  
 Response: -10 dbFS

**Usage:** Query only

**Manual operation:** See ["RMS Level"](#) on page 180

**[[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNAL<ch>:SRATe <Srate>**

Queries the sample rate. If you process user defined signals, you can set the value.

Consider that the sampling rate of the R&S signal generator fits to the sampling rate of R&S DigIConf, as well as to the sampling rate of the R&S signal analyzer.

The table shows the predefined sample rates of the available signals. The sample rate of a digital standard varies corresponding to the frequency.

**Table 9-5: Sample rate values, depending on the signal type**

| Standard     | Frequency variant | Sample Rate  |
|--------------|-------------------|--------------|
| GSM/EDGE     |                   | 270.8333 kHz |
| 3GPP FDD     |                   | 3.84 MHz     |
| CDMA 2000    |                   | 1.228 MHz    |
| LTE          | 1.4 MHz           | 1.92 MHz     |
|              | 3.0 MHz           | 3.84 MHz     |
|              | 5.0 MHz           | 7.68 MHz     |
|              | 10.0 MHz          | 15.36 MHz    |
|              | 15.0 MHz          | 23.04 MHz    |
|              | 20.0 MHz          | 30.72 MHz    |
| WiMAX        | 3.5 MHz           | 4.0 MHz      |
|              | 5.0 MHz           | 5.6 MHz      |
|              | 7.0 MHz           | 8.0 MHz      |
|              | 8.75 MHz          | 10.0 MHz     |
|              | 10.0 MHz          | 11.2 MHz     |
| Sync Pattern |                   | 3.84 MHz     |



**Parameters:**

<Srate> float  
 Range: 1000 to 100000000  
 \*RST: 3840000

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN:SRATE?  
 query the sample rate of the first signal in transmitter mode.

**Manual operation:** See "[Sample Rate](#)" on page 176

---

**[ :SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:STANDard <Standard>**

This command selects a communication standard. R&S DigIConf provides the selection of a standard signal with automatically assigned sample rate. Alternatively, select a signal from a waveform file, the ARB function, or assign user-specific values.

R&S DigIConf supports all current standards and their variants. When selecting a standard signal, the program automatically sets the relevant parameters and values.

For example, a loaded digital standard automatically adjusts the needed AxCs, assigns the sample rate, and sets up several other relevant parameters.

**Note:** The digital standard signals, or user defined signals refer to external signal input or output, i.e. the physical signal sources DIG IQ IN or DIG IQ OUT.

**Parameters:**

&lt;Standard&gt;

USER | W3GPP | LTE\_1M4 | LTE\_3M | LTE\_5M | LTE\_10M |  
 LTE\_15M | LTE\_20M | WIMAX\_3M5 | WIMAX\_5M | WIMAX\_7M |  
 WIMAX\_8M75 | WIMAX\_10M | CDMA2K | WIMAX\_20M | GSM

**USER**

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

**W3GPP**

Selects the parameters of the W-CDMA standard 3GPP FDD. W-CDMA (**W**ideband **C**ode **D**ivision **M**ultiple **A**ccess) covers the radio technology UMTS (**U**niversal **M**obile **T**elecommunications **S**ystem). 3GPP (**3**rd **G**eneration **P**artnership **P**roject) is a collaboration between groups of telecommunication associations, which define a globally applicable third generation mobile phone system specification. 3GPP standardization comprises all GSM and W-CDMA specifications.

**LTE\_1M4|LTE\_3M|LTE\_5M|LTE\_10M|LTE\_15M|LTE\_20M**

Selects an LTE (**L**ong **T**erm **E**volution) signal. Based on UMTS, LTE provides a wireless broadband internet system with voice and other services built on top, e.g. authentication.

LTE bandwidths: 1.4 | 3.0 | 5.0 | 10.0 | 15.0 | 20.0 MHz

**WIMAX\_3M5|WIMAX\_5M|WIMAX\_7M|WIMAX\_8M75|  
WIMAX\_10M|WIMAX\_20M**

Selects the digital standard IEEE 802.16 WiMAX (**W**orldwide **I**nteroperability for **M**icrowave **A**ccess). WiMAX provides wireless transmission of data using a variety of transmission modes, as e.g. point-to-multipoint links or mobile internet access.

WiMAX bandwidths: 3.5 | 5.0 | 7.0 | 8.75 | 10.0 | 20.0 MHz

**CDMA2K**

Selects a signal that follows the CDMA standard.

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

**GSM**

Selects a signal that follows the GSM/EDGE standard.

GSM/EDGE (**G**lobal **S**ystem for **M**obile Communications/**E**nhanced **D**ata **R**ates for **G**SM **E**volution) covers the 2nd generation mobile radio technology. Selecting this signal standard, the sample rate is set to 270,833,333 kSps. This sample rate does not fit well into the CPRI basic frame rate. Therefore, the sampling rate of GSM/EDGE is only achieved by using a rather complicated group setup, the AxC settings over time.

\*RST: W3GPP

**Example:**

SOUR1:EBOX:CPRI:TX:SIGN:STAN LTE\_20M  
 select an LTE signal with 20 MHz bandwidth.

**Manual operation:** See "[Standard](#)" on page 175

---

**[:SOURce<hw>]:EBOX:CPRI:TX|RX:SIGNal<ch>:STATe <State>**

The command activates a signal for transmission selected with <ch>.

**Parameters:**

<State>                    OFF | ON  
                              \*RST:        OFF

**Example:**                SOUR1:EBOX:CPRI:RX:SIGN:STAT ON  
                              activates the first signal for transmission in receiver mode.

**Manual operation:**    See "Signal State" on page 173

---

**[:SOURce<hw>]:EBOX:CPRI:TX|RX:WARNIng?**

The command asks if settings have been changed, but not accepted.

**Return values:**

<Warning>                0 | 1  
                              \*RST:        0

**Example:**                SOUR1:EBOX:CPRI:TX:WARN?  
                              check if changed settings have been accepted.  
                              Response: 1 if settings are not yet accepted, 0 if OK.

**Usage:**                    Query only

**Manual operation:**    See "Apply Setup" on page 189

---

## 9.4.10 CPRI Vendor Data Subsystem

The `VENDOR:DATA` command subsystem provides input of user-specific information via remote control commands.

|                                                                           |     |
|---------------------------------------------------------------------------|-----|
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:VENDOR:DATA&lt;ch&gt;</a> ..... | 352 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:VENDOR:DIRection</a> .....      | 353 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:VENDOR:STATe</a> .....          | 353 |
| <a href="#">[:SOURce&lt;hw&gt;]:EBOX:CPRI:VENDOR:WWIDth?</a> .....        | 353 |

---

**[:SOURce<hw>]:EBOX:CPRI:VENDOR:DATA<ch> <Data>**

Queries or determines vendor-specific data for transmission, depending on the transmission mode.

**Parameters:**

<Data>                    integer  
                              The value range depends on the word width.  
                              Range:        "depends on other settings" to "depends on other settings"

**Example:**                SOUR1:EBOX:CPRI:VEND:DATA 16, #H2A  
                              determine vendor-specific data for transmission.

**Manual operation:** See "[Vendor Data Table](#)" on page 203

---

**[ :SOURce<hw>]:EBOX:CPRI:VENDor:DIRection <Direction>**

The command selects the data direction for vendor data exchange.

**Parameters:**

<Direction>

DOWN | UP

**DOWN**

**CPRI RE test mode (TX):** User data entered in the table is embedded in the CPRI link for transmission to the DUT.

**CPRI REC test mode (RX):** Vendor data is extracted from the CPRI link and displayed in the table.

**UP**

**CPRI RE test mode (RX):** Vendor data is extracted from the CPRI link and displayed in the table.

**CPRI REC test mode (TX):** User data entered in the table is embedded in the CPRI link for transmission to the DUT.

\*RST: DOWN

**Example:**

SOUR1:EBOX:CPRI:VEND:DIR DLIN

determine the direction for vendor data transmission.

**Manual operation:** See "[Direction](#)" on page 201

---

**[ :SOURce<hw>]:EBOX:CPRI:VENDor:STATe <State>**

The command starts and stops vendor data exchange.

**Parameters:**

<State>

OFF | ON

\*RST: OFF

**Example:**

SOUR1:EBOX:CPRI:VEND:STAT ON

start vendor data exchange.

**Manual operation:** See "[State](#)" on page 201

---

**[ :SOURce<hw>]:EBOX:CPRI:VENDor:WWIDth?**

The command queries the word width. The word width depends on the CPRI line bit rate.

The following table shows the word width related to the line bit rate

**Table 9-6: Word width related to the line bit rate.**

| Line bit rate | Word width |
|---------------|------------|
| [Mbit/s]      | [bits]     |
| 2x (1228.8)   | 16         |

| Line bit rate | Word width |
|---------------|------------|
| 4x (2457.6)   | 32         |
| 5x (3072.0)   | 40         |

**Note:** By determining the line bit rate, the DUT also defines the word width. See also [\[:SOURce<hw>\]:EBOX:CPRI:HW:LBRate](#) on page 305.

**Return values:**

<Wwidth>                      float  
Range:                      1 to 18  
Increment:                  1  
\*RST:                        16

**Example:**                      SOUR1:EBOX:CPRI:VEND:WWID?  
query the word width.

**Usage:**                        Query only

**Manual operation:**        See ["Word Width"](#) on page 202

## 10 Interfaces

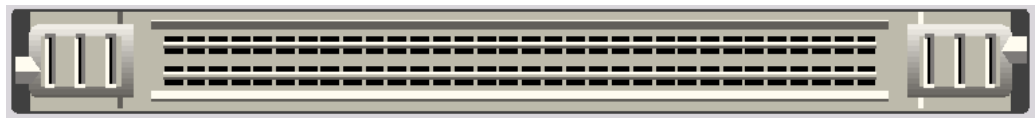
The following chapters describe the characteristics of the user interface and the available breakout boards.

### 10.1 User Interface of the R&S EX-IQ-BOX

The user interface depends on the selected protocol, i.e. the functions of the pins change depending on the standard.

The pin description and pinout table in the following chapters refer to the user interface of **User Defined** protocols, i.e. for single ended or differential applications. For these applications the user interface provides the transmission of serial or parallel I/Q data, data clock and control signals.

#### 10.1.1 Z-DOK-Adapter Board Connector



|               |                               |
|---------------|-------------------------------|
| Type:         | Z-DOK-Adapter Board Connector |
| Manufacturer: | Tyco Electronics              |
| Part number:  | 6367557-1                     |

#### 10.1.2 Pin Description

The user interface consists of a specific and a common part. In the specific part the pins are assigned individually for each breakout board. They are located on the left and the right side of the connector. The common part with fixed pin assignment is located in the middle of the connector.

The pin assignment of the specific part is defined by designing the layout of the breakout boards.

The common pin assignment is shown in [Pinout Z-DOK-Adapter Board Connector \(User Interface\)](#). Additionally, the specific pin assignments of the user interface are shown in the respective drawings of the breakout boards, which are attached to the operating manual.



### Information on Z-DOK-Adapter Board Connector

The described pin assignment applies to applications with the R&S EX-IQ-BOX controlled by R&S DigIConf. If an R&S Instrument controls the R&S EX-IQ-BOX directly, the pinout varies. For information on the differences, refer to [chapter 10.1.3, "Advanced pinout with R&S DigIConf"](#), on page 357.

Find detailed information on the PC Board Footprint, the Housing and the Block Diagram Mating Face Configuration in the customer drawing C-6367557, attached to the operating manual.

**Table 10-1: Pinout Z-DOK-Adapter Board Connector (User Interface)**

| Signal Name                              | Pin                 | Dir | Description                                                                                                                             |
|------------------------------------------|---------------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------|
| BO_TYPE0                                 | A2                  | I   | breakout board identification or EEPROM                                                                                                 |
| BO_TYPE1                                 | A1                  | I   |                                                                                                                                         |
| BO_SENS                                  | Z3, X3, Y3, W3      |     | breakout board sense                                                                                                                    |
| UI_I_N/P0 ... UI_I_N/P17                 | F1/F2 ... C9/C10    | I/O | I data (real part)                                                                                                                      |
| UI_Q_N/P0 ... UI_Q_N/P17                 | C13/C14 ... D23/D24 | I/O | Q data (imaginary part)                                                                                                                 |
| UI_VALID_N/P                             | F13/F14             | I/O | indicates valid data blocks<br><b>Note:</b> This signal must be active in receiver mode.                                                |
| D_CLK_UIN_N/P                            | F25/F26             | I   | interface clock input.<br><b>Note:</b> 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 <sup>[1]</sup> | 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   |                                                                                                                                         |

<sup>[1]</sup> GP0 ... GP5 correspond to the General Purpose signals 0...5 as they are named in other R&S instruments and R&S devices.



The N/P notation applies to differential interface standards (LVDS). For single ended standards (e.g. LVTTTL) only the P signals are used.

### 10.1.3 Advanced pinout with R&S DigIConf

The configurator software R&S DigIConf supports additional signals at the user interface, compared to direct control of the R&S DigIConf by an R&S instrument. The advanced pin assignment applies only to the R&S EX-IQ-BOX 1409.5502.02.

As a result, the pin configuration changed:

- reduction of word length 20 to 18 bits for additional AUX IO signals
- renaming of UI\_MARKER\_ / UI\_TRIGGER\_ / UI\_RESERVE to general purpose signals UI\_GP...

The following table points out the differences in pin assignment depending on the control of R&S DigIConf or R&S Instruments:

**Table 10-2: User Interface > pinout when the R&S EX-IQ-BOX is controlled by ...**

| Pin     | ... R&S DigIConf |      |                                                                                                 | ... R&S Instruments |      |                                                   |
|---------|------------------|------|-------------------------------------------------------------------------------------------------|---------------------|------|---------------------------------------------------|
|         | Signal Name      | Dir. | Description                                                                                     | Signal Name         | Dir. | Description                                       |
| D11/D12 | UI_AUXIO_N/P0    | I/O  | additional auxiliary signals                                                                    | UI_I_N/P18          | I/O  | I data (real part)                                |
| A11/A12 | UI_AUXIO_N/P1    | I/O  |                                                                                                 | UI_I_N/P19          | I/O  |                                                   |
| A23/A24 | UI_AUXIO_N/P2    | I/O  |                                                                                                 | UI_Q_N/P18          | I/O  | Q data (imaginary part)                           |
| F23/F24 | UI_AUXIO_N/P3    | I/O  |                                                                                                 | UI_Q_N/P19          | I/O  |                                                   |
| F11/F12 | UI_GP_N/P0       | I/O  | additional protocol dependent control / signaling. If not needed the signal can be unconnected. | UI_MARKER_N/P0      | I/O  | additional protocol dependent control / signaling |
| C11/C12 | UI_GP_N/P2       |      |                                                                                                 | UI_TRIGGER_N/P0     | I/O  |                                                   |
| D25/D26 | UI_GP_N/P3       |      |                                                                                                 | UI_TRIGGER_N/P1     | I/O  |                                                   |
| C23/C24 | UI_GP_N/P4       |      |                                                                                                 | UI_MARKER_N/P1      | I/O  |                                                   |
| D13/D14 | UI_GP_N/P1       |      |                                                                                                 | UI_RESERVE_N/P0     | I/O  |                                                   |
| A25/A26 | UI_GP_N/P5       |      |                                                                                                 | UI_RESERVE_N/P1     | I/O  |                                                   |

## 10.2 LAN Connector

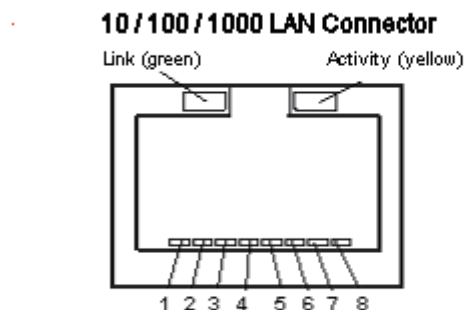


**Fig. 10-1: 10/100/1000 LAN**



**Table 10-3: LAN connector > pinout**

| Pin Number | Signal Description |
|------------|--------------------|
| 1          | TXP                |
| 2          | TXN                |
| 3          | RXP                |
| 4          | Not used           |
| 5          | Not used           |
| 6          | RXN                |
| 7          | Not used           |
| 8          | Not used           |

## 10.3 Breakout Boards

The digital interface module R&S EX-IQ-BOX communicates with the aid of a breakout board directly with the DUT. A variety of available breakout boards provide convenient customization of digital signal formats, since they are all connected at the same interface (user interface) of the R&S EX-IQ-BOX. Thus with the R&S EX-IQ-BOX and the appropriate breakout board you can easily perform applications of user-defined or standardized transmission protocols.

The following chapters provide information on the interfaces, connectors and pinouts of the available breakout boards:

- [chapter 10.1, "User Interface of the R&S EX-IQ-BOX"](#), on page 355
  - [chapter 10.3.1.1, "Breakout Board Single Ended 3585.7280.00"](#), on page 359
  - [chapter 10.3.1.2, "Breakout Board Differential 3585.7296.00"](#), on page 361
  - [chapter 10.3.1.3, "Breakout Board Cadence Palladium 090002-24x"](#), on page 364
- [chapter 10.3.3, "CPRI - Option R&S EXBOX-B85"](#), on page 367

### 10.3.1 User Defined

Various interchangeable breakout boards are available for adjusting customer specific signal formats to the common R&S digital signal format.

A breakout board is connected directly to the user interface on the front panel of the R&S EX-IQ-BOX without using a cable. The pin assignment for each breakout board is defined by the layout.

Two breakout boards for User Defined protocols are included in delivery of the R&S EX-IQ-BOX:

- single ended 090002-22x, type II, see [Breakout Board Single Ended 3585.7280.00](#)

- differential 090002-23x, type III, as described in [Breakout Board Differential 3585.7296.00](#)

For the Cadence emulation as a specific application of the R&S EX-IQ-BOX with the Protocol Tester R&S CMW, a Cadence breakout board is also provided, see [chapter 10.3.1.3, "Breakout Board Cadence Palladium 090002-24x"](#), on page 364. You find the description to this test case in the internet under <http://www.rohde-schwarz.com/appnote/1CM75>.

#### 10.3.1.1 Breakout Board Single Ended 3585.7280.00

This breakout board contains the counterpart to the user interface of the R&S EX-IQ-BOX, i.e. a Z-DOK-Adapter board connector (X1), and two connectors for adjusting the external user signals.

The breakout board is intended for testing single ended signals. The signals are assigned to two 25-pole connectors.

##### Connector Type X2, X3 - Single Ended

|               |                     |
|---------------|---------------------|
| Type:         | 2x25-pole connector |
| Manufacturer: | Harting             |
| Part number:  | 0919 550 6324       |

##### Connector Locations - Single Ended

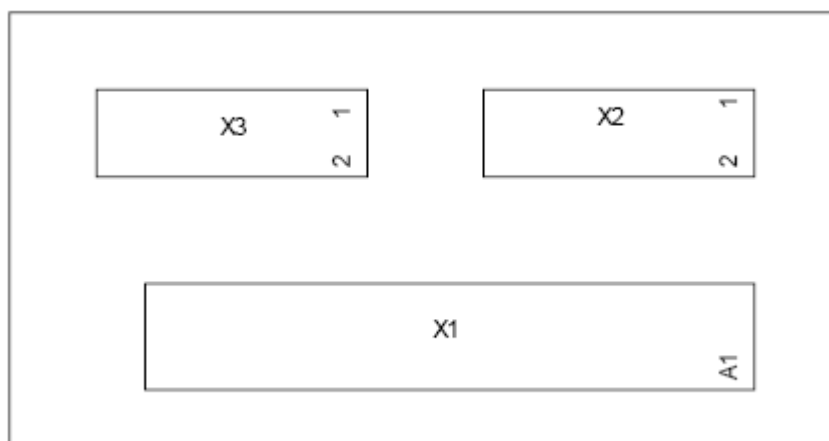


*Fig. 10-2: Connector locations on Single Ended breakout board*

## Pin Description - Single Ended

Table 10-4: Pinout 2 x 50-pin connectors (BreakOut-Board 2, 3585.7280.00)

| Pin Number         | Signal Name  | Comment                                           | Pin Number         | Signal Name | Comment                                           |
|--------------------|--------------|---------------------------------------------------|--------------------|-------------|---------------------------------------------------|
| X2.1               | UI_I_P0      | I component (single ended)                        | X3.1               | UI_Q_P0     | Q component (single ended)                        |
| X2.3               | UI_I_P1      |                                                   | X3.3               | UI_Q_P1     |                                                   |
| X2.5               | UI_I_P2      |                                                   | X3.5               | UI_Q_P2     |                                                   |
| X2.7               | UI_I_P3      |                                                   | X3.7               | UI_Q_P3     |                                                   |
| X2.9               | UI_I_P4      |                                                   | X3.9               | UI_Q_P4     |                                                   |
| X2.11              | UI_I_P5      |                                                   | X3.11              | UI_Q_P5     |                                                   |
| X2.13              | UI_I_P6      |                                                   | X3.13              | UI_Q_P6     |                                                   |
| X2.15              | UI_I_P7      |                                                   | X3.15              | UI_Q_P7     |                                                   |
| X2.17              | UI_I_P8      |                                                   | X3.17              | UI_Q_P8     |                                                   |
| X2.19              | UI_I_P9      |                                                   | X3.19              | UI_Q_P9     |                                                   |
| X2.21              | UI_I_P10     |                                                   | X3.21              | UI_Q_P10    |                                                   |
| X2.23              | UI_I_P11     |                                                   | X3.23              | UI_Q_P11    |                                                   |
| X2.25              | UI_I_P12     |                                                   | X3.25              | UI_Q_P12    |                                                   |
| X2.27              | UI_I_P13     |                                                   | X3.27              | UI_Q_P13    |                                                   |
| X2.29              | UI_I_P14     |                                                   | X3.29              | UI_Q_P14    |                                                   |
| X2.31              | UI_I_P15     |                                                   | X3.31              | UI_Q_P15    |                                                   |
| X2.33              | UI_I_P16     |                                                   | X3.33              | UI_Q_P16    |                                                   |
| X2.35              | UI_I_P17     |                                                   | X3.35              | UI_Q_P17    |                                                   |
| X2.37              | AUX_IO_P0    | auxiliary signals                                 | X3.37              | AUX_IO_P2   | auxiliary signals                                 |
| X2.39              | AUX_IO_P1    |                                                   | X3.39              | AUX_IO_P3   |                                                   |
| X2.41              | GP_GP0       | additional protocol dependent control / signaling | X3.41              | GP_GP4      | additional protocol dependent control / signaling |
| X2.43              | GP_GP1       |                                                   | X3.43              | GP_GP5      |                                                   |
| X2.45              | GP_GP2       |                                                   | X3.45              | GP_GP3      |                                                   |
| X2.47              | D_CLK_UOUT_P | interface clock output                            | X3.47              | D_CLK_UIN_P | interface clock input                             |
| X2.49              | UI_VALID_P   | indicates valid data blocks                       | X3.49              | n.c.        |                                                   |
| even numbered pins | GND          |                                                   | even numbered pins | GND         |                                                   |



In receiver mode, the signal UI\_VALID\_P/N must be operated and continuously active, since this clock signal is required as a reference for the PLL.



#### Information on the pinouts of the connectors - Single Ended Breakout Board

Find a detailed pin assignment to this breakout board in the appendix of the operating manual, drawing number 3585.7280.00. The drawing covers the user interface, connector X1 as well as the connectors X2 and X3.

#### 10.3.1.2 Breakout Board Differential 3585.7296.00

The breakout board supports test cases with differential signals. It contains the Z-DOK-Adapter board connector (X1), for connection to the user interface of the R&S EX-IQ-BOX, and two 50-pole SMD connectors for assigning the differential signals.

#### Connector Type X2, X3 - Differential

|               |                     |
|---------------|---------------------|
| Type:         | 2x50-pole connector |
| Manufacturer: | Samtec              |
| Part number:  | ASP-65067-01        |

#### Connector Locations - Differential

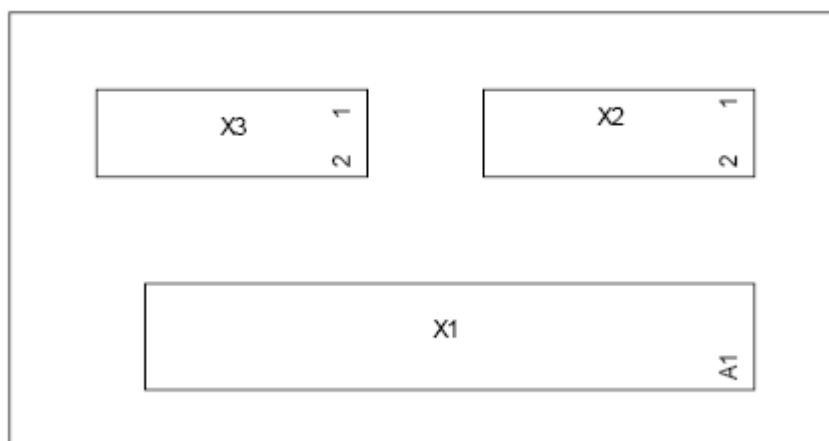


Fig. 10-3: Connector locations on Differential breakout board

#### Pin Description - Differential

Table 10-5: Pinout 2 x 100-pin Samtec Connectors (Breakout-Board 3, 3585.7296.00)

| Pin Number | Signal Name | Comment                    | Pin Number | Signal Name | Comment                    |
|------------|-------------|----------------------------|------------|-------------|----------------------------|
| X2.1, X2.2 | GND         | I component (differential) | X3.1, X3.2 | GND         | Q component (differential) |
| X2.3       | UI_I_N0     |                            | X3.3       | UI_Q_N0     |                            |
| X2.4       | UI_I_P0     |                            | X3.4       | UI_Q_P0     |                            |

| Pin Number   | Signal Name | Comment | Pin Number   | Signal Name | Comment |
|--------------|-------------|---------|--------------|-------------|---------|
| X2.5, X2.6   | GND         |         | X3.5, X3.6   | GND         |         |
| X2.7         | UI_I_N1     |         | X3.7         | UI_Q_N1     |         |
| X2.8         | UI_I_P1     |         | X3.8         | UI_Q_P1     |         |
| X2.9, X2.10  | GND         |         | X3.9, X3.10  | GND         |         |
| X2.11        | UI_I_N2     |         | X3.11        | UI_Q_N2     |         |
| X2.12        | UI_I_P2     |         | X3.12        | UI_Q_P2     |         |
| X2.13, X2.14 | GND         |         | X3.13, X3.14 | GND         |         |
| X2.15        | UI_I_N3     |         | X3.15        | UI_Q_N3     |         |
| X2.16        | UI_I_P3     |         | X3.16        | UI_Q_P3     |         |
| X2.17, X2.18 | GND         |         | X3.17, X3.18 | GND         |         |
| X2.19        | UI_I_N4     |         | X3.19        | UI_Q_N4     |         |
| X2.20        | UI_I_P4     |         | X3.20        | UI_Q_P4     |         |
| X2.21, X2.22 | GND         |         | X3.21, X3.22 | GND         |         |
| X2.23        | UI_I_N5     |         | X3.23        | UI_Q_N5     |         |
| X2.24        | UI_I_P5     |         | X3.24        | UI_Q_P5     |         |
| X2.25, X2.26 | GND         |         | X3.25, X3.26 | GND         |         |
| X2.27        | UI_I_N6     |         | X3.27        | UI_Q_N6     |         |
| X2.28        | UI_I_P6     |         | X3.28        | UI_Q_P6     |         |
| X2.29, X2.30 | GND         |         | X3.29, X3.30 | GND         |         |
| X2.31        | UI_I_N7     |         | X3.31        | UI_Q_N7     |         |
| X2.32        | UI_I_P7     |         | X3.32        | UI_Q_P7     |         |
| X2.33, X2.34 | GND         |         | X3.33, X3.34 | GND         |         |
| X2.35        | UI_I_N8     |         | X3.35        | UI_Q_N8     |         |
| X2.36        | UI_I_P8     |         | X3.36        | UI_Q_P8     |         |
| X2.37, X2.38 | GND         |         | X3.37, X3.38 | GND         |         |
| X2.39        | UI_I_N9     |         | X3.39        | UI_Q_N9     |         |
| X2.40        | UI_I_P9     |         | X3.40        | UI_Q_P9     |         |
| X2.41, X2.42 | GND         |         | X3.41, X3.42 | GND         |         |
| X2.43        | UI_I_N10    |         | X3.43        | UI_Q_N10    |         |
| X2.44        | UI_I_P10    |         | X3.44        | UI_Q_P10    |         |
| X2.45, X2.46 | GND         |         | X3.45, X3.46 | GND         |         |
| X2.47        | UI_I_N11    |         | X3.47        | UI_Q_N11    |         |
| X2.48        | UI_I_P11    |         | X3.48        | UI_Q_P11    |         |

| Pin Number   | Signal Name | Comment                                           | Pin Number   | Signal Name | Comment                                           |
|--------------|-------------|---------------------------------------------------|--------------|-------------|---------------------------------------------------|
| X2.49, X2.50 | GND         |                                                   | X3.49, X3.50 | GND         |                                                   |
| X2.51        | UI_I_N12    |                                                   | X3.51        | UI_Q_N12    |                                                   |
| X2.52        | UI_I_P12    |                                                   | X3.52        | UI_Q_P12    |                                                   |
| X2.53, X2.54 | GND         |                                                   | X3.53, X3.54 | GND         |                                                   |
| X2.55        | UI_I_N13    |                                                   | X3.55        | UI_Q_N13    |                                                   |
| X2.56        | UI_I_P13    |                                                   | X3.56        | UI_Q_P13    |                                                   |
| X2.57, X2.58 | GND         |                                                   | X3.57, X3.58 | GND         |                                                   |
| X2.59        | UI_I_N14    |                                                   | X3.59        | UI_Q_N14    |                                                   |
| X2.60        | UI_I_P14    |                                                   | X3.60        | UI_Q_P14    |                                                   |
| X2.61, X2.62 | GND         |                                                   | X3.61, X3.62 | GND         |                                                   |
| X2.63        | UI_I_N15    |                                                   | X3.63        | UI_Q_N15    |                                                   |
| X2.64        | UI_I_P15    |                                                   | X3.64        | UI_Q_P15    |                                                   |
| X2.65, X2.66 | GND         |                                                   | X3.65, X3.66 | GND         |                                                   |
| X2.67        | UI_I_N16    |                                                   | X3.67        | UI_Q_N16    |                                                   |
| X2.68        | UI_I_P16    |                                                   | X3.68        | UI_Q_P16    |                                                   |
| X2.69, X2.70 | GND         |                                                   | X3.69, X3.70 | GND         |                                                   |
| X2.71        | UI_I_N17    |                                                   | X3.71        | UI_Q_N17    |                                                   |
| X2.72        | UI_I_P17    |                                                   | X3.72        | UI_Q_P17    |                                                   |
| X2.73, X2.74 | GND         | auxiliary signals                                 | X3.73, X3.74 | GND         | auxiliary signals                                 |
| X2.75        | AUX_IO_N0   |                                                   | X3.75        | AUX_IO_N2   |                                                   |
| X2.76        | AUX_IO_P0   |                                                   | X3.76        | AUX_IO_P2   |                                                   |
| X2.77, X2.78 | GND         |                                                   | X3.77, X3.78 | GND         |                                                   |
| X2.79        | AUX_IO_N1   |                                                   | X3.79        | AUX_IO_N3   |                                                   |
| X2.80        | AUX_IO_P1   |                                                   | X3.80        | AUX_IO_P3   |                                                   |
| X2.81, X2.82 | GND         | additional protocol dependent control / signaling | X3.81, X3.82 | GND         | additional protocol dependent control / signaling |
| X2.83        | GP_N0       |                                                   | X3.83        | GP_N4       |                                                   |
| X2.84        | GP_P0       |                                                   | X3.84        | GP_P4       |                                                   |
| X2.85, X2.86 | GND         |                                                   | X3.85, X3.86 | GND         |                                                   |
| X2.87        | GP_N2       |                                                   | X3.87        | GP_N3       |                                                   |
| X2.88        | GP_P2       |                                                   | X3.88        | GP_P3       |                                                   |
| X2.89, X2.90 | GND         |                                                   | X3.89, X3.90 | GND         |                                                   |
| X2.91        | GP_N1       |                                                   | X3.91        | GP_N5       |                                                   |
| X2.92        | GP_P1       |                                                   | X3.92        | GP_P5       |                                                   |

| Pin Number   | Signal Name  | Comment                     | Pin Number   | Signal Name | Comment               |
|--------------|--------------|-----------------------------|--------------|-------------|-----------------------|
| X2.93, X2.94 | GND          | interface clock output      | X3.93, X3.94 | GND         | interface clock input |
| X2.95        | D_CLK_UOUT_N |                             | X3.95        | D_CLK_UIN_N |                       |
| X2.96        | D_CLK_UOUT_P |                             | X3.96        | D_CLK_UIN_P |                       |
| X2.97, X2.98 | GND          | indicates valid data blocks | X3.97, X3.98 | GND         |                       |
| X2.99        | UI_VALID_N   |                             | X3.99        | n.c.        |                       |
| X2.100       | UI_VALID_P   |                             | X3.100       | n.c.        |                       |



The signal UI\_VALID\_P/N must be active in receiver mode. This clock signal is required as a reference for PLL. Therefore, it must be active continuously.



#### Information on the pinouts of the connectors - Differential breakout board

Find a detailed pin assignment to this breakout board in the appendix of the operating manual, drawing number 3585.7296.00. The drawing covers the user interface, connector X1 as well as the connectors X2 and X3.

#### 10.3.1.3 Breakout Board Cadence Palladium 090002-24x

This breakout board, option R&S EXBOX-Z3 consists of the connector to the R&S EX-IQ-BOX and one connector for adjusting the external user signals.

The breakout board is used for signal transmission between a cadence palladium emulator and R&S measurement equipment. The signals are assigned to a 68-pole SCSI connector.

|               |                                      |
|---------------|--------------------------------------|
| Type:         | 68-pole D Subminiatur SCSI connector |
| Manufacturer: | Tyco Electronics                     |
| Part number:  | 787170-7                             |

### Connector Locations

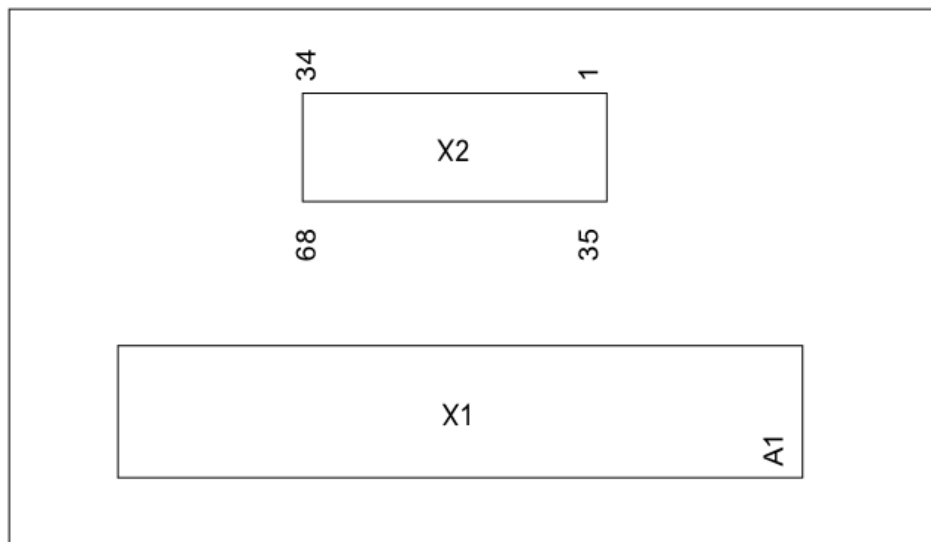


Fig. 10-4: Connector locations on Cadence Palladium breakout board

### Pin Description

Table 10-6: Pinout 1 x 68-pin connector

| Pin Number | Signal Name | Comment     | Pin Number | Signal Name | Comment |
|------------|-------------|-------------|------------|-------------|---------|
| X2.1       | UI_I_P0     | I component | X2.35      | GND         |         |
| X2.2       | UI_I_P1     |             | X2.36      | GND         |         |
| X2.3       | UI_I_P2     |             | X2.37      | GND         |         |
| X2.4       | UI_I_P3     |             | X2.38      | GND         |         |
| X2.5       | UI_I_P4     |             | X2.39      | GND         |         |
| X2.6       | UI_I_P5     |             | X2.40      | GND         |         |
| X2.7       | UI_I_P6     |             | X2.41      | GND         |         |
| X2.8       | UI_I_P7     |             | X2.42      | GND         |         |
| X2.9       | UI_I_P8     |             | X2.43      | GND         |         |
| X2.10      | UI_I_P9     |             | X2.44      | GND         |         |
| X2.11      | UI_I_P10    |             | X2.45      | GND         |         |
| X2.12      | UI_I_P11    |             | X2.46      | GND         |         |
| X2.13      | UI_I_P12    |             | X2.47      | GND         |         |
| X2.14      | UI_I_P13    |             | X2.48      | GND         |         |
| X2.15      | UI_I_P14    |             | X2.49      | GND         |         |
| X2.16      | UI_I_P15    |             | X2.50      | GND         |         |



| Pin Number | Signal Name  | Comment                | Pin Number | Signal Name | Comment                     |
|------------|--------------|------------------------|------------|-------------|-----------------------------|
| X2.17      | UI_Q_P0      | Q component            | X2.51      | GND         |                             |
| X2.18      | UI_Q_P1      |                        | X2.52      | GND         |                             |
| X2.19      | UI_Q_P2      |                        | X2.53      | GND         |                             |
| X2.20      | UI_Q_P3      |                        | X2.54      | GND         |                             |
| X2.21      | UI_Q_P4      |                        | X2.55      | GND         |                             |
| X2.22      | UI_Q_P5      |                        | X2.56      | GND         |                             |
| X2.23      | UI_Q_P6      |                        | X2.57      | GND         |                             |
| X2.24      | UI_Q_P7      |                        | X2.58      | GND         |                             |
| X2.25      | UI_Q_P8      |                        | X2.59      | GND         |                             |
| X2.26      | UI_Q_P9      |                        | X2.60      | GND         |                             |
| X2.27      | UI_Q_P10     |                        | X2.61      | GND         |                             |
| X2.28      | UI_Q_P11     |                        | X2.62      | GND         |                             |
| X2.29      | UI_Q_P12     |                        | X2.63      | GND         |                             |
| X2.30      | UI_Q_P13     |                        | X2.64      | GND         |                             |
| X2.31      | UI_Q_P14     |                        | X2.65      | GND         |                             |
| X2.32      | UI_Q_P15     |                        | X2.66      | n.c.        |                             |
| X2.33      | D_CLK_UOUT_P | interface clock output | X2.67      | D_CLK_UIN_P | interface clock input       |
| X2.34      | D_CLK_UOUT_N |                        | X2.68      | UI_VALID_P  | indicates valid data blocks |



#### Information on the pinouts of the connectors - Cadence Palladium breakout board

Find the pin assignments of this breakout board in the appendix of the operating manual, drawing number 090101-331-25AEZ00. The drawing covers the user interface, connector X1 and the SCSI connector X2.

### 10.3.2 Other Customer Breakout Boards

Other connected Customer Breakout Boards always run in "User defined" mode. This mode will only work properly if the breakout board is recognized as a "customer board".

In order for the breakout board to be recognized as a "Customer Breakout Board", the following conditions must be met:

The signals BO\_TYPE0, BO\_TYPE1 and BOB\_SENSE must be set to **LOW**.

**Information on the pinouts of the connectors**

Find the pin assignments of the connector X1 in the appendix of the operating manual, drawing number 3585.7280.00.

**10.3.3 CPRI - Option R&S EXBOX-B85**

The CPRI breakout board performs tests directly at the CPRI interface between the REC (base station radio equipment control) and the RE (base station radio equipment).

The board contains the user interface to the R&S EX-IQ-BOX, two different interfaces for data exchange with the DUT, two interfaces for additional control & management information exchange, and three general purpose interfaces.

On the front panel, two SFP cages support the optical link. The breakout board additionally contains a differential electrical interface, realized by four SMA connectors.

The front panel also provides the connectors for C&M data exchange. For fast C&M, use the Ethernet interface, and for slow C&M, the RS-232-C interface.

Three BNC connectors for general purposes, input or output, enable controlling the DUT, or reading the signals from the DUT, such as for user-specific purposes. These connectors are located on top of the breakout board.



Connect the breakout board directly at the user interface with the R&S EX-IQ-BOX, i.e. without using a cable. Use in all other interfaces the suitable cables and modules to make sure that data transmission works properly.

**10.3.3.1 Connector Locations - CPRI Breakout Board**

The schematic view shows the location of the connectors of the CPRI breakout board, which are briefly listed after the graphic.



Find detailed information about the specification and properties of the interfaces in the CPRI data sheet.

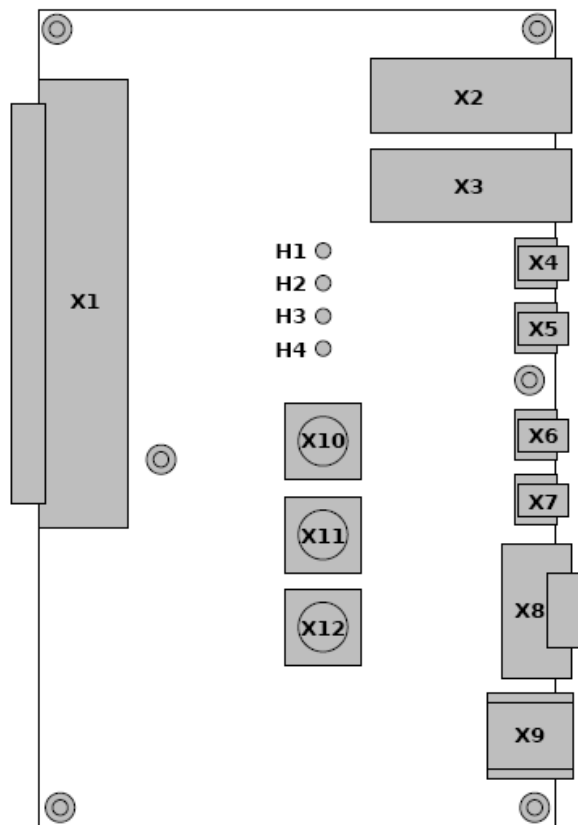


**Fig. 10-5: Connector locations on CPRI breakout board**

|                |                                                                                                                                                                            |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| X1             | <b>User interface</b><br>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          | <b>SFP interface</b><br>The type of these SFP modules depends on the used equipment<br><b>Note:</b> These modules must fit to the transmission characteristics of the DUT. |
| X4, X5, X6, X7 | <b>SMA Differential Tx/Rx Interfaces</b><br>The interface consists of four SMA coaxial connectors.                                                                         |
| X8             | <b>Fast C&amp;M Interface</b><br>type Ethernet.                                                                                                                            |
| X9             | <b>Slow C&amp;M Interface</b><br>connector type RS-232-C.                                                                                                                  |
| X10, X11, X12  | <b>GPIO Marker &amp; Clock Outputs</b><br>BNC connectors.                                                                                                                  |
| H1 ... H4      | <b>Multicolor LEDs</b><br>indicating the status of the CPRI link.                                                                                                          |

# A Annex

The annex contains a list of abbreviations, an overview of automatically assigned file extensions and tables of preset values to the respective transmission protocols.

## A.1 Abbreviations

The following lists contain some common abbreviations used in this manual. For more abbreviations that relate to CPRI, see the CPRI specification at <http://www.cpri.info/spec.html>.

**Table 1-1: Abbreviations and acronyms used in the CRPI protocol**

| Abbreviation | Term                                                                            |
|--------------|---------------------------------------------------------------------------------|
| ACP          | Adjacent Channel Power                                                          |
| AGC          | Automatic Gain Control                                                          |
| AxC          | Antenna-carrier                                                                 |
| BBMUS        | BBM Unspecified                                                                 |
| BPNC         | Backplane Not Connected                                                         |
| C&M          | Control and Management                                                          |
| ceil         | ceiling function                                                                |
| CML          | Current Mode Logic                                                              |
| CPRI         | Common Public Radio Interface                                                   |
| CRC          | Cyclic Redundancy Check)                                                        |
| DL           | Downlink                                                                        |
| DUT          | Device Under Test                                                               |
| ESD          | End-of-Stream Delimiter                                                         |
| EVM          | Error Vector Magnitude                                                          |
| FCS          | Frame Check Sequence                                                            |
| FL           | Forward Link, synonym to downlink                                               |
| FP           | Fabric Port                                                                     |
| FPGA         | Field Programmable Array                                                        |
| GBps         | Giga Byte per second [GB/s]                                                     |
| GND          | Ground Digital Ground                                                           |
| HDLC         | High-level Data Link Control                                                    |
| Iub          | Interface between Radio Network Controller and UMTS radio base station (Node B) |
| IP           | Internet Protocol                                                               |

| Abbreviation | Term                                                                                                      |
|--------------|-----------------------------------------------------------------------------------------------------------|
| LAN          | Local Area Network                                                                                        |
| LOF          | Loss of Frame                                                                                             |
| LOS          | Loss of Signal                                                                                            |
| LVDS         | Low Voltage Differential Signal                                                                           |
| MA           | Module Address                                                                                            |
| MBps         | Mega Byte per second [MB/s]                                                                               |
| MGT          | Multi-Gigabit Transceiver                                                                                 |
| MNC          | Module Not Connected                                                                                      |
| RAI          | Remote Alarm Indication                                                                                   |
| RCLK         | Reference Clock                                                                                           |
| RE           | Radio Equipment                                                                                           |
| REC          | Radio Equipment Control                                                                                   |
| RL           | Reverse Link, synonym to uplink                                                                           |
| RP3L         | Reference Point 3 Link                                                                                    |
| Rx           | Receive                                                                                                   |
| SA           | Shelf Address                                                                                             |
| SAP          | Service Acces Point                                                                                       |
| SCLK         | System Clock                                                                                              |
| SDI          | SAP Defect Indication                                                                                     |
| SFP          | Small Form-factor Pluggable                                                                               |
| SMA          | SubMiniatur version A                                                                                     |
| SYNC         | Synchronization Signal                                                                                    |
| Tc           | CPRI basic frame length = UTRA FDD Chip period = 1/3.84MHz                                                |
| Tx           | Transmit                                                                                                  |
| UE           | User Equipment                                                                                            |
| UL           | Uplink                                                                                                    |
| Uu           | Interface between the radio equipment of the UMTS radio base station (Node B) and the user equipment (UE) |
| XAUI         | X Attachment Unit Interface (10 Gigabit)                                                                  |

## A.2 Extensions for User Files

The following table list all available file extensions for user files. The currently available files on the instrument depend on the installed options.

**Table 1-2: List of the automatically assigned file extensions in R&S DigiConf**

| Function/Digital Standard | List type | Contents                                                        | File suffix |
|---------------------------|-----------|-----------------------------------------------------------------|-------------|
| CPRI                      | Settings  | CPRI configuration, vendor data included<br>Instrument settings | *.cpri      |
|                           | Waveform  | Waveforms and multi segment waveforms                           | *.wv        |
| User Defined              | Settings  | User Defined Protocol configuration                             | *.iqbox     |
| Configuration Software    | Settings  | R&S DigiConf settings                                           | *.savrc1    |

## A.3 Preset

The following lists give an overview of the key preset values of the corresponding protocols.

### A.3.1 User Defined Default Settings

This section contains the default settings of the parameters for user defined protocols, sorted by the tabs in R&S DigiConf.

#### Main Controls

| Parameter  | Default value |
|------------|---------------|
| State      | Off           |
| Logic Type | 3.3 V CMOS    |
| Direction  | Transmitter   |

#### Protocol

| Parameter    | Default value   |
|--------------|-----------------|
| Format       | Parallel        |
| Data Rate    | SDR             |
| Interleaving | Not Interleaved |

#### Data

| Parameter      | Default value |
|----------------|---------------|
| Word Size      | 16 Bit        |
| Word Alignment | LSB           |

|                |                |
|----------------|----------------|
| Bit Order      | LSB            |
| Numeric Format | 2's Complement |

### Clock

|                         |                       |
|-------------------------|-----------------------|
| Clock Rate              | 10 MHz                |
| Clock Source            | Internal (BNC REF IN) |
| Clock Phase             | 0 deg                 |
| Clock Skew              | 0 ns                  |
| Sample/Clock Rate Ratio | 1                     |
| Source                  | REF IN                |
| Frequency               | 10 MHz                |

### Test

| Parameter               | Default value |
|-------------------------|---------------|
| Tx Test                 | Off           |
| Test Signal             | PRBS          |
| IQ Words (Rec)          | 0             |
| Rx BER (Rec)            | 0.00 E+00     |
| Wave File (ARB)         | None          |
| Sample Rate (ARB)       | 0             |
| Number of Samples (ARB) | 0             |

## A.3.2 CPRI Default Settings

This section contains the default settings of the parameters for CPRI, sorted by the tabs in R&S DigIConf.

### Main Controls

| Parameter | Default value |
|-----------|---------------|
| State     | Off           |
| Mode      | CPRI RE Test  |

**Hardware**

| Parameter                 | Default value      |
|---------------------------|--------------------|
| CPRI Line Bit Rate        | 2x (1228.8 Mbit/s) |
| FPGA Internal Loopback    | None               |
| Input                     | SFP1               |
| Output                    | SFP1               |
| Differential Output Swing | 0.800 Vpp          |
| Equalizer                 | 0 dB               |

**Downlink / Uplink**

| Parameter                       | Default value            |
|---------------------------------|--------------------------|
| Signal table/ - name            | signal_1                 |
| Signal State                    | Off                      |
| Standard                        | 3GPP FDD                 |
| Physical Source (downlink)      | DIG IQ IN 1              |
| Signal Output (uplink)          | DIG IQ OUT 2             |
| Sample Rate                     | 3,84 MHz                 |
| Pattern Length                  | 16                       |
| Oversampling                    | 1 (Downlink), 2 (Uplink) |
| I/Q Resolution                  | 16                       |
| Downscale                       | 0                        |
| AxC Allocation                  | Packed                   |
| AxC(s) / Data Rate              | 1 / 122.88 Mbit/s        |
| (Assigned)                      | 1 / 122.88 Mbit/s        |
| Number of Groups                | 1                        |
| Groups Table Repetition         | 1                        |
| Groups Table AxC<index> State   | On                       |
| Groups Table AxC<index> Pattern | 0x0000                   |
| Available Data Rate (I/Q)       | 921.30 MBit/s            |
| Assigned Data Rate (AxC)        | 0.00 MBit/s              |
| AxC Table Source                | signal_1                 |
| AxC Table Word Address          | 1                        |
| AxC Table Bit Address           | 0                        |
| AxC Table Size / bits           | 32                       |



**Control & Management**

| Parameter                   | Default value     |
|-----------------------------|-------------------|
| State - Slow C&M (HDLC )    | Off               |
| Bit Rate                    | 240 kbit/s        |
| Source                      | Terminal          |
| Mode                        | HDLC EN/DE Coding |
| State - Fast C&M (Ethernet) | Off               |
| Ethernet Pointer            | 20                |
| Pref. Eth. Pointer          | 20                |
| Bit Rate (Ethernet)         | 42.124 MBit/s     |

**Vendor Data**

| Parameter                           | Default value      |
|-------------------------------------|--------------------|
| State                               | Off                |
| Line Bit Rate                       | 2x (1228.8 Mbit/s) |
| Direction                           | Downlink           |
| Word Width                          | 16                 |
| Ethernet Pointer                    | 20                 |
| Z.aa.0,1/Z.bb.0,1/Z.cc.0,1/Z.dd.0,1 | 0                  |

**Test and Diagnostic**

| Parameter              | Default value |
|------------------------|---------------|
| GPIO Direction (1...3) | Off           |
| GPIO Signal (1...3)    | Constant Low  |
| SDI                    | Off           |
| RE Reset               | Off           |
| PRBX Test Tx/Rx        | Off           |

**ARB**

| Parameter              | Default value |
|------------------------|---------------|
| File (ARB 1 ... ARB 4) | None          |
| Option(s)              |               |
| Sample Rate/Samples    | 0             |

| Parameter     | Default value       |
|---------------|---------------------|
| State         | Off                 |
| Total Samples | 0.00 / 128 MSamples |

### Recorder

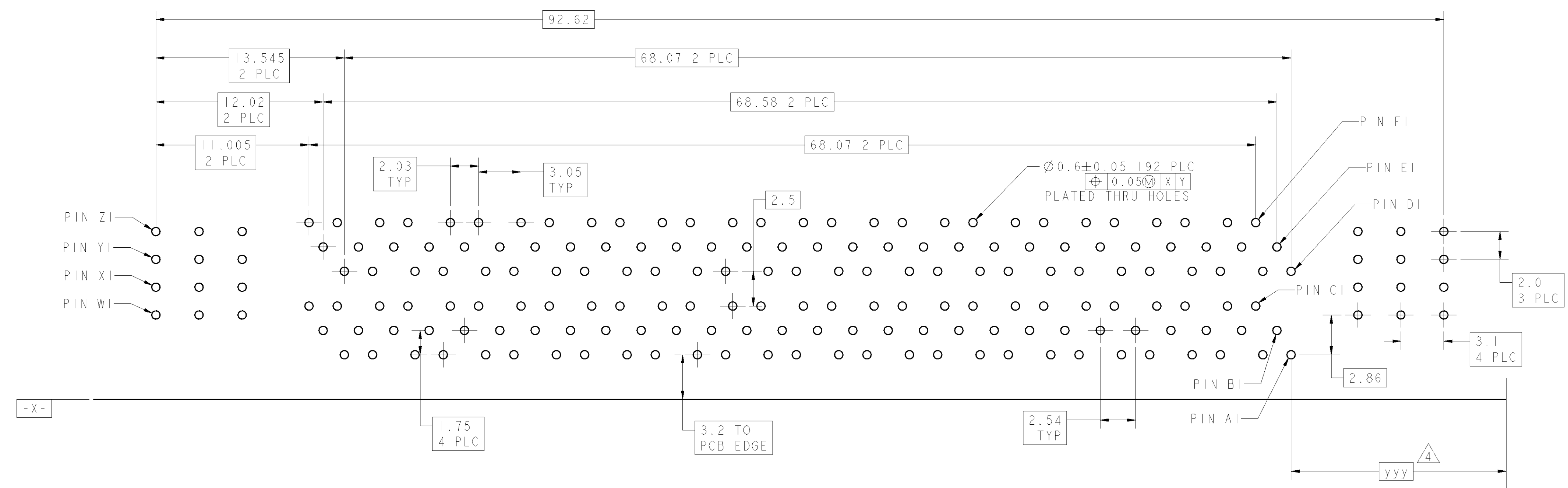
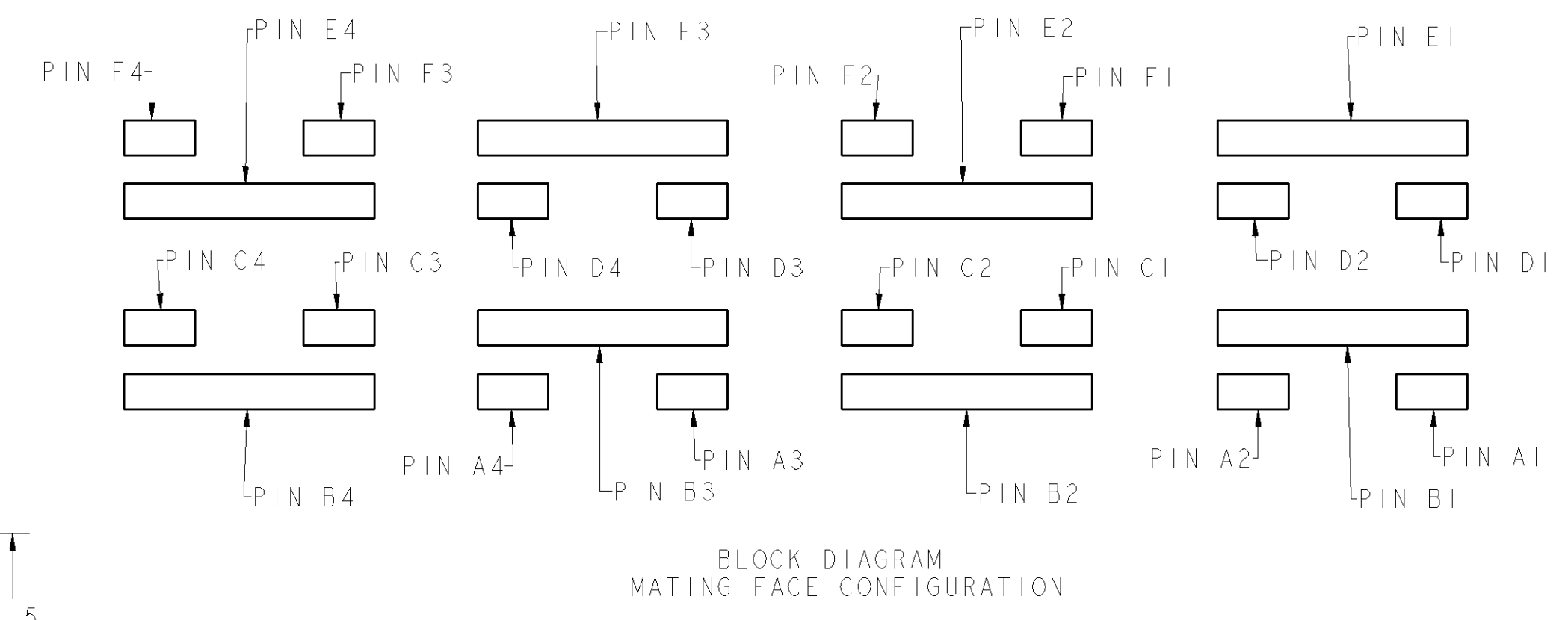
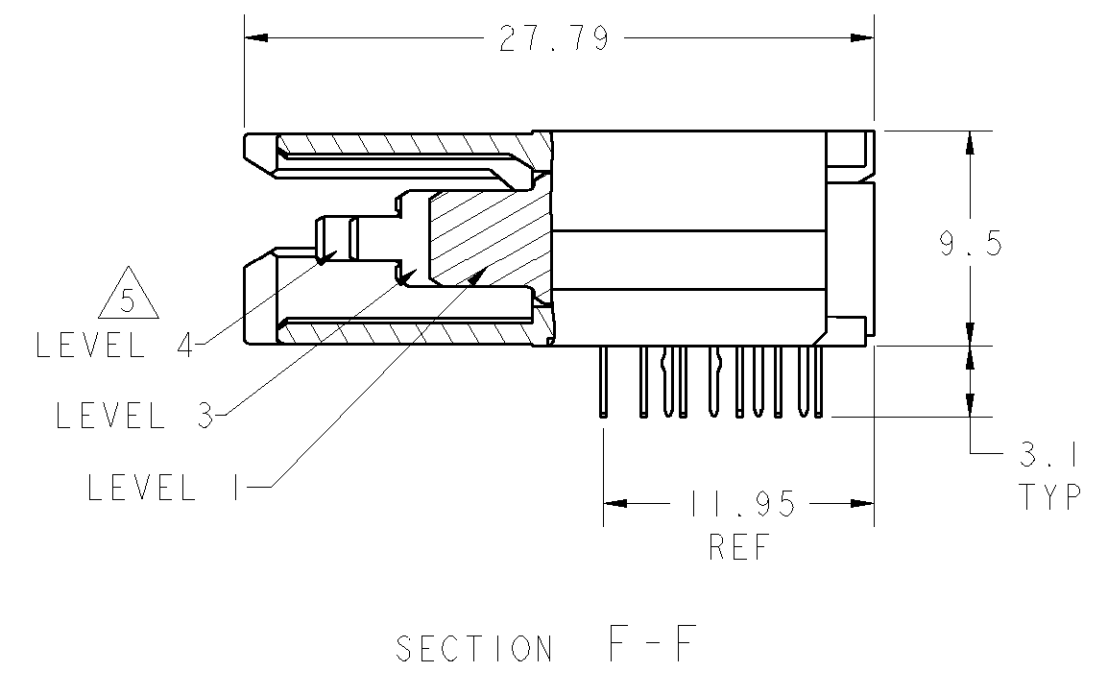
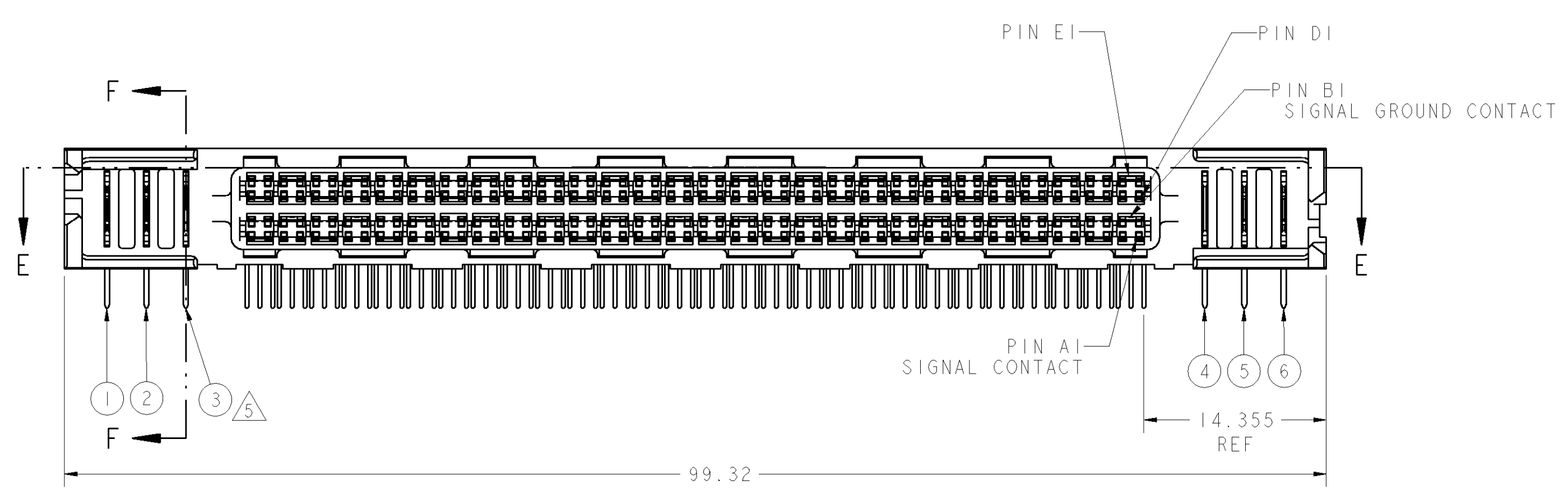
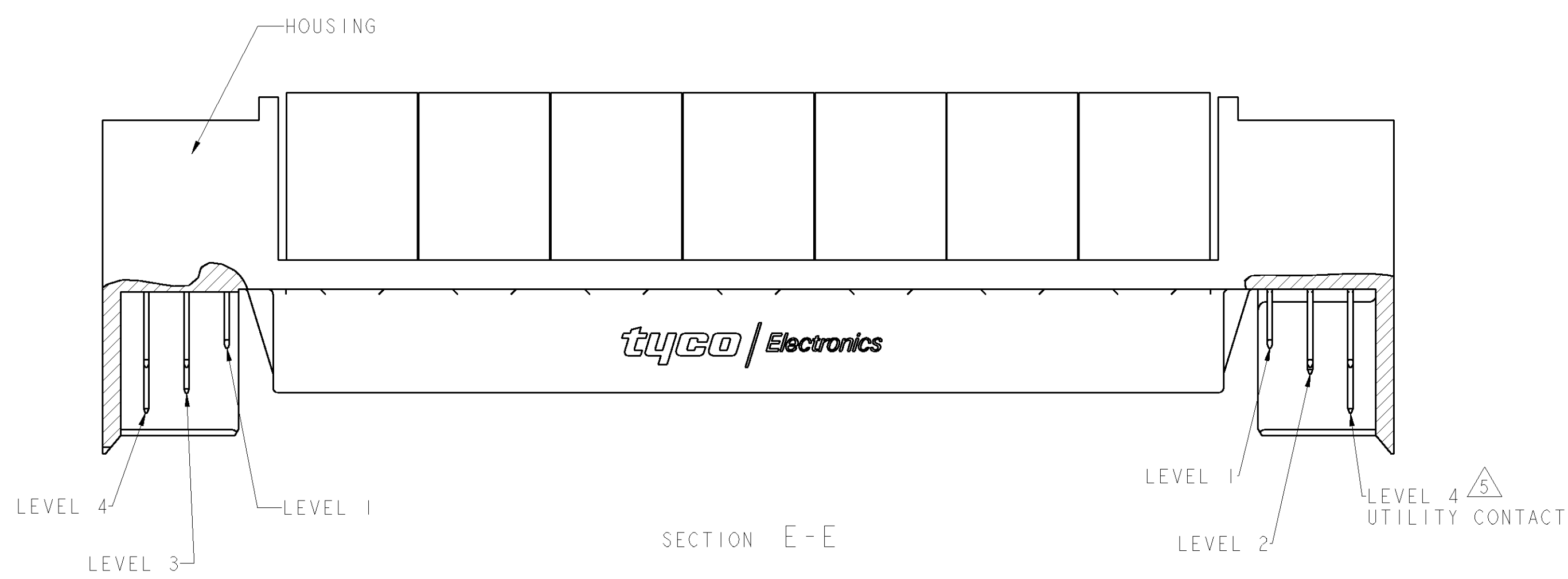
| Parameter        | Default value |
|------------------|---------------|
| Data Source      | (signal_1)    |
| Recording Length | 100 Samples   |
| State            | Off           |
| Trigger Source   | Software      |
| Trigger Position | 0 Samples     |

## A.4 Drawings

The following appendix contains the customer drawings of the user defined breakout boards, where you can find the location of the connectors and the corresponding pin assignments. See [chapter 10, "Interfaces"](#), on page 355 for description on the interfaces and breakout boards.

Included drawings:

- C-6367557  
Tyco Z-Dok Adapter Board Connector, (56 differential pairs), see also [chapter 10.1, "User Interface of the R&S EX-IQ-BOX"](#), on page 355.
- 3585.7280.00  
Single Ended Breakout Board with connector X1, the User Interface, and the connectors X2 and X3 (2x25 pole), see [chapter 10.3.1.1, "Breakout Board Single Ended 3585.7280.00"](#), on page 359.
- 3585.7296.00  
Differential Breakout Board, with connector X1, the User Interface, and the connectors X2 and X3 (2x50 pole), see [chapter 10.3.1.2, "Breakout Board Differential 3585.7296.00"](#), on page 361.
- 090101-331-25AEZ00  
Cadence Palladium Breakout Board with connector X1, the User Interface, and the connector X2 (1x68 pole SCSI), see [chapter 10.3.1.3, "Breakout Board Cadence Palladium 090002-24x"](#), on page 364.



RECOMMENDED PC BOARD FOOTPRINT  
COMPONENT SIDE SHOWN  
SCALE 5:1

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.

| LOC |    | DIST |     | REVISONS              |           |     |      |
|-----|----|------|-----|-----------------------|-----------|-----|------|
| GP  | 00 | P    | LTR | DESCRIPTION           | DATE      | DWN | APVD |
|     |    | A    |     | DRAWN                 | 09SEP105  | WVS | EB   |
|     |    | A1   |     | REV PER ECO-06-002399 | 01FEB2006 | EDB | EDB  |
|     |    |      |     |                       |           |     |      |

| UTILITY CONTACT SEQUENCE TABLE      |   |   |   |   |   |           | PART<br>NUMBER |
|-------------------------------------|---|---|---|---|---|-----------|----------------|
| UTILITY CONTACT LEVEL 1, 2, 3, OR 4 |   |   |   |   |   |           |                |
| 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 |                |
| ①                                   | ② | ③ | ④ | ⑤ | ⑥ |           |                |
| UTILITY CONTACT LOCATION            |   |   |   |   |   |           |                |

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DIMENSIONS:  
mm

MATERIAL  
: 1

TOLERANCES UNLESS OTHERWISE SPECIFIED:  
9 PLC ±.3  
1 PLC ±0.25  
3 PLC ±.25  
4 PLC ±.25  
ANGLES ±.25

FINISH  
: 1

DRAWN  
W. VAN SCOYK  
CHK.  
E. BRIANT  
APVD  
F. BRIANT

09SEP105  
09SEP105  
09SEP105

PRODUCT SPEC  
108-1985  
APPLICATION SPEC  
114-13068

WEIGHT  
-

CUSTOMER DRAWING

**tyco**  
**Electronics**

Tyco Electronics  
Harrisburg, PA 17105-3608

NAME  
Z-DOK+ ADAPTER BOARD CONNECTOR  
ASSEMBLY, 56 SIGNAL DIFF. PAIR,  
3 UTILITY CONTACTS PER SIDE

SIZE  
A1

CAGE CODE  
00779

DRAWING NO.  
6367557

RESTRICTED TO  
-

SCALE  
3:1

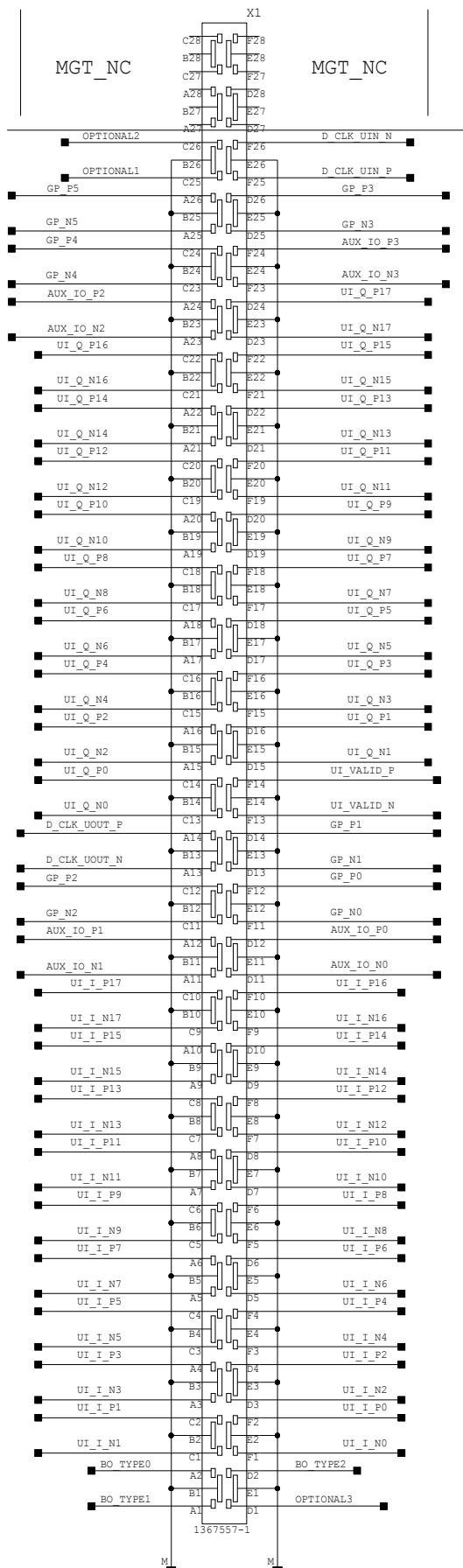
SHEET  
1

OF  
1

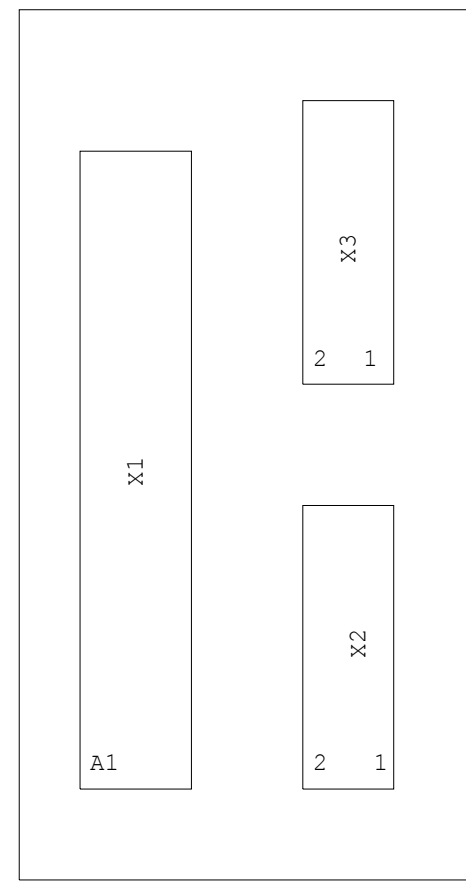
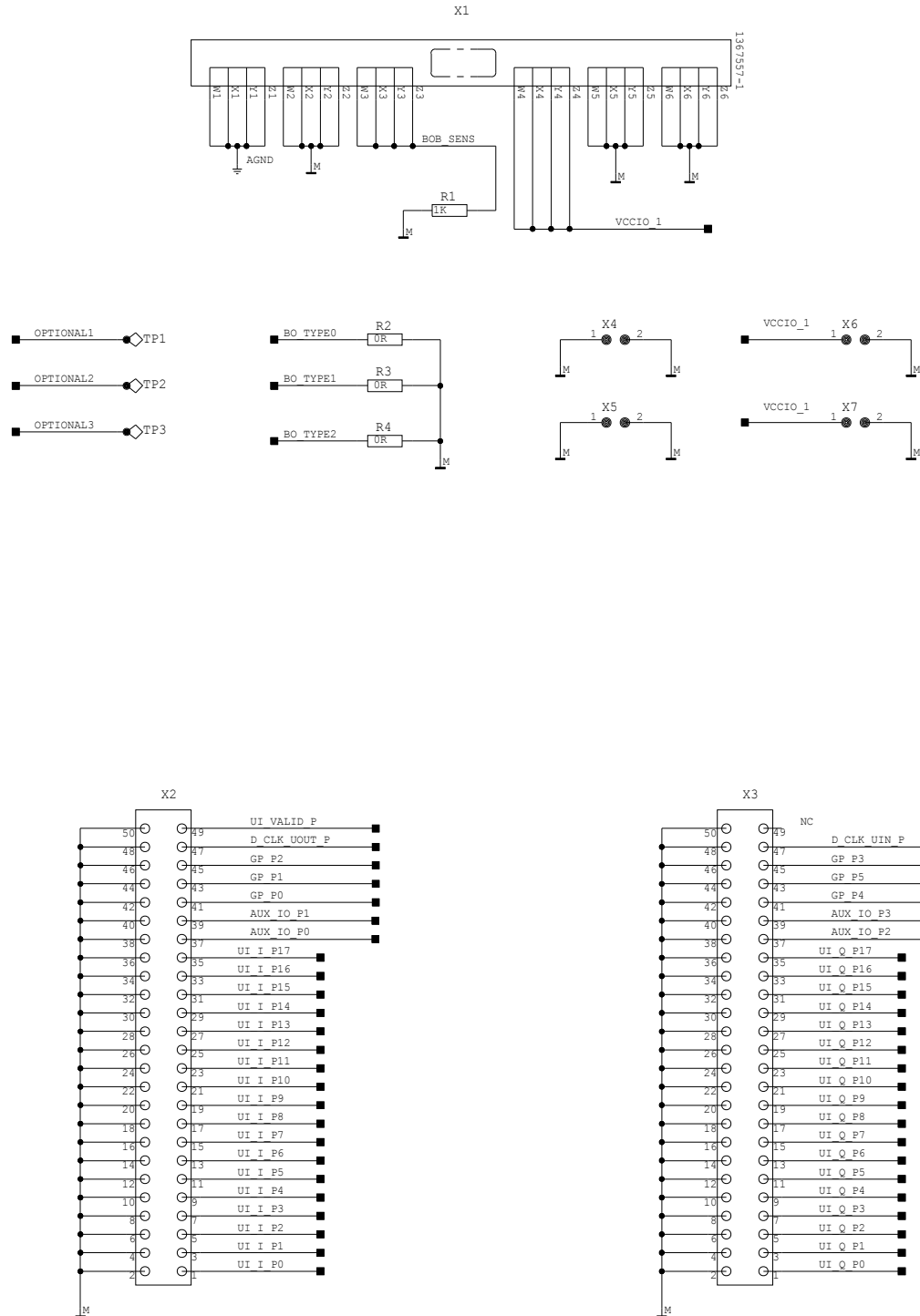
REV  
A1

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A  
B  
C  
D  
E  
F



FRONT VIEW



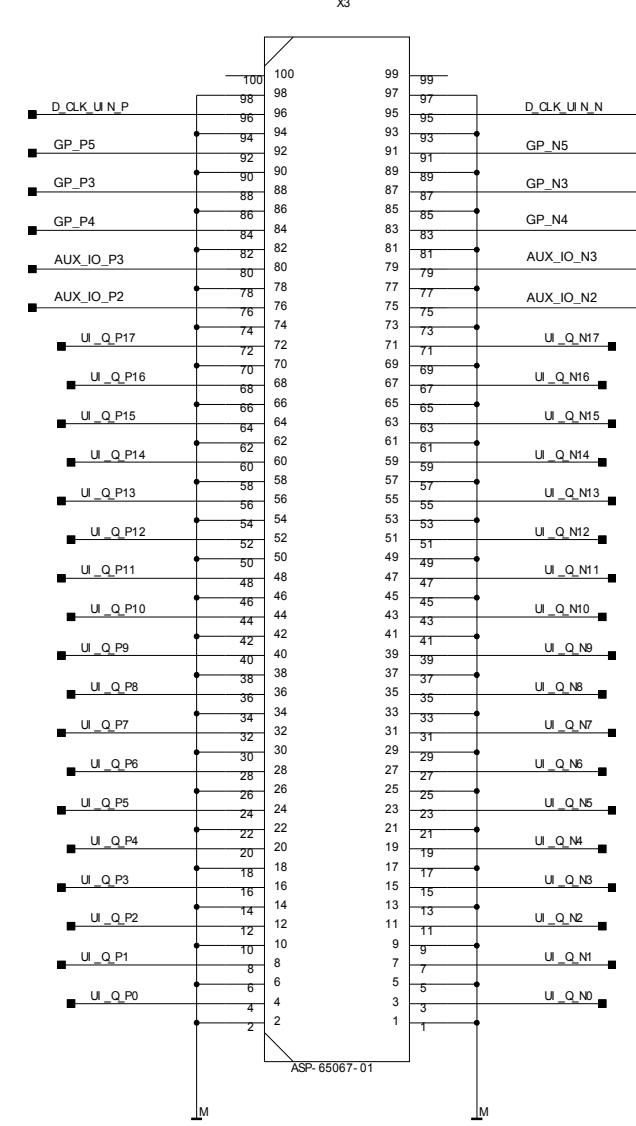
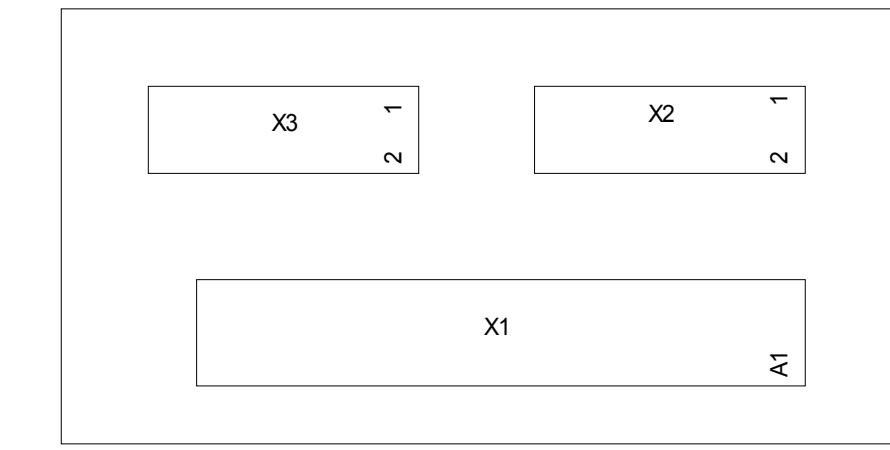
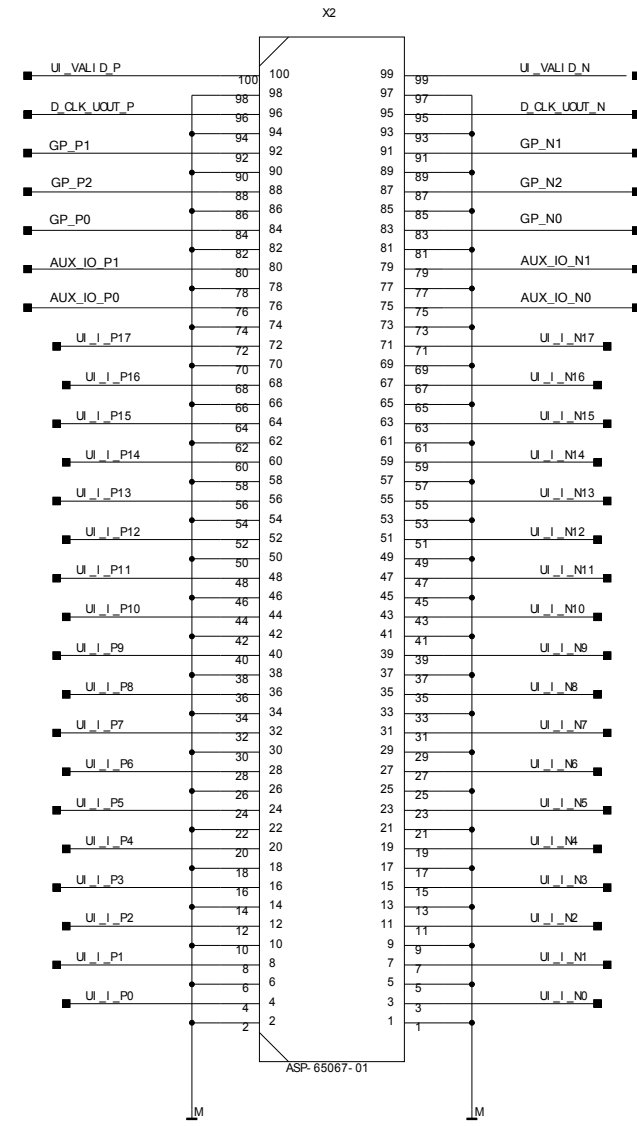
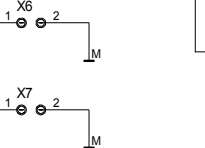
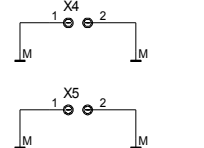
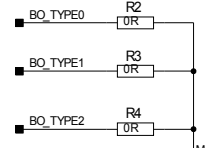
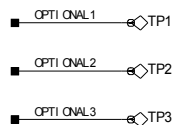
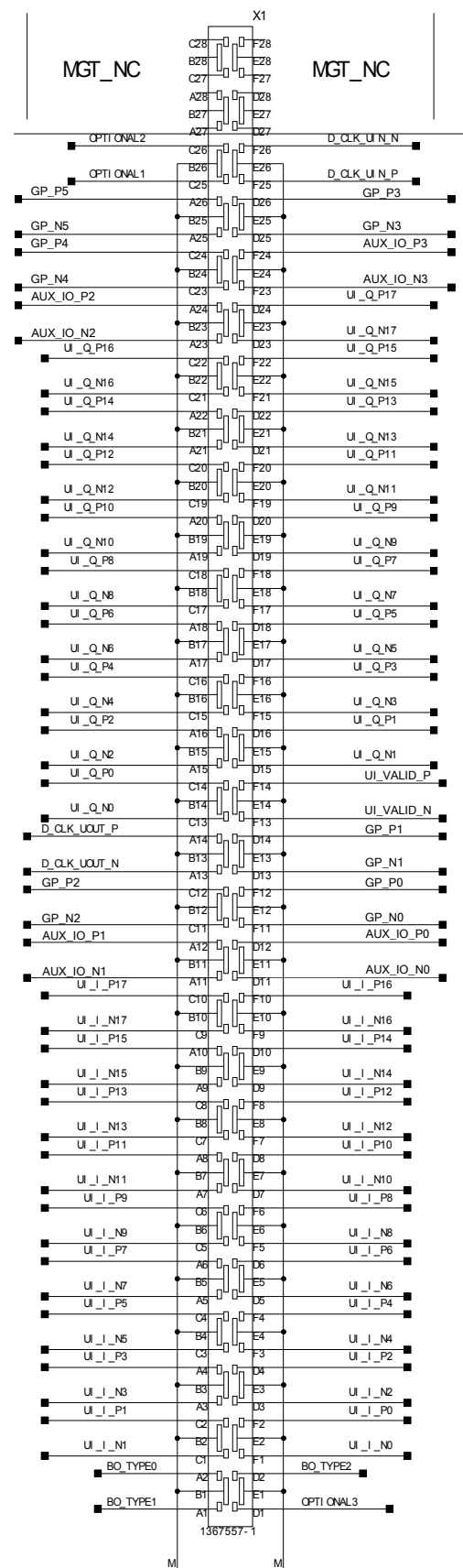
Bindende Angaben ueber Varianten,  
Trimmwerte, Bauteile und  
nicht bestueckte Bauteile siehe ST.  
For binding information on models,  
trimming and components values and  
nonfitted components see parts list.  
Electrostatic sensitiv devices  
require a special handling.  
Elektrostatisch gefaehrdete  
Bauelemente erfordern eine  
besondere Handhabung.



ACHTUNG: ESD!  
ATTENTION: ESD!

|               |                                                       |  |  |                       |                     |                                                                  |
|---------------|-------------------------------------------------------|--|--|-----------------------|---------------------|------------------------------------------------------------------|
| ROHDE&SCHWARZ | Benennung / Designat.:<br>BreakOut-Board Single Ended |  |  | Spr.:/Lang.:<br>de en | Aei:/C.I.:<br>01.00 | Blatt:/Sh.:<br>1 -                                               |
|               | Datum:<br>Date: 29.07.2007                            |  |  | Abteilung:<br>Dept.:  | Name:<br>Name:      | Zeichn.Nr.:/Drawing No.:<br>3585.7280.00<br>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.:      |            |                      | Spr.:/Lang.:   | Aei:/C.I.:                           | Blatt:/Sh.: |
|               | BreakOut-Board Differential |            |                      | de en          | 01.00                                | 1 -         |
|               | Datum:<br>Date.:            | 22.11.2005 | Abteilung:<br>Dept.: | Name:<br>Name: | Zeichn.Nr.:/Drawing No.:             |             |
|               |                             |            |                      |                | 3585.7296.00<br>090002-231-25(SP)(3) |             |



## List of Commands

|                                         |     |
|-----------------------------------------|-----|
| *CLS.....                               | 236 |
| *IDN?.....                              | 237 |
| *OPC.....                               | 237 |
| *OPT?.....                              | 237 |
| *RCL.....                               | 238 |
| *RST.....                               | 238 |
| *SAV.....                               | 238 |
| :DIAGnostic:EBOX:CATalog?.....          | 244 |
| :DIAGnostic:EBOX:CPRI:EXECute.....      | 245 |
| :DIAGnostic:EBOX:CPRI:TEST:STORe.....   | 245 |
| :DIAGnostic:EBOX:CPRI:TEST?.....        | 245 |
| :DIAGnostic:EBOX:LVDS:BER?.....         | 246 |
| :DIAGnostic:EBOX:LVDS:DCM?.....         | 246 |
| :DIAGnostic:EBOX:LVDS:ERRors?.....      | 246 |
| :DIAGnostic:EBOX:LVDS:NDATa?.....       | 246 |
| :DIAGnostic:EBOX:LVDS:PLL?.....         | 247 |
| :DIAGnostic:EBOX:LVDS:RCV?.....         | 247 |
| :DIAGnostic:EBOX:LVDS:RX TX:SOURce..... | 247 |
| :DIAGnostic:EBOX:LVDS:RX TX:STATe.....  | 247 |
| :DIAGnostic:EBOX:POINT.....             | 247 |
| :DIAGnostic:EBOX:POINT:VALue?.....      | 248 |
| :DIAGnostic:EBOX:SElect.....            | 248 |
| ERR?.....                               | 238 |
| MMEMory:CATalog?.....                   | 254 |
| MMEMory:CDIRectory.....                 | 255 |
| MMEMory:DELeTe.....                     | 255 |
| MMEMory:LOAD:STATe.....                 | 255 |
| MMEMory:MDIRectory.....                 | 256 |
| MMEMory:RDIRectory.....                 | 256 |
| MMEMory:STORe:STATe.....                | 256 |
| SOURce:RECeiver:CLOCK:PHASe.....        | 267 |
| SOURce:RECeiver:CLOCK:POLarity.....     | 267 |
| SOURce:RECeiver:CLOCK:RATE.....         | 268 |
| SOURce:RECeiver:CLOCK:SKEW:IN.....      | 269 |
| SOURce:RECeiver:CLOCK:SKEW:OUT.....     | 270 |
| SOURce:RECeiver:CLOCK:SOURce.....       | 270 |
| SOURce:RECeiver:DATA:ALIGNment.....     | 272 |
| SOURce:RECeiver:DATA:BORDER.....        | 273 |
| SOURce:RECeiver:DATA:NFORmat.....       | 273 |
| SOURce:RECeiver:DATA:POLarity:IQ.....   | 275 |
| SOURce:RECeiver:DATA:SIZE.....          | 275 |
| SOURce:RECeiver:DATA:SPOLarity.....     | 275 |
| SOURce:RECeiver:DATA:SPOSition.....     | 276 |
| SOURce:RECeiver:DATA:STYPe.....         | 276 |
| SOURce:RECeiver:DATA:TYPe.....          | 277 |

|                                                |     |
|------------------------------------------------|-----|
| SOURce:RECeiver:DRATe.....                     | 263 |
| SOURce:RECeiver:FORMat.....                    | 264 |
| SOURce:RECeiver:ILEaving.....                  | 265 |
| SOURce:RECeiver:LOGictype.....                 | 259 |
| SOURce:RECeiver:SCRatio.....                   | 271 |
| SOURce:RECeiver:SRATe.....                     | 265 |
| SOURce:TRANsmitter:CLOCK:PHASe.....            | 267 |
| SOURce:TRANsmitter:CLOCK:POLarity.....         | 267 |
| SOURce:TRANsmitter:CLOCK:RATE.....             | 267 |
| SOURce:TRANsmitter:CLOCK:SKEW:IN.....          | 269 |
| SOURce:TRANsmitter:CLOCK:SKEW:OUT.....         | 270 |
| SOURce:TRANsmitter:CLOCK:SOURce.....           | 270 |
| SOURce:TRANsmitter:DATA:ALIGNment.....         | 272 |
| SOURce:TRANsmitter:DATA:BORDER.....            | 273 |
| SOURce:TRANsmitter:DATA:NFORMat.....           | 273 |
| SOURce:TRANsmitter:DATA:POLarity:IQ.....       | 275 |
| SOURce:TRANsmitter:DATA:SIZE.....              | 275 |
| SOURce:TRANsmitter:DATA:SPOLarity.....         | 275 |
| SOURce:TRANsmitter:DATA:SPOSition.....         | 276 |
| SOURce:TRANsmitter:DATA:STYPe.....             | 276 |
| SOURce:TRANsmitter:DATA:TYPe.....              | 277 |
| SOURce:TRANsmitter:DRATe.....                  | 263 |
| SOURce:TRANsmitter:FORMat.....                 | 264 |
| SOURce:TRANsmitter:ILEaving.....               | 264 |
| SOURce:TRANsmitter:LOGictype.....              | 259 |
| SOURce:TRANsmitter:SCRatio.....                | 271 |
| SOURce:TRANsmitter:SENDto.....                 | 260 |
| SOURce:TRANsmitter:SRATe.....                  | 265 |
| [SOURce<hw>]:EBOX:ARB:CATalog?.....            | 249 |
| [SOURce<hw>]:EBOX:ARB:DELeTe.....              | 249 |
| [SOURce<hw>]:EBOX:CATalog?.....                | 249 |
| [SOURce<hw>]:EBOX:COUNT.....                   | 250 |
| [SOURce<hw>]:EBOX:CPRI:ARB:OPTion?.....        | 287 |
| [SOURce<hw>]:EBOX:CPRI:ARB:PEAK?.....          | 287 |
| [SOURce<hw>]:EBOX:CPRI:ARB:PRESet.....         | 288 |
| [SOURce<hw>]:EBOX:CPRI:ARB:RELoad.....         | 288 |
| [SOURce<hw>]:EBOX:CPRI:ARB:RMS?.....           | 288 |
| [SOURce<hw>]:EBOX:CPRI:ARB:SAMPles:TOTal?..... | 288 |
| [SOURce<hw>]:EBOX:CPRI:ARB<ch>:CONFLict?.....  | 289 |
| [SOURce<hw>]:EBOX:CPRI:ARB<ch>:FILE.....       | 289 |
| [SOURce<hw>]:EBOX:CPRI:ARB<ch>:SAMPles?.....   | 289 |
| [SOURce<hw>]:EBOX:CPRI:ARB<ch>:SRATe?.....     | 290 |
| [SOURce<hw>]:EBOX:CPRI:ARB<ch>:STATe.....      | 290 |
| [SOURce<hw>]:EBOX:CPRI:CM:ETH:ACTive?.....     | 291 |
| [SOURce<hw>]:EBOX:CPRI:CM:ETH:BRATe?.....      | 291 |
| [SOURce<hw>]:EBOX:CPRI:CM:ETH:COMMand.....     | 292 |
| [SOURce<hw>]:EBOX:CPRI:CM:ETH:EXECute.....     | 292 |
| [SOURce<hw>]:EBOX:CPRI:CM:ETH:PPTR.....        | 292 |



|                                                    |     |
|----------------------------------------------------|-----|
| [SOURce<hw>]:EBOX:CPRI:CM:ETH:PTR?                 | 293 |
| [SOURce<hw>]:EBOX:CPRI:CM:ETH:STATe                | 293 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:ACTive?             | 293 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:BAUDRate            | 291 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:BRATe               | 294 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:COMManD             | 294 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:EXECute             | 295 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:MODE                | 295 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:RFRames?            | 295 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:RST                 | 296 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:RX?                 | 296 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:SFRames?            | 296 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:SOURce              | 296 |
| [SOURce<hw>]:EBOX:CPRI:CM:HDLC:STATe               | 297 |
| [SOURce<hw>]:EBOX:CPRI:HW:ALARm?                   | 298 |
| [SOURce<hw>]:EBOX:CPRI:HW:BBRevision?              | 298 |
| [SOURce<hw>]:EBOX:CPRI:HW:CMODE?                   | 299 |
| [SOURce<hw>]:EBOX:CPRI:HW:CORE?                    | 299 |
| [SOURce<hw>]:EBOX:CPRI:HW:EBRevision?              | 300 |
| [SOURce<hw>]:EBOX:CPRI:HW:FBVersion?               | 300 |
| [SOURce<hw>]:EBOX:CPRI:HW:FCVersion?               | 300 |
| [SOURce<hw>]:EBOX:CPRI:HW:GPIO:MFWidth:BFRame      | 300 |
| [SOURce<hw>]:EBOX:CPRI:HW:GPIO:MFWidth:HFRame      | 301 |
| [SOURce<hw>]:EBOX:CPRI:HW:GPIO:MFWidth:NFRame      | 301 |
| [SOURce<hw>]:EBOX:CPRI:HW:GPIO<ch>:DIRection       | 301 |
| [SOURce<hw>]:EBOX:CPRI:HW:GPIO<ch>:SIGnal          | 302 |
| [SOURce<hw>]:EBOX:CPRI:HW:HSSS:INPut               | 303 |
| [SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP1[:STATe] | 304 |
| [SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SFP2[:STATe] | 304 |
| [SOURce<hw>]:EBOX:CPRI:HW:HSSS:OUTPut:SMA[:STATe]  | 305 |
| [SOURce<hw>]:EBOX:CPRI:HW:LBRate                   | 305 |
| [SOURce<hw>]:EBOX:CPRI:HW:LOF?                     | 306 |
| [SOURce<hw>]:EBOX:CPRI:HW:LOS?                     | 306 |
| [SOURce<hw>]:EBOX:CPRI:HW:PROTOcol                 | 306 |
| [SOURce<hw>]:EBOX:CPRI:HW:R21T?                    | 307 |
| [SOURce<hw>]:EBOX:CPRI:HW:RCLock:CRLocked?         | 307 |
| [SOURce<hw>]:EBOX:CPRI:HW:RCLock:CSLocked?         | 307 |
| [SOURce<hw>]:EBOX:CPRI:HW:RCLock:ROLocked?         | 308 |
| [SOURce<hw>]:EBOX:CPRI:HW:RCLock:SOURce            | 308 |
| [SOURce<hw>]:EBOX:CPRI:HW:SEED:RECeived?           | 309 |
| [SOURce<hw>]:EBOX:CPRI:HW:SEED:SCRambling          | 309 |
| [SOURce<hw>]:EBOX:CPRI:HW:SMA:DOSWing              | 310 |
| [SOURce<hw>]:EBOX:CPRI:HW:SMA:RXEGain              | 310 |
| [SOURce<hw>]:EBOX:CPRI:HW:T14T                     | 311 |
| [SOURce<hw>]:EBOX:CPRI:HW:TIMing?                  | 311 |
| [SOURce<hw>]:EBOX:CPRI:HW:TOFFset                  | 311 |
| [SOURce<hw>]:EBOX:CPRI:L1:HDLC:BRATe?              | 312 |
| [SOURce<hw>]:EBOX:CPRI:L1:RX:LOCAL:LOF?            | 312 |

|                                                         |     |
|---------------------------------------------------------|-----|
| [SOURce<hw>]:EBOX:CPRI:L1:RX:LOCAl:LOS?                 | 312 |
| [SOURce<hw>]:EBOX:CPRI:L1:RX:LOCAl:RAI?                 | 313 |
| [SOURce<hw>]:EBOX:CPRI:L1:RX:REMOte:LOF?                | 313 |
| [SOURce<hw>]:EBOX:CPRI:L1:RX:REMOte:LOS?                | 313 |
| [SOURce<hw>]:EBOX:CPRI:L1:RX:REMOte:RAI?                | 314 |
| [SOURce<hw>]:EBOX:CPRI:L1:RX:REMOte:RESet?              | 314 |
| [SOURce<hw>]:EBOX:CPRI:L1:RX:REMOte:SAP?                | 314 |
| [SOURce<hw>]:EBOX:CPRI:L1:VERSion?                      | 315 |
| [SOURce<hw>]:EBOX:CPRI:MODE                             | 315 |
| [SOURce<hw>]:EBOX:CPRI:PRBS:RST                         | 325 |
| [SOURce<hw>]:EBOX:CPRI:PRESet                           | 315 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:ABORt                | 317 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:DATA:SOURce          | 317 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:DATA:SOURce:CATalog? | 317 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:DATA:SRATe?          | 317 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:EXECute              | 318 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:FILE:CREate          | 318 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:FILE:SELEct          | 318 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:RLENgth              | 319 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:RTIME?               | 319 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:STATe?               | 319 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:STATus?              | 320 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:TRIGger:POSition     | 320 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:TRIGger:SOURce       | 321 |
| [SOURce<hw>]:EBOX:CPRI:RECOder<ch>:VIEW                 | 321 |
| [SOURce<hw>]:EBOX:CPRI:RX:SIGNAl<ch>:OUTPut             | 331 |
| [SOURce<hw>]:EBOX:CPRI:SETTing:CATalog?                 | 322 |
| [SOURce<hw>]:EBOX:CPRI:SETTing:DELeTe                   | 322 |
| [SOURce<hw>]:EBOX:CPRI:SETTing:LOAD                     | 323 |
| [SOURce<hw>]:EBOX:CPRI:SETTing:STORe                    | 323 |
| [SOURce<hw>]:EBOX:CPRI:SFRame<st>:DATA                  | 332 |
| [SOURce<hw>]:EBOX:CPRI:STATe                            | 316 |
| [SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:RATE?                | 324 |
| [SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:STATe                | 324 |
| [SOURce<hw>]:EBOX:CPRI:TEST:BER:RX:WORDs?               | 325 |
| [SOURce<hw>]:EBOX:CPRI:TEST:BER:TX:STATe                | 325 |
| [SOURce<hw>]:EBOX:CPRI:TEST:RX:LOF?                     | 325 |
| [SOURce<hw>]:EBOX:CPRI:TEST:RX:LOS?                     | 326 |
| [SOURce<hw>]:EBOX:CPRI:TEST:RX:RAI?                     | 326 |
| [SOURce<hw>]:EBOX:CPRI:TEST:RX:RESet?                   | 326 |
| [SOURce<hw>]:EBOX:CPRI:TEST:RX:SDI?                     | 327 |
| [SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:INFO?               | 327 |
| [SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:LOS?                | 327 |
| [SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:TX:DISAbled?        | 328 |
| [SOURce<hw>]:EBOX:CPRI:TEST:SFP<st>:TX:FAULt?           | 328 |
| [SOURce<hw>]:EBOX:CPRI:TEST:TX:REReset                  | 328 |
| [SOURce<hw>]:EBOX:CPRI:TEST:TX:SDI                      | 329 |
| [SOURce<hw>]:EBOX:CPRI:TX:SIGNAl<ch>:SOURce             | 332 |

|                                                                      |     |
|----------------------------------------------------------------------|-----|
| [SOURce<hw>]:EBOX:CPRI:TX RX:APPLY.....                              | 333 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC:COUNT?.....                         | 333 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:BADDRESS.....                  | 334 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:CONFLICT?.....                 | 334 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:PSRC?.....                     | 334 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:SIZE?.....                     | 335 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:SOURce?.....                   | 335 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXC<ch0>:WADDRESS.....                  | 336 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:AXCStatus?.....                         | 336 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:DRATE:ASSigned?.....                    | 336 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:DRATE:AVailable?.....                   | 337 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:GROup<user0>:PATTERN.....               | 344 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:INTERleaving.....                       | 337 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL:APPend.....                      | 337 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL:COUNT?.....                      | 338 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:ARB:CONFLICT?.....           | 338 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:ARB:FILE?.....               | 338 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:ALLocation.....          | 339 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:COUNT:ASSign?.....       | 339 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:COUNT:NEEDed?.....       | 340 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:DRATE:ASSigned?.....     | 341 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:DRATE:NEEDed?.....       | 341 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:DRATE:STATus?.....       | 341 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:AXC:LIST?.....               | 342 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:COPY.....                    | 342 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:CRESt.....                   | 342 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:DELeTe.....                  | 343 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:GAIN.....                    | 343 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:IQResolution.....            | 345 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:NAME.....                    | 346 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:NFORmat.....                 | 346 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:OSAMpling.....               | 348 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:PLENgtH.....                 | 348 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:RMS?.....                    | 348 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:SRATE.....                   | 349 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:STANDard.....                | 350 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SIGNAL<ch>:STATe.....                   | 352 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SOURce:GROup:CALC.....                  | 344 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SOURce<ch>:GROup:COUNT.....             | 344 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SOURce<ch>:GROup<user0>:REPetition..... | 345 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:SOURce<ch>:GROup<user0>:STATe.....      | 345 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:TRIGger:ARM.....                        | 332 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:TRIGger:SOURce.....                     | 332 |
| [SOURce<hw>]:EBOX:CPRI:TX RX:WARNing?.....                           | 352 |
| [SOURce<hw>]:EBOX:CPRI:VENDor:DATA<ch>.....                          | 352 |
| [SOURce<hw>]:EBOX:CPRI:VENDor:DIRection.....                         | 353 |
| [SOURce<hw>]:EBOX:CPRI:VENDor:STATe.....                             | 353 |
| [SOURce<hw>]:EBOX:CPRI:VENDor:WWIDth?.....                           | 353 |

|                                                  |     |
|--------------------------------------------------|-----|
| [SOURce<hw>]:EBOX:CPRI:VERSion?                  | 316 |
| [SOURce<hw>]:EBOX:DEVIce:BOARd:PART?             | 242 |
| [SOURce<hw>]:EBOX:DEVIce:BOARd:REVision?         | 242 |
| [SOURce<hw>]:EBOX:DEVIce:BOARd:SERial?           | 242 |
| [SOURce<hw>]:EBOX:DEVIce:BOB:REVision?           | 242 |
| [SOURce<hw>]:EBOX:DEVIce:BOB:SERial?             | 243 |
| [SOURce<hw>]:EBOX:DEVIce:BOB:TYPE?               | 243 |
| [SOURce<hw>]:EBOX:DEVIce:CATalog?                | 239 |
| [SOURce<hw>]:EBOX:DEVIce:CONTroller?             | 240 |
| [SOURce<hw>]:EBOX:DEVIce:CPLD?                   | 240 |
| [SOURce<hw>]:EBOX:DEVIce:FIRMware:SUPPorted?     | 243 |
| [SOURce<hw>]:EBOX:DEVIce:FPG:BASe?               | 240 |
| [SOURce<hw>]:EBOX:DEVIce:FPG:BOB?                | 241 |
| [SOURce<hw>]:EBOX:DEVIce:FPG:DIGio?              | 241 |
| [SOURce<hw>]:EBOX:DEVIce:PART                    | 241 |
| [SOURce<hw>]:EBOX:DEVIce:PPCVersion?             | 241 |
| [SOURce<hw>]:EBOX:DEVIce:SElect                  | 244 |
| [SOURce<hw>]:EBOX:DEVIce:SERial                  | 244 |
| [SOURce<hw>]:EBOX:ID?                            | 250 |
| [SOURce<hw>]:EBOX:INST<ch>:NAME?                 | 251 |
| [SOURce<hw>]:EBOX:INST<ch>:PORT?                 | 252 |
| [SOURce<hw>]:EBOX:INST<ch>:SERial?               | 252 |
| [SOURce<hw>]:EBOX:INST<ch>:TYPE?                 | 252 |
| [SOURce<hw>]:EBOX:OPT                            | 250 |
| [SOURce<hw>]:EBOX:SElect                         | 251 |
| [SOURce<hw>]:EBOX:STATe?                         | 251 |
| [SOURce<hw>]:EBOX:USER:CLOCK:PHASe               | 267 |
| [SOURce<hw>]:EBOX:USER:CLOCK:POLarity            | 267 |
| [SOURce<hw>]:EBOX:USER:CLOCK:RATE                | 268 |
| [SOURce<hw>]:EBOX:USER:CLOCK:REFerence:FREQuency | 269 |
| [SOURce<hw>]:EBOX:USER:CLOCK:REFerence:VALue?    | 269 |
| [SOURce<hw>]:EBOX:USER:CLOCK:SKEW:IN             | 269 |
| [SOURce<hw>]:EBOX:USER:CLOCK:SKEW:OUT            | 270 |
| [SOURce<hw>]:EBOX:USER:CLOCK:SOURce              | 270 |
| [SOURce<hw>]:EBOX:USER:DATA:ALIGnment            | 272 |
| [SOURce<hw>]:EBOX:USER:DATA:BORDer               | 273 |
| [SOURce<hw>]:EBOX:USER:DATA:NFORmat              | 273 |
| [SOURce<hw>]:EBOX:USER:DATA:POLarity:IQ          | 275 |
| [SOURce<hw>]:EBOX:USER:DATA:SIZE                 | 275 |
| [SOURce<hw>]:EBOX:USER:DATA:SPOLarity            | 275 |
| [SOURce<hw>]:EBOX:USER:DATA:SPOSition            | 276 |
| [SOURce<hw>]:EBOX:USER:DATA:STYPe                | 276 |
| [SOURce<hw>]:EBOX:USER:DATA:TYPE                 | 277 |
| [SOURce<hw>]:EBOX:USER:DIRection                 | 258 |
| [SOURce<hw>]:EBOX:USER:DRATe                     | 263 |
| [SOURce<hw>]:EBOX:USER:FIRMware:SUPPorted?       | 243 |
| [SOURce<hw>]:EBOX:USER:FORMat                    | 264 |
| [SOURce<hw>]:EBOX:USER:ILEaving                  | 265 |

|                                                       |     |
|-------------------------------------------------------|-----|
| [SOURce<hw>]:EBOX:USER:LOGic[:TYPE].....              | 259 |
| [SOURce<hw>]:EBOX:USER:PRESet.....                    | 260 |
| [SOURce<hw>]:EBOX:USER:SCRatio.....                   | 271 |
| [SOURce<hw>]:EBOX:USER:SETTing:CATalog?.....          | 261 |
| [SOURce<hw>]:EBOX:USER:SETTing:DELeTe.....            | 262 |
| [SOURce<hw>]:EBOX:USER:SETTing:LOAD.....              | 262 |
| [SOURce<hw>]:EBOX:USER:SETTing:STORe.....             | 262 |
| [SOURce<hw>]:EBOX:USER:SRATe?.....                    | 265 |
| [SOURce<hw>]:EBOX:USER:SSI:CMDData:RX TX.....         | 283 |
| [SOURce<hw>]:EBOX:USER:SSI:CMSize.....                | 284 |
| [SOURce<hw>]:EBOX:USER:SSI:GAIN:FSElect.....          | 284 |
| [SOURce<hw>]:EBOX:USER:SSI:GAIN:STATe.....            | 284 |
| [SOURce<hw>]:EBOX:USER:SSI:LFSYnc.....                | 284 |
| [SOURce<hw>]:EBOX:USER:SSI:SIZE.....                  | 284 |
| [SOURce<hw>]:EBOX:USER:SSI:SPI:CLOCK:FREQuency.....   | 285 |
| [SOURce<hw>]:EBOX:USER:SSI:SPI:CLOCK:PHASe.....       | 285 |
| [SOURce<hw>]:EBOX:USER:SSI:SPI:CSElect.....           | 285 |
| [SOURce<hw>]:EBOX:USER:SSI:SPI:FSElect.....           | 285 |
| [SOURce<hw>]:EBOX:USER:SSI:SPI:RBYTe?.....            | 286 |
| [SOURce<hw>]:EBOX:USER:SSI:SPI:WBYTe.....             | 286 |
| [SOURce<hw>]:EBOX:USER:STATe.....                     | 261 |
| [SOURce<hw>]:EBOX:USER:TEST:RX:BER?.....              | 277 |
| [SOURce<hw>]:EBOX:USER:TEST:RX:SIGNAL.....            | 278 |
| [SOURce<hw>]:EBOX:USER:TEST:RX:STATe.....             | 278 |
| [SOURce<hw>]:EBOX:USER:TEST:RX:WORDs?.....            | 279 |
| [SOURce<hw>]:EBOX:USER:TEST:TX:SIGNAL.....            | 279 |
| [SOURce<hw>]:EBOX:USER:TEST:TX:SINE:AMPLitude.....    | 280 |
| [SOURce<hw>]:EBOX:USER:TEST:TX:SINE:FREQuency.....    | 281 |
| [SOURce<hw>]:EBOX:USER:TEST:TX:STATe.....             | 281 |
| [SOURce<hw>]:EBOX:USER:TRIGger:ARM.....               | 281 |
| [SOURce<hw>]:EBOX:USER:TRIGger:CStat?.....            | 282 |
| [SOURce<hw>]:EBOX:USER:TRIGger:DELaY.....             | 282 |
| [SOURce<hw>]:EBOX:USER:TRIGger:REStArt.....           | 282 |
| [SOURce<hw>]:EBOX:USER:TRIGger:SOURce.....            | 282 |
| [SOURce<hw>]:EBOX:USER:TRIGger:STATe?.....            | 283 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:CLOCK:PHASe.....      | 267 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:CLOCK:POLarity.....   | 267 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:CLOCK:RATE.....       | 267 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:CLOCK:SKEW:IN.....    | 269 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:CLOCK:SKEW:OUT.....   | 270 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:CLOCK:SOURce.....     | 270 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:DATA:ALIGNment.....   | 272 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:DATA:BORDer.....      | 273 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:DATA:NFORmat.....     | 273 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:DATA:POLarity:IQ..... | 275 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:DATA:SIZE.....        | 275 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:DATA:SPOLarity.....   | 275 |
| [SOURce<hw>]:IQ:OUTPut:EXTErnal:DATA:SPOStion.....    | 276 |

|                                                          |     |
|----------------------------------------------------------|-----|
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:STYPe.....          | 276 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DATA:TYPE.....           | 277 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DIRectiOn.....           | 258 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:DRATe.....               | 263 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:FIRMWare:SUPPorted?..... | 243 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:FORMat.....              | 264 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:ILeaving.....            | 264 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:LOGic[:TYPE].....        | 259 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:SCRatiO.....             | 271 |
| [SOURce<hw>]:IQ:OUTPut:EXtErnal:SRATe?.....              | 265 |
| [SOURce]:BBIN:EXtErnal:CLOCK:PHASe.....                  | 267 |
| [SOURce]:BBIN:EXtErnal:CLOCK:POLarity.....               | 267 |
| [SOURce]:BBIN:EXtErnal:CLOCK:RATE.....                   | 267 |
| [SOURce]:BBIN:EXtErnal:CLOCK:SKEW:IN.....                | 269 |
| [SOURce]:BBIN:EXtErnal:CLOCK:SKEW:OUT.....               | 270 |
| [SOURce]:BBIN:EXtErnal:CLOCK:SOURce.....                 | 270 |
| [SOURce]:BBIN:EXtErnal:DATA:ALIGNment.....               | 272 |
| [SOURce]:BBIN:EXtErnal:DATA:BORDER.....                  | 273 |
| [SOURce]:BBIN:EXtErnal:DATA:NFORMAT.....                 | 273 |
| [SOURce]:BBIN:EXtErnal:DATA:POLarity:IQ.....             | 275 |
| [SOURce]:BBIN:EXtErnal:DATA:SIZE.....                    | 275 |
| [SOURce]:BBIN:EXtErnal:DATA:SPOlarity.....               | 275 |
| [SOURce]:BBIN:EXtErnal:DATA:SPOSitiOn.....               | 276 |
| [SOURce]:BBIN:EXtErnal:DATA:STYPe.....                   | 276 |
| [SOURce]:BBIN:EXtErnal:DATA:TYPE.....                    | 277 |
| [SOURce]:BBIN:EXtErnal:DIRectiOn.....                    | 258 |
| [SOURce]:BBIN:EXtErnal:DRATe.....                        | 263 |
| [SOURce]:BBIN:EXtErnal:FIRMWare:SUPPorted?.....          | 243 |
| [SOURce]:BBIN:EXtErnal:FORMat.....                       | 264 |
| [SOURce]:BBIN:EXtErnal:ILeaving.....                     | 264 |
| [SOURce]:BBIN:EXtErnal:LOGic[:TYPE].....                 | 259 |
| [SOURce]:BBIN:EXtErnal:SCRatiO.....                      | 271 |
| [SOURce]:BBIN:EXtErnal:SRATe?.....                       | 265 |
| [SOURce]:RECEiver:SENDto.....                            | 260 |

# Index

## Symbols

|                        |          |
|------------------------|----------|
| 2's complement         |          |
| CPRI                   | 177, 346 |
| 2's complement 9E2     |          |
| CPRI                   | 177, 346 |
| 3GPP FDD               |          |
| CPRI standard          | 175, 350 |
| 10 MHz reference clock |          |
| CPRI GPIO              | 162, 302 |

## A

|                         |          |
|-------------------------|----------|
| Abort                   |          |
| CPRI recorder           | 211      |
| Accessories             | 24       |
| Tyco Z-Dok connector    | 24       |
| Z2 demo breakout board  | 24       |
| Z6 LVDS cable           | 24       |
| Activate trigger        |          |
| CPRI                    | 189      |
| Alarm                   |          |
| CPRI hardware status    | 298      |
| CPRI L1 analysis        | 152, 167 |
| Amplitude               |          |
| TX test - user defined  | 123, 280 |
| Append                  |          |
| CPRI                    | 173, 337 |
| Application directory   | 35       |
| Application examples    | 47       |
| BB receiver chip test   | 47       |
| CPRI REC test setup     | 49       |
| CPRI RE test setup      | 48       |
| Apply                   |          |
| CPRI                    | 333      |
| Apply warning           |          |
| CPRI                    | 189, 352 |
| ARB                     |          |
| catalog                 | 249      |
| CPRI                    | 173, 205 |
| delete                  | 249      |
| File (CPRI)             | 205      |
| Options (CPRI)          | 206      |
| Options conflict (CPRI) | 207      |
| PEP dBFS (CPRI)         | 207      |
| Reload (CPRI)           | 207      |
| Reset (CPRI)            | 207      |
| Sample rate (CPRI)      | 206      |
| Samples (CPRI)          | 206      |
| State (CPRI)            | 207      |
| Total samples (CPRI)    | 207      |
| ARB catalog             |          |
| CPRI                    | 249      |
| ARB file                |          |
| CPRI                    | 205, 289 |
| ARB options conflict    |          |
| CPRI                    | 289      |
| ARB preset              |          |
| CPRI                    | 288      |
| ARB reload              |          |
| CPRI                    | 288      |
| ARB samples total       |          |
| CPRI                    | 288      |

|                              |          |
|------------------------------|----------|
| ARB settings                 |          |
| CPRI                         | 205      |
| ARB signal conflict          |          |
| CPRI                         | 173, 338 |
| ARB subsystem                |          |
| CPRI                         | 287      |
| ARB toolbox                  |          |
| CPRI recorder                | 212      |
| Architecture of R&S DigiConf | 56       |
| Arm                          |          |
| Software trigger CPRI        | 189      |
| trigger - user defined       | 120, 281 |
| Assigned data rate AxC(s)    |          |
| CPRI                         | 187, 336 |
| Auto                         |          |
| Number of groups (CPRI)      | 182      |
| Available data rate I/Q      |          |
| CPRI                         | 187, 337 |
| AxC(s) / data rate assigned  |          |
| CPRI                         | 339      |
| AxC(s) / data rate available |          |
| CPRI                         | 187, 337 |
| AxC(s) / data rate needed    |          |
| CPRI                         | 180, 340 |
| AxC(s) / data rate status    |          |
| CPRI                         | 181, 341 |
| AxC(s) signal assigned       |          |
| CPRI                         | 181      |
| AxC allocation               |          |
| CPRI                         | 180, 339 |
| AxC Container Definition     |          |
| CPRI                         | 186      |
| AxC group pattern            |          |
| CPRI                         | 183      |
| AxC group state              |          |
| CPRI                         | 183      |
| AxC list                     |          |
| CPRI                         | 342      |
| AxC size (AxC table)         |          |
| CPRI                         | 188, 335 |
| AxCs used                    |          |
| CPRI                         | 333      |
| AxC table                    |          |
| CPRI                         | 188      |

## B

|                                |          |
|--------------------------------|----------|
| Baseband Input Settings        | 87       |
| Base Settings                  |          |
| Logic Type                     | 259      |
| Basic                          |          |
| CPRI Output marker frame width | 163      |
| Basic frame                    |          |
| CPRI GPIO                      | 162, 302 |
| Baudrate                       |          |
| RS232 (CPRI)                   | 197      |
| Binary offset                  |          |
| CPRI                           | 177, 346 |
| Bit address (AxC table)        |          |
| CPRI                           | 188, 334 |
| Bit order                      | 110, 273 |
| DigiConf                       | 110, 273 |



|                              |          |
|------------------------------|----------|
| Bit order LSB                |          |
| parallel .....               | 110      |
| Bit Order LSB                |          |
| parallel .....               | 273      |
| serial .....                 | 110, 273 |
| Bit order MSB                |          |
| parallel .....               | 110      |
| serial .....                 | 110      |
| Bit Order MSB                |          |
| parallel .....               | 273      |
| serial .....                 | 273      |
| Bit rate                     |          |
| CPRI Ethernet .....          | 199, 291 |
| CPRI HDLC .....              | 195, 294 |
| CPRI xxx kbit/s (HDLC) ..... | 195      |
| Breakout board               | 358      |
| Cadence palladium .....      | 364      |
| CPRI .....                   | 367      |
| Customer .....               | 366      |
| Breakout Board               |          |
| Differential .....           | 361      |
| single ended .....           | 359      |
| Breakout board revision      |          |
| CPRI .....                   | 155, 298 |

## C

|                                                                     |          |
|---------------------------------------------------------------------|----------|
| C&M Data .....                                                      | 125      |
| C&M Size .....                                                      | 124      |
| C&M subsystem                                                       |          |
| CPRI .....                                                          | 290      |
| Catalog                                                             |          |
| CPRI .....                                                          | 322      |
| EX-IQ-BOX .....                                                     | 239      |
| user defined .....                                                  | 261      |
| CCDF diagram .....                                                  | 77       |
| CDMA 2000                                                           |          |
| CPRI standard .....                                                 | 175, 350 |
| Change directory .....                                              | 255      |
| Clear                                                               |          |
| CPRI fast C&M .....                                                 | 200      |
| CPRI HDLC .....                                                     | 197, 200 |
| Clock frequency                                                     |          |
| SPI .....                                                           | 125      |
| Clock in skew                                                       |          |
| DigiConf .....                                                      | 118      |
| Clock In skew .....                                                 | 118      |
| Clock phase .....                                                   | 118, 267 |
| DigiConf .....                                                      | 118, 267 |
| Clock polarity                                                      |          |
| DigiConf .....                                                      | 267      |
| negative .....                                                      | 267      |
| positive .....                                                      | 267      |
| Clock Polarity .....                                                | 267      |
| Clock rate .....                                                    | 115, 268 |
| DigiConf .....                                                      | 115, 268 |
| Clock Rate/Sample Rate .....                                        | 108      |
| DigiConf .....                                                      | 108      |
| Clock recovery                                                      |          |
| CPRI .....                                                          | 155, 308 |
| Clock recovery locked                                               |          |
| CPRI reference clock .....                                          | 155, 307 |
| Clock settings                                                      | 115      |
| clock in skew .....                                                 | 118      |
| clock phase .....                                                   | 118      |
| clock rate .....                                                    | 115      |
| clock skew .....                                                    | 118      |
| clock source .....                                                  | 116, 270 |
| Counter .....                                                       | 119      |
| reference frequency .....                                           | 118, 269 |
| sample/clock rate ratio .....                                       | 107      |
| sample rate .....                                                   | 265      |
| Clock settings display .....                                        | 107      |
| DigiConf .....                                                      | 107      |
| Clock setup .....                                                   | 115      |
| clock in skew .....                                                 | 118      |
| clock phase .....                                                   | 118      |
| clock polarity .....                                                | 267      |
| clock rate .....                                                    | 115, 268 |
| clock skew .....                                                    | 118      |
| clock source .....                                                  | 116, 270 |
| reference frequency .....                                           | 269      |
| sample/clock rate ratio .....                                       | 107, 271 |
| samplerate .....                                                    | 265      |
| Clock Setup                                                         |          |
| Clock phase .....                                                   | 267      |
| Clock skew .....                                                    | 118      |
| DigiConf .....                                                      | 118      |
| Clock source .....                                                  | 116, 270 |
| DigiConf .....                                                      | 116, 270 |
| external .....                                                      | 116, 270 |
| internal .....                                                      | 116, 270 |
| Clock subsystem                                                     |          |
| User defined .....                                                  | 266      |
| Clock synthesis locked                                              |          |
| CPRI reference clock .....                                          | 307      |
| CPRI status .....                                                   | 155      |
| CML output voltage swing                                            |          |
| CPRI .....                                                          | 159, 310 |
| Command                                                             |          |
| CPRI Ethernet .....                                                 | 292      |
| CPRI HDLC .....                                                     | 197      |
| Command line                                                        |          |
| CPRI fast C&M .....                                                 | 200      |
| Components                                                          |          |
| accessories .....                                                   | 24       |
| differential breakout board .....                                   | 21       |
| DigiConf .....                                                      | 23       |
| digital standards with WinIQSIM2 .....                              | 23       |
| Digital standards with WinIQSIM2 .....                              | 206      |
| R&S EX-IQ-BOX .....                                                 | 21       |
| R&S instruments .....                                               | 25       |
| single ended breakout board .....                                   | 21       |
| standardized protocols .....                                        | 22       |
| Tyco Z-Dok connector .....                                          | 24       |
| user defined breakout boards .....                                  | 21       |
| user defined protocol options .....                                 | 22       |
| Waveform memory, multi waveform playback and recording memory ..... | 23       |
| Z2 demo breakout board .....                                        | 24       |
| Z3 SCSI II / Palladium .....                                        | 22       |
| Z4 MDR (Mini DeltaRibbon) .....                                     | 22       |
| Z6 LVDS cable .....                                                 | 24       |
| Config                                                              |          |
| transient recorder .....                                            | 71       |
| Configure instrument .....                                          | 70       |
| Conflict (AxC table)                                                |          |
| CPRI .....                                                          | 334      |
| Connecting .....                                                    | 42       |
| breakout board .....                                                | 42       |
| CPRI breakout board .....                                           | 144      |
| DIG I/Q IN/OUT .....                                                | 42       |



|                                       |          |                                  |          |
|---------------------------------------|----------|----------------------------------|----------|
| DUT .....                             | 42       | AxC(s) assigned .....            | 339      |
| power supply .....                    | 42, 144  | AxC(s) signal assigned .....     | 181      |
| REF IN .....                          | 42       | AxC allocation .....             | 180, 339 |
| USB .....                             | 42       | AxC Container Definition .....   | 186      |
| Connector .....                       |          | AxC group pattern .....          | 183      |
| CPRI Ethernet .....                   | 143      | AxC group state .....            | 183      |
| CPRI RS-232-C .....                   | 142      | AxC list .....                   | 342      |
| CPRI SFP .....                        | 142      | AxC Size (AxC table) .....       | 188, 335 |
| CPRI TX/RX .....                      | 142      | AxCs used .....                  | 333      |
| I/Q IN/OUT .....                      | 32       | AxC table .....                  | 188      |
| LAN .....                             | 33       | basic frame .....                | 133      |
| reference signal .....                | 32       | Basic frame graph .....          | 186      |
| TYCO Z-DOK .....                      | 355      | binary offset .....              | 346      |
| Connector type .....                  |          | Binary offset .....              | 177      |
| Cadence palladium .....               | 364      | bit address (AxC table) .....    | 334      |
| Differential .....                    | 361      | Bit address (AxC table) .....    | 188      |
| single ended .....                    | 359      | bit rate (Ethernet) .....        | 291      |
| user interface .....                  | 355      | Bit rate (Ethernet) .....        | 199      |
| Contents .....                        | 60       | bit rate (HDLC) .....            | 294      |
| Control elements and connectors ..... |          | Bit rate (HDLC) .....            | 195      |
| CPRI .....                            | 138, 367 | Bit rate xxx kbit/s (HDLC) ..... | 195      |
| front panel view .....                | 30       | BOB FPGA version .....           | 154      |
| rear panel view .....                 | 32       | breakout board revision .....    | 298      |
| Copy and append .....                 |          | Breakout board revision .....    | 155      |
| CPRI .....                            | 173, 342 | C&M .....                        | 193      |
| Core mode .....                       |          | C&M subsystem .....              | 290      |
| CPRI .....                            | 168, 299 | catalog .....                    | 322      |
| Counter .....                         | 119      | Clear (fast C&M ) .....          | 200      |
| DiglConf .....                        | 119      | Clear (HDLC) .....               | 197, 200 |
| CPRI .....                            | 207      | clock recovery .....             | 308      |
| 2's complement .....                  | 177, 346 | Clock recovery .....             | 155      |
| 2's complement 9E2 .....              | 177, 346 | clock recovery locked .....      | 307      |
| Abort .....                           | 211      | Clock recovery locked .....      | 155      |
| alarm .....                           | 298      | clock synthesis locked .....     | 307      |
| Alarm .....                           | 152, 167 | Clock synthesis locked .....     | 155      |
| append a signal .....                 | 337      | CML output voltage swing .....   | 159, 310 |
| Append a signal .....                 | 173      | command (Ethernet) .....         | 292      |
| apply .....                           | 333      | Command line (fast C&M ) .....   | 200      |
| Apply .....                           | 189      | Command line (HDLC) .....        | 197      |
| Apply warning .....                   | 189      | conflict (AxC table) .....       | 334      |
| apply warning) .....                  | 352      | Connect fast C&M .....           | 200      |
| ARB .....                             | 173      | control word .....               | 133      |
| ARB file .....                        | 205, 289 | Copy and append .....            | 173      |
| ARB level dBFS .....                  | 207      | copy and append a signal .....   | 342      |
| ARBI PEP dBFS .....                   | 207      | core mode .....                  | 299      |
| ARB options .....                     | 206      | Core mode .....                  | 168      |
| ARB options conflict .....            | 207, 289 | crest factor .....               | 342      |
| ARB preset .....                      | 288      | Crest factor .....               | 180      |
| ARB reload .....                      | 207, 288 | Current Rx alarms .....          | 166      |
| ARB reset .....                       | 207      | Data source .....                | 209      |
| ARB sample rate .....                 | 206, 290 | delete .....                     | 322      |
| ARB samples .....                     | 206, 289 | delete a signal .....            | 343      |
| ARB samples total .....               | 288      | Delete a signal .....            | 173      |
| ARB Settings .....                    | 205      | Diagnostics .....                | 203      |
| ARB signal conflict .....             | 173, 338 | differential output swing .....  | 159, 310 |
| ARB state .....                       | 207      | DIG IQ IN .....                  | 173      |
| ARB subsystem .....                   | 287      | DIG IQ OUT .....                 | 174      |
| ARB total samples .....               | 207      | direction GPIO .....             | 301      |
| assigned data rate AxC .....          | 336      | Direction GPIO .....             | 162      |
| Assigned data rate AxC .....          | 187      | Disconnect fast C&M .....        | 200      |
| available data rate I/Q .....         | 337      | Downlink .....                   | 170, 329 |
| Available data rate I/Q .....         | 187      | equalizer gain .....             | 310      |
| AxC(s) / available data rate .....    | 187      | Equalizer gain .....             | 159      |
| AxC(s) / available data rate .....    | 337      | Ethernet .....                   | 197      |
| AxC(s) / data rate assigned .....     | 339      | Ethernet active fast C&M .....   | 199, 291 |
| AxC(s) / data rate needed .....       | 180, 340 | Ethernet bit rate .....          | 199, 291 |
| AxC(s) / data rate status .....       | 181, 341 | Ethernet command .....           | 292      |

|                                       |                    |                                    |               |
|---------------------------------------|--------------------|------------------------------------|---------------|
| Ethernet execute .....                | 292                | HDLC rate .....                    | 166           |
| Ethernet pointer fast C&M .....       | 167, 199, 202, 293 | HDLC RS232 .....                   | 195           |
| Ethernet pointer L1 Analysis .....    | 167, 199, 202      | HDLC source .....                  | 195, 296      |
| Ethernet pointer vendor data .....    | 167, 199, 202      | HDLC state .....                   | 195, 297      |
| Ethernet preferred pointer .....      | 292                | HDLC Terminal .....                | 195           |
| Events .....                          | 169                | High speed serial switch .....     | 159           |
| execute (Ethernet) .....              | 292                | Host fast C&M .....                | 199           |
| EX-IQ-BOX board revision .....        | 154, 300           | hyper frame .....                  | 133           |
| Fast C&M .....                        | 197                | I/Q data interleaving .....        | 187           |
| Fast C&M clear .....                  | 200                | I/Q recorder .....                 | 150           |
| Fast C&M command line .....           | 200                | I/Q resolution .....               | 179, 345      |
| Fast C&M connect .....                | 200                | input .....                        | 303           |
| Fast C&M disconnect .....             | 200                | Input .....                        | 160, 161      |
| fast C&M Ethernet active .....        | 291                | Input/Output .....                 | 161           |
| Fast C&M Ethernet active .....        | 199                | Input window (fast C&M ) .....     | 200           |
| fast C&M Ethernet pointer .....       | 293                | Input window (HDLC) .....          | 197           |
| Fast C&M Ethernet pointer .....       | 167, 199, 202      | internal loopback .....            | 303           |
| Fast C&M execute .....                | 200                | Internal loopback .....            | 160, 161      |
| Fast C&M host .....                   | 199                | internal reference clock .....     | 308           |
| Fast C&M input window .....           | 200                | Internal reference clock .....     | 155           |
| Fast C&M login/logout .....           | 200                | L1 analysis .....                  | 163           |
| Fast C&M logout .....                 | 200                | L1 Analysis Ethernet pointer ..... | 167, 199, 202 |
| Fast C&M password .....               | 200                | L1 analysis subsystem .....        | 312           |
| Fast C&M port .....                   | 199                | L1 inband protocol .....           | 164           |
| Fast C&M pref. Ethernet pointer ..... | 198                | L1 inband protocol version .....   | 165           |
| fast C&M state .....                  | 293                | Line bit rate .....                | 157, 186, 201 |
| Fast C&M state .....                  | 198                | Link settings .....                | 157           |
| File manager .....                    | 152                | List of signals .....              | 172           |
| FPGA base version .....               | 154, 300           | load .....                         | 323           |
| FPGA version .....                    | 154, 300           | load waveform .....                | 289           |
| Frame data .....                      | 176                | Load waveform .....                | 205           |
| frames received (HDLC) .....          | 295                | Local LOF .....                    | 168           |
| Frames received (HDLC) .....          | 197                | Local LOS .....                    | 168           |
| frames sent (HDLC) .....              | 296                | Local RAI .....                    | 168           |
| Frames sent (HDLC) .....              | 196                | LOF .....                          | 168, 306      |
| frame structure .....                 | 133                | Login/logout fast C&M .....        | 200           |
| gain .....                            | 343                | Logout (fast C&M ) .....           | 200           |
| Gain .....                            | 179                | Logout (HDLC) .....                | 200           |
| General purpose I/O .....             | 161                | LOS .....                          | 168, 306      |
| General purpose input/output .....    | 140                | low level BER IQ words .....       | 325           |
| GPIO .....                            | 140                | Low level BER received bits .....  | 193           |
| GPIO 10MHz reference clock .....      | 162, 302           | Low level BER test .....           | 191           |
| GPIO basic frame .....                | 162, 302           | low level BER test state .....     | 290, 324, 325 |
| GPIO direction .....                  | 162, 301           | Main configuration dialog .....    | 150           |
| GPIO hyper frame .....                | 162, 302           | Main controls .....                | 152           |
| GPIO node B frame .....               | 162, 302           | main settings subsystem .....      | 315           |
| GPIO signal .....                     | 162, 302           | mode .....                         | 315           |
| GPIO signal low .....                 | 162, 302           | Mode .....                         | 152           |
| GPIO timing measurement clock .....   | 162, 302           | mode (HDLC) .....                  | 295           |
| GPIO trigger .....                    | 162, 302           | Mode (HDLC) .....                  | 195           |
| Group pattern .....                   | 183                | mode master/slave .....            | 299           |
| Group repetition .....                | 183                | Mode master/slave .....            | 168           |
| Group table .....                     | 183, 186           | Node B frame .....                 | 133           |
| Hardware .....                        | 153, 154           | Number of groups .....             | 182           |
| Hardware subsystem .....              | 297                | Number of groups (Auto) .....      | 182           |
| HDLC active .....                     | 196, 293           | numeric format .....               | 346           |
| HDLC bit rate .....                   | 195, 294           | Numeric format .....               | 177           |
| HDLC clear .....                      | 197, 200           | output .....                       | 304, 305      |
| HDLC command .....                    | 197                | Output .....                       | 160, 161      |
| HDLC execute .....                    | 295                | Output marker frame width .....    | 163           |
| HDLC frames received .....            | 197, 295           | oversampling .....                 | 348           |
| HDLC frames sent .....                | 196, 296           | Oversampling .....                 | 177           |
| HDLC input window .....               | 197                | parameter overview .....           | 138           |
| HDLC logout .....                     | 200                | Password fast C&M .....            | 200           |
| HDLC mode .....                       | 195, 295           | Pattern .....                      | 173           |
| HDLC mode direct .....                | 195, 295           | Pattern length .....               | 177           |
| HDLC mode EN/DE coding .....          | 195, 295           | Physical source .....              | 173           |

|                                       |          |                                      |               |
|---------------------------------------|----------|--------------------------------------|---------------|
| PLL status LED .....                  | 141      | Set to default .....                 | 152           |
| Port fast C&M .....                   | 199      | SFP1 output .....                    | 304           |
| PRBS .....                            | 173      | SFP2 output .....                    | 304           |
| PRBS RX state .....                   | 324      | SFP bit rate .....                   | 204           |
| PRBS Tx state .....                   | 290      | SFP connector type .....             | 204           |
| PRBS TX state .....                   | 325      | SFP diagnostics .....                | 204, 323      |
| Pref. Ethernet pointer fast C&M ..... | 198      | SFP info .....                       | 204, 327      |
| preferred pointer (Ethernet) .....    | 292      | SFP input .....                      | 160, 161, 303 |
| preset .....                          | 315      | SFP LOS .....                        | 204, 327      |
| Preset .....                          | 152      | SFP module alarms .....              | 204           |
| Protocol version .....                | 158      | SFP module temperature .....         | 204           |
| R21 .....                             | 157      | SFP module warnings .....            | 204           |
| recall .....                          | 323      | SFP output .....                     | 160, 161      |
| Recall .....                          | 152      | SFP part number .....                | 204           |
| Received seed .....                   | 158      | SFP Tx/Rx power .....                | 204           |
| Record .....                          | 211      | SFP Tx disabled .....                | 204           |
| Recorder .....                        | 174      | SFP TX disabled .....                | 328           |
| Recorder settings .....               | 207, 316 | SFP Tx fault .....                   | 204           |
| recording length .....                | 209      | SFP TX fault .....                   | 328           |
| Recording status .....                | 210      | SFP Vcc .....                        | 204           |
| Recording time .....                  | 210      | SFP vendor .....                     | 204           |
| REC test .....                        | 152, 315 | SFP wavelength .....                 | 204           |
| Reference clock .....                 | 155      | Show/Hide group details .....        | 181           |
| reference clock source .....          | 308      | Show/Hide signal details .....       | 177           |
| Reference clock source .....          | 155      | signal data rate assigned .....      | 341           |
| reference output locked .....         | 308      | signal data rate needed .....        | 341           |
| Reference output locked .....         | 155      | Signal definition .....              | 172           |
| REF IN .....                          | 155, 308 | signal GPIO .....                    | 302           |
| Remote control commands .....         | 286      | Signal GPIO .....                    | 162           |
| Remote LOF .....                      | 169      | signal name .....                    | 346           |
| Remote LOS .....                      | 169      | Signal name .....                    | 173           |
| Remote RAI .....                      | 169      | Signal output .....                  | 174           |
| Remote Reset .....                    | 169      | signals active .....                 | 338           |
| Remote SDI .....                      | 169      | signal state .....                   | 352           |
| RE reset .....                        | 170, 328 | Signal state .....                   | 173           |
| Reset Rx BER .....                    | 193      | SMA input .....                      | 160, 161, 303 |
| RE test .....                         | 152, 315 | SMA output .....                     | 160, 161, 305 |
| rms level .....                       | 348      | SMA settings .....                   | 158           |
| Rms level .....                       | 180      | Software trigger armed .....         | 189           |
| RS232 baudrate .....                  | 197      | Software trigger run .....           | 189           |
| RS232 data bits .....                 | 197      | Source (AxC table) .....             | 188           |
| RS232 parity .....                    | 197      | source (HDLC) .....                  | 296           |
| RS232 stop bit .....                  | 197      | Source (HDLC) .....                  | 195           |
| Rx alarm LOS .....                    | 166      | standard digital signal .....        | 350           |
| RX alarm LOS .....                    | 326      | Standard digital signal .....        | 175           |
| Rx alarms LOF .....                   | 166      | Start condition .....                | 188           |
| RX alarms LOF .....                   | 325      | State .....                          | 152           |
| Rx alarms RAI .....                   | 166      | state fast C&M .....                 | 293           |
| RX alarms RAI .....                   | 326, 327 | State fast C&M .....                 | 198           |
| Rx alarms reset .....                 | 166      | state HDLC .....                     | 297           |
| RX alarms reset .....                 | 326      | State HDLC .....                     | 195           |
| Rx alarms SDI .....                   | 166      | state vendor data .....              | 353           |
| Rx BER .....                          | 193      | State vendor data .....              | 201           |
| RX BER .....                          | 324      | Static frame .....                   | 173           |
| Rx equalizer .....                    | 159      | status all AxCs) .....               | 336           |
| RX equalizer .....                    | 310      | status LEDs .....                    | 140           |
| sample rate .....                     | 349      | subchannel .....                     | 133           |
| Sample rate .....                     | 176, 210 | Sync pattern .....                   | 173           |
| save .....                            | 323      | T14 .....                            | 157           |
| Save .....                            | 152, 211 | Target file .....                    | 211           |
| Scrambling seed .....                 | 158      | timing valid .....                   | 311           |
| SDI (SAP defect indication) .....     | 169, 329 | TOffset .....                        | 157           |
| select receiver .....                 | 303      | top view .....                       | 140           |
| Select receiver .....                 | 160, 161 | transmission protocol overview ..... | 129           |
| select tansmitter .....               | 304, 305 | Trigger position .....               | 209           |
| Select transmitter .....              | 160, 161 | Tx level adjustment .....            | 159           |
| set to default .....                  | 315      |                                      |               |

|                                            |               |                                     |          |
|--------------------------------------------|---------------|-------------------------------------|----------|
| TX level adjustment .....                  | 310           | CPRI SFP .....                      | 142      |
| Uplink .....                               | 170, 329      | connector .....                     | 142      |
| Vendor data .....                          | 200, 203, 352 | interface .....                     | 142      |
| vendor data downlink CPRI RE .....         | 353           | CPRI standard .....                 |          |
| Vendor data downlink CPRI RE .....         | 201           | 3GPP FDD .....                      | 175, 350 |
| vendor data downlink CPRI REC .....        | 353           | CDMA 2000 .....                     | 175, 350 |
| Vendor data downlink CPRI REC .....        | 201           | GSM/EDGE .....                      | 175, 350 |
| Vendor data Ethernet pointer .....         | 167, 199, 202 | LTE .....                           | 175, 350 |
| vendor data state .....                    | 353           | sync pattern .....                  | 350      |
| Vendor data state .....                    | 201           | user defined .....                  | 350      |
| Vendor data table .....                    | 203           | User defined .....                  | 175      |
| vendor data uplink CPRI RE .....           | 353           | WiMAX .....                         | 175, 350 |
| Vendor data uplink CPRI RE .....           | 201           | CPRI test .....                     |          |
| vendor data uplink CPRI REC .....          | 353           | diagnostic .....                    | 245      |
| Vendor data uplink CPRI REC .....          | 201           | CPRI Test& Diagnostics .....        |          |
| vendor word width .....                    | 353           | SFP diagnostics .....               | 323      |
| Vendor word width .....                    | 202           | CPRI top view .....                 |          |
| View .....                                 | 212           | general purpose IO connectors ..... | 140      |
| wave file .....                            | 338           | PLL LED .....                       | 141      |
| Wave file .....                            | 176           | POWER LED .....                     | 141      |
| Waveform memory .....                      | 150           | RX LED .....                        | 141      |
| word address (AxC table) .....             | 336           | TX LED .....                        | 141      |
| Word address (AxC table) .....             | 188           | CPRI TX/RX .....                    | 142      |
| Word length .....                          | 186           | connector .....                     | 142      |
| CPRI breakout board .....                  | 367           | interface .....                     | 142      |
| CPRI communication link .....              |               | CPRI Viewer .....                   |          |
| status .....                               | 140           | CPRI recorder .....                 | 212      |
| CPRI connectors .....                      |               | Create directory .....              | 256      |
| GPIO .....                                 | 140           | Crest factor .....                  |          |
| CPRI connector type .....                  |               | CPRI .....                          | 180, 342 |
| Ethernet .....                             | 367           | Current Rx alarms .....             |          |
| RS-232-C .....                             | 367           | CPRI .....                          | 166      |
| SFP .....                                  | 367           |                                     |          |
| SMA .....                                  | 367           | <b>D</b> .....                      |          |
| User interface .....                       | 367           | Data bits .....                     |          |
| CPRI control elements and connectors ..... | 138, 367      | RS232 (CPRI) .....                  | 197      |
| front panel .....                          | 141           | Data rate .....                     | 102, 263 |
| rear panel .....                           | 141           | DigiConf .....                      | 102, 263 |
| top view .....                             | 140           | double .....                        | 102, 263 |
| CPRI Diagnostics .....                     |               | Data Rate .....                     |          |
| SFP diagnostics .....                      | 204           | Single .....                        | 258      |
| CPRI Ethernet .....                        | 143           | Data settings .....                 | 107, 108 |
| connector .....                            | 143           | DigiConf .....                      | 107      |
| interface .....                            | 143           | signal type .....                   | 108      |
| CPRI front view .....                      |               | word size .....                     | 109, 275 |
| CPRI Ethernet connector .....              | 143           | Data Settings .....                 |          |
| CPRI RS-232-C connector .....              | 142           | I/Q Polarity .....                  | 275      |
| CPRI SFP modules .....                     | 142           | Data setup .....                    | 108      |
| CPRI TX/RX connector .....                 | 142           | bit order .....                     | 110, 273 |
| CPRI Output marker frame width .....       |               | data type .....                     | 277      |
| Basic .....                                | 163           | numeric format .....                | 112, 273 |
| Hyper .....                                | 163           | signal type .....                   | 276      |
| Node B .....                               | 163           | strobe polarity .....               | 113, 275 |
| CPRI protocol version .....                |               | strobe position .....               | 114, 276 |
| CPRI L1 inband analysis .....              | 165           | word alignment .....                | 109, 272 |
| CPRI rear panel .....                      |               | word size .....                     | 275      |
| user interface .....                       | 141           | Data Setup .....                    |          |
| CPRI recorder .....                        | 316           | I/Q Polarity .....                  | 275      |
| Discard .....                              | 211           | numeric format .....                | 273      |
| Trigger source .....                       | 209           | Data source .....                   |          |
| CPRI reference signal .....                |               | CPRI recorder .....                 | 209      |
| input .....                                | 140           | Data subsystem .....                |          |
| CPRI RS-232-C .....                        | 142           | user defined .....                  | 271      |
| connector .....                            | 142           | Data tab .....                      | 108      |
| interface .....                            | 142           |                                     |          |

Data type ..... 277  
 DiglConf ..... 277  
 PFSAMPles ..... 277  
 SAMPles ..... 277  
 DDR ..... 102, 263  
 Delay  
   trigger - user defined ..... 120, 282  
 Delete ..... 255  
   ARB ..... 249  
   CPRI ..... 322  
   user defined ..... 262  
 Delete a seignal  
   CPRI ..... 343  
 Delete a signal  
   CPRI ..... 173  
 Delivery list ..... 29  
 Device  
   Subsystem ..... 239  
 Device driver ..... 42  
 Device ID  
   Device manager ..... 67  
 Device manager ..... 65  
   Device ID ..... 67  
   Enter license key ..... 68  
   EX-IQ-BOX device ..... 66  
   Export license key ..... 68  
   Hardware ..... 66  
   Import license key ..... 68  
   Installed options ..... 68  
   Options ..... 67  
   Status information ..... 68  
   Update firmware ..... 68  
 Diagnostic  
   CPRI test ..... 245  
   EX-IQ-BOX catalog ..... 244  
   save CPRI test report ..... 245  
   select EX-IQ-BOX ..... 248  
   Subsystem ..... 244  
 Diagnostics  
   CPRI ..... 203  
   CPRI SFP ..... 323  
 Dialogs ..... 57  
 Differential output swing  
   CPRI ..... 159, 310  
 DiglConf ..... 23  
   Application window ..... 36  
   bit order ..... 110, 273  
   Block diagram ..... 62  
   clock in skew ..... 118  
   clock phase ..... 118, 267  
   clock polarity ..... 267  
   clock rate ..... 115, 268  
   clock rate/sample rate ..... 108  
   clock settings display ..... 107  
   clock skew ..... 118  
   clock source ..... 116, 270  
   Counter ..... 119  
   data rate ..... 102, 263  
   data settings ..... 107  
   data type ..... 277  
   direction ..... 99, 258  
   display ..... 54  
   Download ..... 23, 53  
   format ..... 101, 264  
   I/Q polarity ..... 275  
   interleaving ..... 104, 265

load ..... 100  
 logic type ..... 99, 259  
 numeric format ..... 112, 273  
 preset ..... 260  
 reference frequency ..... 118, 269  
 sample/clock rate ratio ..... 107  
 Sample/Clock rate ratio ..... 271  
 sample rate ..... 265  
 save ..... 100  
 set to default ..... 260  
 signal type ..... 108, 276  
 Simulation mode ..... 23  
 strobe polarity ..... 113, 275  
 strobe position ..... 114, 276  
 user defined state ..... 261  
 winbar ..... 57  
 word alignment ..... 109, 272  
 word size ..... 109, 275  
 DIG IQ IN  
   CPRI ..... 173  
 DIG IQ OUT  
   CPRI ..... 174  
 Digital baseband input ..... 32  
 Digital baseband output ..... 32  
 Digital interface  
   I/Q IN ..... 32  
   I/Q OUT ..... 32  
   status LEDs ..... 30  
 Direction ..... 99  
   CPRI GPIO ..... 162, 301  
   DiglConf ..... 99, 258  
   receiver ..... 99, 258  
   transmitter ..... 99, 258  
 Directory ..... 255  
 Discard  
   CPRI recorder ..... 211  
 Downlink  
   CPRI ..... 170, 329

## E

EBOX  
   Device subsystem ..... 239  
   Diagnostic subsystem ..... 244  
   instrument subsystem ..... 251  
   subsystem ..... 248  
 Enable automatic gain ..... 125  
 Enter license key  
   Device manager ..... 68  
 Equalizer gain  
   CPRI ..... 159, 310  
 Error indication ..... 31  
 Error LED ..... 31  
 Error queue query ..... 238  
 Ethernet active  
   CPRI fast C&M ..... 199, 291  
 Ethernet pointer  
   CPRI fast C&M ..... 167, 199, 202, 293  
   CPRI L1 Analysis ..... 167, 199, 202  
   CPRI vendor data ..... 167, 199, 202  
 Ethernet pointer pref.  
   CPRI fast C&M ..... 198  
 Events  
   CPRI ..... 169  
 Execute  
   CPRI Ethernet ..... 292  
   CPRI HDLC ..... 295

- EXIQ
  - general commands ..... 239
- EX-IQ-BOX
  - ARB file dialog ..... 205, 289
  - catalog ..... 239
  - diagnostic ..... 244
  - instrument name ..... 251
  - instrument port ..... 252
  - instrument serial number ..... 252
  - instrument type ..... 252
  - options ..... 250
  - select device ..... 244, 251
  - state ..... 251
- EX-IQ-Box BBIN
  - bit order ..... 273
  - Clock phase ..... 267
  - clock polarity ..... 267
  - clock rate ..... 268
  - clock source ..... 270
  - data type ..... 277
  - I/Q Polarity ..... 275
  - Logic Type ..... 259
  - numeric format ..... 273
  - sample/clock rate ratio ..... 271
  - signal type ..... 276
  - word alignment ..... 272
- EX-IQ-BOX BBIN ..... 99, 258
  - bit order ..... 110
  - C&M data ..... 125
  - C&M size ..... 124
  - Chip select ..... 126
  - Clock frequency ..... 125
  - clock in skew ..... 118
  - clock phase ..... 118
  - Clock phase ..... 125
  - clock rate ..... 115
  - clock rate/sample rate ..... 108
  - clock settings display ..... 107
  - clock setup ..... 115
  - clock skew ..... 118
  - clock source ..... 116
  - data rate ..... 102, 263
  - data settings ..... 107
  - data tab ..... 108
  - direction ..... 99
  - Enable automatic gain ..... 125
  - format ..... 101, 264
  - Gain file ..... 125
  - interleaving ..... 104, 265
  - Late frame sync ..... 125
  - logic type ..... 99
  - numeric format ..... 112
  - protocol tab ..... 100
  - RX test - IQ words ..... 124, 279
  - RX test - Rx BER ..... 124, 277
  - RX test - signal ..... 123, 278
  - RX test - state ..... 123, 278
  - sample/clock rate ratio ..... 107
  - sample rate ..... 265
  - signal type ..... 108
  - SPI setup ..... 125
  - SSI setup ..... 124
  - strobe polarity ..... 113, 275
  - strobe position ..... 114, 276
  - TX test - signal ..... 121, 279
  - TX test - sine amplitude ..... 123, 280
  - TX test - sine frequency ..... 123, 281
  - TX test - state ..... 281
  - TX test- state ..... 121
  - word alignment ..... 109
  - word size ..... 109, 275
  - Word size ..... 124
  - Write byte ..... 126
- TX test - sine frequency ..... 123, 281
- TX test - state ..... 121, 281
- word alignment ..... 109
- word size ..... 109, 275
- Word size (SSI) ..... 124
- Write byte ..... 126
- EX-IQ-Box BBOUT
  - bit order ..... 273
  - Clock phase ..... 267
  - clock polarity ..... 267
  - clock rate ..... 268
  - clock source ..... 270
  - data type ..... 277
  - I/Q Polarity ..... 275
  - Logic Type ..... 259
  - numeric format ..... 273
  - sample/clock rate ratio ..... 271
  - signal type ..... 276
  - word alignment ..... 272
- EX-IQ-BOX BBOUT ..... 99, 258
  - bit order ..... 110
  - C&M data ..... 125
  - C&M size ..... 124
  - Chip select ..... 126
  - Clock frequency ..... 125
  - clock in skew ..... 118
  - clock phase ..... 118
  - Clock phase ..... 125
  - clock rate ..... 115
  - clock rate/sample rate ..... 108
  - clock settings display ..... 107
  - clock setup ..... 115
  - clock skew ..... 118
  - clock source ..... 116
  - data rate ..... 102, 263
  - data settings ..... 107
  - data tab ..... 108
  - data type ..... 277
  - direction ..... 99
  - format ..... 101, 264
  - interleaving ..... 104, 265
  - Late frame sync ..... 125
  - logic type ..... 99
  - numeric format ..... 112
  - protocol tab ..... 100
  - RX test - IQ words ..... 124, 279
  - RX test - Rx BER ..... 124, 277
  - RX test - signal ..... 123, 278
  - RX test - state ..... 278
  - RX test- state ..... 123
  - sample/clock rate ratio ..... 107
  - sample rate ..... 265
  - signal type ..... 108, 276
  - SPI setup ..... 125
  - SSI setup ..... 124
  - strobe polarity ..... 113, 275
  - strobe position ..... 114, 276
  - TX test - signal ..... 121, 279
  - TX test - sine amplitude ..... 123, 280
  - TX test - sine frequency ..... 123, 281
  - TX test - state ..... 281
  - TX test- state ..... 121
  - word alignment ..... 109
  - word size ..... 109, 275
  - Word size ..... 124
  - Write byte ..... 126

|                          |          |
|--------------------------|----------|
| EX-IQ-BOX board revision |          |
| CPRI                     | 154, 300 |
| EX-IQ-BOX device         |          |
| Device manager           | 66       |
| EX-IQ-Box Receiver       |          |
| Clock Phase              | 267      |
| clock polarity           | 267      |
| clock source             | 270      |
| EX-IQ-Box REceiver       |          |
| bit order                | 273      |
| I/Q Polarity             | 275      |
| Logic Type               | 259      |
| numeric format           | 112, 273 |
| Send to                  | 260      |
| word alignment           | 272      |
| EX-IQ-BOX receiver       |          |
| Enable automatic gain    | 125      |
| EX-IQ-BOX Receiver       |          |
| Gain file                | 125      |
| EX-IQ-BOX REceiver       |          |
| bit order                | 110      |
| clock rate/sample rate   | 108      |
| clock settings display   | 107      |
| data rate                | 102, 263 |
| data settings            | 107      |
| data type                | 277      |
| format                   | 101, 264 |
| interleaving             | 104, 265 |
| logic type               | 99       |
| Send to                  | 94       |
| signal type              | 108, 276 |
| strobe polarity          | 113, 275 |
| strobe position          | 114, 276 |
| word alignment           | 109      |
| word size                | 109, 275 |
| EXIQ-Box Settings        | 92       |
| EX-IQ-Box Transmitter    |          |
| Clock Phase              | 267      |
| clock polarity           | 267      |
| clock source             | 270      |
| EX-IQ-Box TRANsmitter    |          |
| bit order                | 273      |
| I/Q Polarity             | 275      |
| Logic Type               | 259      |
| numeric format           | 112, 273 |
| Send to                  | 260      |
| word alignment           | 272      |
| EX-IQ-BOX TRANsmitter    |          |
| bit order                | 110      |
| clock rate/sample rate   | 108      |
| clock settings display   | 107      |
| data rate                | 102, 263 |
| data settings            | 107      |
| data type                | 277      |
| format                   | 101, 264 |
| interleaving             | 104, 265 |
| logic type               | 99       |
| Send to                  | 94       |
| signal type              | 108, 276 |
| strobe polarity          | 113, 275 |
| strobe position          | 114, 276 |
| word alignment           | 109      |
| word size                | 109, 275 |
| Export license key       |          |
| Device manager           | 68       |

## F

|                        |          |
|------------------------|----------|
| FFT diagram            | 78       |
| File                   | 55, 58   |
| CPRI ARB               | 205, 289 |
| exit                   | 58       |
| menu                   | 58       |
| new                    | 58       |
| open                   | 58       |
| save                   | 58       |
| save as                | 58       |
| File list              | 254      |
| File management        |          |
| CPRI ARB               | 205, 289 |
| File manager           | 152      |
| CPRI                   | 152      |
| File menu              | 55       |
| Firmware update        |          |
| Device manager         | 68       |
| Format                 | 101, 264 |
| DiglConf               | 101, 264 |
| parallel               | 101, 264 |
| serial                 | 101, 264 |
| FPGA base version      |          |
| CPRI                   | 154, 300 |
| FPGA version           |          |
| CPRI                   | 154, 300 |
| Frame data             |          |
| CPRI                   | 176      |
| Frames received        |          |
| CPRI HDLC              | 197, 295 |
| Frames sent            |          |
| CPRI HDLC              | 196, 296 |
| Free run               |          |
| CPRI recording status  | 210      |
| Frequency              | 118      |
| TX test - user defined | 123, 281 |
| Front panel            | 30       |
| breakout board         | 30       |
| CPRI breakout board    | 141      |
| DIG I/Q IN/OUT 1       | 30       |
| DIG I/Q IN/OUT 2       | 30       |
| ERROR LED              | 31       |
| MODE LED               | 31       |
| PLL                    | 30       |
| status LEDs            | 30       |
| user interface         | 31       |

## G

|                                 |          |
|---------------------------------|----------|
| Gain                            |          |
| CPRI                            | 179, 343 |
| Gain file                       | 125      |
| General commands                |          |
| EX-IQ-BOX                       | 239      |
| General information             |          |
| CPRI                            | 154      |
| General Purpose I/O             |          |
| CPRI                            | 161      |
| General purpose input/output    |          |
| CPRI                            | 140      |
| Getting started                 | 26       |
| connecting the EX-IQ-BOX        | 42       |
| control elements and connectors | 29       |
| Installing DiglConf             | 34       |
| Installing EX-IQ-BOX options    | 44       |



|                                      |          |
|--------------------------------------|----------|
| safety instructions .....            | 26       |
| Unpacking .....                      | 29       |
| GPIO                                 |          |
| CPRI .....                           | 140      |
| GPIO Direction                       |          |
| CPRI .....                           | 162, 301 |
| GPIO Signal                          |          |
| CPRI .....                           | 162, 302 |
| Group pattern                        |          |
| CPRI .....                           | 183      |
| Group repetition                     |          |
| CPRI .....                           | 183      |
| Group table                          |          |
| CPRI .....                           | 183, 186 |
| GSM/EDGE                             |          |
| CPRI standard .....                  | 175, 350 |
| <b>H</b>                             |          |
| Hardware                             |          |
| CPRI .....                           | 153      |
| CPRI GPIO .....                      | 161      |
| CPRI high speed serial switch .....  | 159      |
| CPRI Input/Output .....              | 161      |
| CPRI link settings .....             | 157      |
| CPRI Output marker frame width ..... | 163      |
| CPRI reference clock .....           | 155      |
| CPRI SMA settings .....              | 158      |
| Device manager .....                 | 66       |
| General information (CPRI) .....     | 154      |
| Hardware components .....            | 24, 25   |
| Hardware subsystem                   |          |
| CPRI .....                           | 297      |
| HDLC active                          |          |
| CPRI .....                           | 196, 293 |
| HDLC command                         |          |
| CPRI Ethernet .....                  | 197      |
| HDLC execute                         |          |
| CPRI Ethernet .....                  | 295      |
| Help .....                           | 60       |
| contents .....                       | 60       |
| index .....                          | 60       |
| menu .....                           | 60       |
| Hide taskbar .....                   | 70       |
| High speed serial switch             |          |
| CPRI .....                           | 159      |
| Host                                 |          |
| CPRI fast C&M .....                  | 199      |
| Hyper                                |          |
| CPRI Output marker frame width ..... | 163      |
| <b>I</b>                             |          |
| I/Q data interleaving                |          |
| CPRI .....                           | 187      |
| I/Q diagram .....                    | 75       |
| I/Q IN .....                         | 32       |
| I/Q IN/OUT                           |          |
| connector .....                      | 32       |
| LED .....                            | 32       |
| I/Q OUT .....                        | 32       |
| I/Q Output Settings .....            | 87       |
| I/Q polarity                         |          |
| DigIConf .....                       | 275      |
| I/Q Polarity .....                   | 275      |
| Negative .....                       | 275      |
| Positive .....                       | 275      |

|                                               |               |
|-----------------------------------------------|---------------|
| I/Q resolution                                |               |
| CPRI .....                                    | 179, 345      |
| Idle                                          |               |
| CPRI recording status .....                   | 210           |
| Import license key                            |               |
| Device manager .....                          | 68            |
| Index .....                                   | 60            |
| Indication                                    |               |
| Connected Device .....                        | 85            |
| DIG I/Q IN labeled symbol, generator .....    | 85            |
| DIG I/Q OUT labeled symbol, generator .....   | 85            |
| ExBox status parameters, analyzer .....       | 90            |
| EX-IQ-BOX labeled symbol, generator .....     | 85            |
| EX-IQ-Box Settings, generator .....           | 85            |
| EXIQ hotkey .....                             | 90            |
| R&S signal analyzer's diagram .....           | 90            |
| R&S signal generator's block diagram .....    | 85            |
| R&S signal generator's settings dialogs ..... | 85            |
| Info                                          |               |
| Hardware device manager .....                 | 66            |
| Input                                         |               |
| CPRI .....                                    | 160, 161, 303 |
| CPRI GPIO .....                               | 162, 301      |
| I/Q IN .....                                  | 32            |
| REF IN .....                                  | 32            |
| Input/Output                                  |               |
| CPRI .....                                    | 161           |
| Input window                                  |               |
| CPRI fast C&M .....                           | 200           |
| CPRI HDLC .....                               | 197           |
| Installed Options                             |               |
| Device manager .....                          | 68            |
| Installing DigIConf                           |               |
| Destination location .....                    | 35            |
| Hardware requirements .....                   | 34            |
| Installing .....                              | 35            |
| Setup file .....                              | 35            |
| Software requirements .....                   | 34            |
| uninstall .....                               | 38            |
| Installing options                            |               |
| Enter key code .....                          | 44            |
| Indicate installed options .....              | 44            |
| Installing .....                              | 44            |
| Installing several options .....              | 44            |
| Prerequisites .....                           | 34, 44        |
| Start DigIConf .....                          | 34, 44        |
| Instrument .....                              | 70            |
| subsystem .....                               | 251           |
| Instrument name                               |               |
| EX-IQ-BOX .....                               | 251           |
| Instrument port                               |               |
| EX-IQ-BOX .....                               | 252           |
| Instrument serial number                      |               |
| EX-IQ-BOX .....                               | 252           |
| Instrument settings                           |               |
| change directory .....                        | 255           |
| create directory .....                        | 256           |
| delete .....                                  | 255           |
| recall .....                                  | 255           |
| remove directory .....                        | 256           |
| save .....                                    | 238, 256      |
| Instrument type                               |               |
| EX-IQ-BOX .....                               | 252           |
| Interface                                     |               |
| CPRI Ethernet .....                           | 143           |
| CPRI RS-232-C .....                           | 142           |
| CPRI SFP .....                                | 142           |



|                              |               |
|------------------------------|---------------|
| CPRI TX/RX .....             | 142           |
| LAN .....                    | 33            |
| Interfaces .....             | 355           |
| Interleaving .....           | 104, 265      |
| DigiConf .....               | 104, 265      |
| I/Q Interleaved .....        | 104, 265      |
| Not Interleaved .....        | 104, 265      |
| Q/I Interleaved .....        | 104, 265      |
| Internal loopback            |               |
| CPRI input .....             | 160, 161, 303 |
| Internal reference clock     |               |
| CPRI .....                   | 155, 308      |
| IQ words                     |               |
| RX test - user defined ..... | 124, 279      |

## L

|                                |          |
|--------------------------------|----------|
| L1 analysis                    |          |
| CPRI .....                     | 163      |
| HDLC rate (CPRI) .....         | 166      |
| L1 analysis subsystem          |          |
| CPRI .....                     | 312      |
| L1 inband protocol             |          |
| CPRI .....                     | 164      |
| CPRI protocol version .....    | 165      |
| HDLC rate (CPRI) .....         | 166      |
| LAN .....                      | 33       |
| connector .....                | 33       |
| interface .....                | 33       |
| Pin assignment .....           | 357      |
| Late frame sync .....          | 125      |
| LED                            |          |
| CPRI status .....              | 140      |
| error .....                    | 31       |
| I/Q IN/OUT .....               | 32       |
| mode .....                     | 31       |
| Power .....                    | 34, 42   |
| status .....                   | 30       |
| Level dBFS                     |          |
| CPRI ARB .....                 | 207      |
| Line bit rate                  |          |
| CPRI .....                     | 157      |
| CPRI 2x 1228.8 Mbit/s .....    | 157      |
| CPRI 4x 2457.6 Mbit/s .....    | 157      |
| CPRI 5x 3072.0 Mbit/s .....    | 157      |
| CPRI vendor data .....         | 201      |
| Link settings                  |          |
| CPRI .....                     | 157      |
| Link status .....              | 167      |
| List of signals                |          |
| CPRI DL/UL .....               | 172      |
| Load .....                     | 262, 323 |
| CPRI .....                     | 323      |
| DigiConf .....                 | 100      |
| user defined .....             | 262      |
| Load instrument settings ..... | 255      |
| Local                          |          |
| LOF (CPRI) .....               | 168      |
| LOS (CPRI) .....               | 168      |
| RAI (CPRI) .....               | 168      |
| LOF                            |          |
| CPRI Rx alarms .....           | 166      |
| CPRI RX alarms .....           | 325      |
| CPRI status .....              | 168, 306 |
| Local .....                    | 168      |
| Remote .....                   | 169      |

|                                  |          |
|----------------------------------|----------|
| Logic type                       |          |
| CMOS .....                       | 99       |
| DigiConf .....                   | 99, 259  |
| LVDS .....                       | 99       |
| LVTTTL .....                     | 99       |
| SSI .....                        | 99       |
| Logic Type .....                 | 259      |
| 1.5V CMOS .....                  | 259      |
| 1.5V SSI .....                   | 259      |
| 1.8V CMOS .....                  | 259      |
| 1.8V SSI .....                   | 259      |
| 2.5V CMOS .....                  | 259      |
| 3.3V CMOS .....                  | 259      |
| LVDS .....                       | 259      |
| LVTTTL .....                     | 259      |
| Login/logout                     |          |
| CPRI fast C&M .....              | 200      |
| Logout                           |          |
| CPRI fast C&M .....              | 200      |
| CPRI HDLC .....                  | 200      |
| LOS                              |          |
| CPRI Rx alarms .....             | 166      |
| CPRI RX alarms .....             | 326      |
| CPRI status .....                | 168, 306 |
| Local .....                      | 168      |
| Remote .....                     | 169      |
| Low level BER test               |          |
| CPRI .....                       | 191      |
| Low level BER test IQ words      |          |
| CPRI .....                       | 325      |
| Low level BER test received bits |          |
| CPRI .....                       | 193      |
| Low level BER test RX state      |          |
| CPRI .....                       | 324      |
| Low level BER test TX state      |          |
| CPRI .....                       | 325      |
| LTE                              |          |
| CPRI standard .....              | 175, 350 |

## M

|                              |          |
|------------------------------|----------|
| Main application window      |          |
| toolbar .....                | 55       |
| Main controls                |          |
| CPRI .....                   | 152      |
| user defined .....           | 258      |
| Main settings                |          |
| clock rate/sample rate ..... | 108      |
| clock settings display ..... | 107      |
| data rate .....              | 102, 263 |
| data settings .....          | 107      |
| format .....                 | 101, 264 |
| interleaving .....           | 104, 265 |
| logic type .....             | 99       |
| Main settings subsystem      |          |
| CPRI .....                   | 315      |
| Master                       |          |
| CPRI mode .....              | 168, 299 |
| Menu .....                   | 55       |
| Menu bar .....               | 55       |
| Menus                        |          |
| file .....                   | 58       |
| File .....                   | 55       |
| help .....                   | 60       |
| tools .....                  | 59       |
| MMEemory                     |          |
| subsystem .....              | 253      |

- Mode
  - CPRI ..... 152, 315
  - CPRI HDLC ..... 195, 295
  - CPRI status ..... 168, 299
- Mode indication ..... 31
- Mode LED ..... 31
- Multi waveform playback ..... 19
- N**
- Node B
  - CPRI Output marker frame width ..... 163
- Node B frame
  - CPRI GPIO ..... 162, 302
- Number of groups
  - CPRI ..... 182
- Numeric format ..... 273
  - 2's complement ..... 273
  - 2's Complement ..... 112
  - binary offset ..... 273
  - Binary Offset ..... 112
  - CPRI ..... 177, 346
  - DigiConf ..... 112, 273
  - user defined ..... 112
- O**
- Open file ..... 58
  - look in ..... 58
- Operation complete
  - remote ..... 237
- Option
  - Check the installed ..... 46
  - CPRI ARB settings ..... 206
- Option identification
  - remote ..... 237
- Options ..... 22
  - 1xEV-DO REV.A ..... 23
  - 3GPP FDD ..... 23
  - 3GPP FDD Enhanced ..... 23
  - 3GPP FDD HSUPA ..... 23
  - CDMA 2000 incl. 1xEV-DV ..... 23
  - CPRI ..... 22
  - CPRI RE ..... 22
  - CPRI REC ..... 22
  - Device manager ..... 67
  - differential breakout board ..... 21
  - EDGE Evolution ..... 23
  - EUTRA/LTE ..... 23
  - EX-IQ-BOX ..... 250
  - GSM/EDGE ..... 23
  - HSPA+ ..... 23
  - IEEE 802.11n (WLAN-N) ..... 23
  - IEEE 802.16 (WiMAX) ..... 23
  - multi waveform playback ..... 23
  - recording memory ..... 23
  - single ended breakout board ..... 21
  - TD-SCDMA ..... 23
  - TD-SCDMA Enhanced ..... 23
  - Tyco Z-Dok connector ..... 24
  - user defined protocols ..... 22
  - waveform memory 64 MS ..... 23
  - Z2 demo breakout board ..... 24
  - Z3 SCSI II / Palladium ..... 22
  - Z4 MDR (Mini DeltaRibbon) ..... 22
  - Z6 LVDS cable ..... 24
- Options conflict
  - CPRI ARB settings ..... 207
- Output
  - CPRI ..... 160, 161, 304, 305
  - CPRI GPIO ..... 162, 301
  - I/Q OUT ..... 32
- Output marker frame width
  - CPRI ..... 163
- Oversampling
  - CPRI ..... 177, 348
- P**
- Parity
  - RS232 (CPRI) ..... 197
- Password
  - CPRI fast C&M ..... 200
- Pattern
  - CPRI ..... 173
- Pattern length
  - CPRI ..... 177
- PEP dBFS
  - CPRI ARB ..... 207
- Physical source
  - CPRI ..... 173
- Pin assignments
  - Cadence palladium breakout board ..... 364
  - Differential breakout board ..... 361
  - single ended breakout board ..... 359
- PLL
  - status LED ..... 30
- Port
  - CPRI fast C&M ..... 199
- Power LED ..... 34, 42
- Power Spectrum diagram ..... 78
- Power supply ..... 26
- Power Supply ..... 42, 144
- PRBS
  - CPRI ..... 173
  - TX test signal - user ..... 121, 279
- Preference ..... 69
  - Default settings directory ..... 69
  - Info server port ..... 70
  - SCPI server port ..... 70
- Preferred pointer
  - CPRI Ethernet ..... 292
- Preset ..... 100
  - CPRI ..... 152, 315
  - DigiConf ..... 260
- Protocol commands
  - user defined ..... 263
- Protocol settings ..... 100
- Protocol setup ..... 100
- Protocol tab ..... 100
  - clock rate/sample rate ..... 108
  - clock settings display ..... 107
  - data settings display ..... 107
- R**
- R&S instruments
  - PC ..... 34
  - signal analyzers ..... 25
  - signal generators ..... 25
  - wideband radio communication tester ..... 25
- R21
  - CPRI ..... 157

- Radio Equipment Control ..... 152
  - Radio Equipment Control test ..... 315
  - Radio Equipment test ..... 152, 315
  - RAI
    - CPRI Rx alarms ..... 166
    - CPRI RX alarms ..... 326, 327
    - Local ..... 168
    - Remote ..... 169
  - Ready
    - CPRI recording status ..... 210
  - Rear panel ..... 32
    - CPRI breakout board ..... 141
    - DIG I/Q IN/OUT2,1 connectors ..... 32
    - IN/OUT LED ..... 32
    - LAN connector ..... 33
    - LAN interface ..... 33
    - power supply ..... 34
    - REF IN connector ..... 32
    - USB connector ..... 33
    - USB interface ..... 33
  - Recall ..... 152
    - CPRI ..... 152, 323
    - user defined ..... 262
  - Recall instrument settings ..... 238, 255
  - Recall intermediate ..... 238
  - Received seed
    - CPRI ..... 158
  - Receiver ..... 99, 258
    - CPRI ..... 160, 161, 303
  - Record
    - CPRI recorder ..... 211
  - Record done
    - CPRI recording status ..... 210
  - Recorder
    - CPRI ..... 174, 207
    - CPRI ARB toolbox ..... 212
    - CPRI viewer ..... 212
  - Recorder settings
    - CPRI ..... 316
  - Recording
    - trigger source ..... 74
  - Recording length
    - CPRI ..... 209
  - Recording memory ..... 19
  - Recording status
    - CPRI recorder ..... 210
  - Recording time
    - CPRI recorder ..... 210
  - Reference clock
    - CPRI ..... 155
    - CPRI clock recovery locked ..... 155, 307
    - CPRI clock synthesis locked ..... 155, 307
    - CPRI reference output locked ..... 155, 308
    - CPRI source ..... 155, 308
  - Reference frequency ..... 269
    - DigiConf ..... 118, 269
  - Reference output locked
    - CPRI reference clock ..... 155, 308
  - Reference signal
    - input ..... 32
  - REF IN ..... 32
    - CPRI ..... 155, 308
  - Remote
    - LOF (CPRI) ..... 169
    - LOS (CPRI) ..... 169
    - RAI (CPRI) ..... 169
    - Reset (CPRI) ..... 169
    - SDI (CPRI) ..... 169
  - Remote control ..... 16, 18
    - R&S DigiConf ..... 16
    - R&S instrument ..... 18
    - SCPI ..... 16
  - Remote control commands
    - CPRI ..... 286
    - User defined ..... 257
  - Remove directory ..... 256
  - RE reset
    - CPRI ..... 170, 328
  - Reset
    - CPRI Rx alarms ..... 166
    - CPRI RX alarms ..... 326
    - remote ..... 238
    - Remote ..... 169
    - Rx BER (CPRI) ..... 193
  - Restart
    - trigger - user defined ..... 282
  - Rms level
    - CPRI ..... 180, 348
  - RS232
    - Baudrate (CPRI) ..... 197
    - CPRI HDLC ..... 195
    - Data bits (CPRI) ..... 197
    - Parity (CPRI) ..... 197
    - Stop bits (CPRI) ..... 197
  - RS-232-C
    - CPRI HDLC ..... 296
  - Run
    - Software trigger CPRI ..... 189
  - Rx BER
    - CPRI ..... 193
    - RX test - user defined ..... 124, 277
  - RX BER
    - CPRI ..... 324
  - Rx equalizer
    - CPRI ..... 159
  - RX equalizer
    - CPRI ..... 310
  - RX test
    - EX-IQ-BOX BBIN - IQ words ..... 124, 279
    - EX-IQ-BOX BBIN - Rx BER ..... 124, 277
    - EX-IQ-BOX BBIN - signal ..... 123, 278
    - EX-IQ-BOX BBIN - state ..... 123, 278
    - EX-IQ-BOX BBOUT - IQ words ..... 124, 279
    - EX-IQ-BOX BBOUT - Rx BER ..... 124, 277
    - EX-IQ-BOX BBOUT - signal ..... 123, 278
    - EX-IQ-BOX BBOUT - state ..... 123, 278
    - IQ words - user defined ..... 124, 279
    - Rx BER - user defined ..... 124, 277
    - signal - user defined ..... 123, 278
    - state - user defined ..... 123, 278
- S**
- Safety instructions ..... 26
    - connector overload ..... 26
    - EMI suppression ..... 26
    - LVDS levels ..... 26
    - power supply ..... 26
    - risk of device damage ..... 26
    - risk of electrostatic discharge ..... 26
    - shock hazard ..... 26
  - Sample/clock rate ratio ..... 107

|                                |                    |                                 |               |
|--------------------------------|--------------------|---------------------------------|---------------|
| Sample/Clock rate ratio .....  | 271                | SFP part number .....           |               |
| DiglConf .....                 | 107, 271           | CPRI .....                      | 204           |
| Sample rate .....              | 265                | SFP Tx/Rx power .....           |               |
| CPRI .....                     | 176, 349           | CPRI .....                      | 204           |
| CPRI ARB settings .....        | 206, 290           | SFP Tx disabled .....           |               |
| CPRI recorder .....            | 210                | CPRI .....                      | 204           |
| DiglConf .....                 | 265                | SFP TX disabled .....           |               |
| Samples .....                  |                    | CPRI .....                      | 328           |
| CPRI ARB settings .....        | 206, 289           | SFP Tx fault .....              |               |
| SAP defect indication .....    |                    | CPRI .....                      | 204, 328      |
| CPRI .....                     | 169, 329           | SFP Vcc .....                   |               |
| Save .....                     | 100, 152, 262, 323 | CPRI .....                      | 204           |
| CPRI .....                     | 152, 323           | SFP vendor .....                |               |
| CPRI recorder .....            | 211                | CPRI .....                      | 204           |
| DiglConf .....                 | 100                | SFP wave length .....           |               |
| user defined .....             | 100, 262           | CPRI .....                      | 204           |
| Save/Recall .....              |                    | Show/Hide group details .....   |               |
| load .....                     | 262, 323           | CPRI .....                      | 181           |
| Recall .....                   | 152                | Show/Hide signal details .....  |               |
| save .....                     | 100, 262, 323      | CPRI .....                      | 177           |
| Save .....                     | 152                | Show taskbar .....              | 70            |
| Save CPRI test report .....    |                    | Signal .....                    |               |
| diagnostic .....               | 245                | CPRI GPIO .....                 | 162, 302      |
| Save instrument settings ..... | 238, 256           | Signal data rate assigned ..... |               |
| Save intermediate .....        | 238                | CPRI .....                      | 341           |
| SCPI .....                     | 16                 | Signal data rate needed .....   |               |
| Scrambling seed .....          |                    | CPRI .....                      | 341           |
| CPRI .....                     | 158                | Signal definition .....         |               |
| SDI .....                      |                    | CPRI .....                      | 172           |
| CPRI .....                     | 169, 329           | Signal high .....               |               |
| CPRI Rx alarms .....           | 166                | CPRI GPIO .....                 | 162, 302      |
| Remote .....                   | 169                | Signal low .....                |               |
| SDR .....                      | 258                | CPRI GPIO .....                 | 162, 302      |
| Select EX-IQ-BOX .....         | 244, 251           | Signal name .....               |               |
| diagnostic .....               | 248                | CPRI .....                      | 173, 346      |
| Select type .....              |                    | Signal output .....             |               |
| receiver .....                 | 99, 258            | CPRI .....                      | 174           |
| transmitter .....              | 99, 258            | Signals active .....            |               |
| Select Type .....              | 99                 | CPRI .....                      | 338           |
| Send to .....                  | 94, 260            | Signal state .....              |               |
| Settings subsystem .....       |                    | CPRI .....                      | 173, 352      |
| user defined .....             | 261                | Signal type .....               | 108, 276      |
| Set to default .....           | 100                | DiglConf .....                  | 108, 276      |
| SFP .....                      |                    | IF .....                        | 108           |
| CPRI input .....               | 160, 161, 303      | IQ .....                        | 108           |
| CPRI output .....              | 160, 161           | Signal Type .....               |               |
| SFP1 .....                     |                    | IF .....                        | 276           |
| CPRI output .....              | 304                | IQ .....                        | 276           |
| SFP2 .....                     |                    | Slave .....                     |               |
| CPRI output .....              | 304                | CPRI mode .....                 | 168, 299      |
| SFP bit rate .....             |                    | SMA .....                       |               |
| CPRI .....                     | 204                | CPRI input .....                | 160, 161, 303 |
| SFP connector type .....       |                    | CPRI output .....               | 160, 161, 305 |
| CPRI .....                     | 204                | SMA settings .....              |               |
| SFP Diagnostics .....          |                    | CPRI .....                      | 158           |
| CPRI .....                     | 204                | Source .....                    |               |
| SFP info .....                 |                    | CPRI HDLC .....                 | 195, 296      |
| CPRI .....                     | 204, 327           | trigger - user defined .....    | 119, 282      |
| SFP LOS .....                  |                    | Source (AxC table) .....        |               |
| CPRI .....                     | 204, 327           | CPRI .....                      | 188           |
| SFP module alarms .....        |                    | SPI settings .....              | 125           |
| CPRI .....                     | 204                | Chip select .....               | 126           |
| SFP module temperature .....   |                    | Clock frequency .....           | 125           |
| CPRI .....                     | 204                | Clock phase .....               | 125           |
| SFP module warnings .....      |                    | Write byte .....                | 126           |
| CPRI .....                     | 204                |                                 |               |

|                                  |          |                                                |                    |
|----------------------------------|----------|------------------------------------------------|--------------------|
| SPI setup .....                  | 125      | Strobe position .....                          |                    |
| Chip select .....                | 126      | DiglConf .....                                 | 114, 276           |
| Clock frequency .....            | 125      | Stop bits .....                                |                    |
| Clock phase .....                | 125      | RS232 (CPRI) .....                             | 197                |
| Write byte .....                 | 126      | Strobe polarity .....                          | 113, 275           |
| SPI subsystem .....              |          | DiglConf .....                                 | 113, 275           |
| User defined .....               | 283      | negative .....                                 | 113, 275           |
| SSI .....                        |          | positive .....                                 | 113, 275           |
| SPI settings .....               | 125      | Strobe position .....                          | 114, 276           |
| SPI setup .....                  | 125      | Strobe settings .....                          |                    |
| SSI general .....                | 124      | strobe polarity .....                          | 113, 275           |
| SSI settings .....               | 124      | strobe position .....                          | 114, 276           |
| C&M data .....                   | 125      | sync pattern .....                             |                    |
| C&M size .....                   | 124      | CPRI standard .....                            | 350                |
| Enable automatic gain .....      | 125      | Sync pattern .....                             |                    |
| Gain file .....                  | 125      | CPRI .....                                     | 173                |
| Late frame sync .....            | 125      | System overview .....                          | 14                 |
| Word size .....                  | 124      | accessories .....                              | 24                 |
| SSI setup .....                  |          | components .....                               | 21                 |
| C&M data .....                   | 125      | Configuration software .....                   | 23                 |
| C&M size .....                   | 124      | DiglConf controlling the EX-IQ-BOX .....       | 14                 |
| Enable automatic gain .....      | 125      | hardware components .....                      | 25                 |
| Gain file .....                  | 125      | R&S instrument controlling the EX-IQ-BOX ..... | 16                 |
| Late frame sync .....            | 125      | receiver mode .....                            | 14                 |
| Word size .....                  | 124      | transmitter mode .....                         | 14, 16             |
| SSI subsystem .....              |          |                                                |                    |
| User defined .....               | 283      | <b>T</b>                                       |                    |
| Standardized protocols .....     |          | T14 .....                                      |                    |
| options .....                    | 22       | CPRI .....                                     | 157                |
| Start condition .....            |          | Target File .....                              |                    |
| CPRI .....                       | 188      | CPRI recorder .....                            | 211                |
| Starting R&S DiglConf .....      | 36       | TCPIP address .....                            | 214                |
| State .....                      |          | Terminal .....                                 |                    |
| CPRI .....                       | 152      | CPRI HDLC .....                                | 195, 296           |
| CPRI ARB settings .....          | 207      | Test signal .....                              |                    |
| CPRI fast C&M .....              | 198, 293 | RX test - user defined .....                   | 123, 278           |
| CPRI HDLC .....                  | 195, 297 | TX test - user .....                           | 121, 279           |
| CPRI vendor data .....           | 201, 353 | TX test - user defined .....                   | 121, 279           |
| EX-IQ-BOX .....                  | 251      | Test sine amplitude .....                      |                    |
| RX test - user defined .....     | 123, 278 | TX test - user .....                           | 123, 280           |
| TX test - user defined .....     | 121, 281 | Test sine frequency .....                      |                    |
| user defined .....               | 99, 261  | TX test - user .....                           | 123, 281           |
| Static frame .....               |          | Test subsystem .....                           |                    |
| CPRI .....                       | 173      | user defined .....                             | 277                |
| Status .....                     |          | The card requires drivers.....                 | 39                 |
| CPRI communication link .....    | 140      | Timing .....                                   |                    |
| CPRI core mode .....             | 168, 299 | CPRI status .....                              | 311                |
| CPRI hardware status alarm ..... | 298      | Timing measurement clock .....                 |                    |
| CPRI I1 analysis .....           | 152, 167 | CPRI GPIO .....                                | 162, 302           |
| CPRI LOF .....                   | 168, 306 | Timing measurements .....                      | 156                |
| CPRI LOS .....                   | 168, 306 | Trigger subsystem .....                        |                    |
| CPRI master/slave .....          | 168, 299 | User defined .....                             | 281                |
| CPRI PLL LED .....               | 141      | TOffset .....                                  |                    |
| CPRI timing .....                | 311      | CPRI .....                                     | 157                |
| digital interface .....          | 30       | Toolbar .....                                  | 55                 |
| PLL .....                        | 30       | Tool bar .....                                 | 55                 |
| trigger - user defined .....     | 120, 283 | Tools .....                                    | 59                 |
| user interface .....             | 30       | EX-IQ-BOX Device Manager .....                 | 59                 |
| Status all AxCs .....            |          | menu .....                                     | 59                 |
| CPRI .....                       | 336      | Preferences .....                              | 59                 |
| Status information .....         |          | Protection .....                               | 59                 |
| Device manager .....             | 68       | Top view .....                                 |                    |
| Status LED .....                 | 30       | CPRI breakout board .....                      | 140                |
| CPRI clock recovery locked ..... | 155, 307 | Transient recorder .....                       | 71                 |
| Status reporting system .....    |          | Transmitter .....                              | 99, 258            |
| common commands .....            | 236      | CPRI .....                                     | 160, 161, 304, 305 |

|                                    |          |
|------------------------------------|----------|
| Trigger                            |          |
| arm - user defined                 | 120, 281 |
| CPRI GPIO                          | 162, 302 |
| delay - user defined               | 120, 282 |
| DiglConf - user defined            | 119      |
| restart - user defined             | 282      |
| source - user defined              | 119, 282 |
| status - user defined              | 120, 283 |
| user defined                       | 119      |
| Triggered                          |          |
| CPRI recording status              | 210      |
| Trigger GP_1 (Marker 1)            | 74       |
| Trigger mode                       | 74       |
| continuous                         | 74       |
| single                             | 74       |
| Trigger position                   |          |
| CPRI recorder                      | 209      |
| Trigger source                     |          |
| CPRI recorder                      | 209      |
| data valid                         | 74       |
| External CPRI recorder             | 209      |
| GP_0 (Marker 0)                    | 74       |
| software                           | 74       |
| Software CPRI recorder             | 209      |
| Trigger type                       | 74       |
| falling edge                       | 74       |
| high level                         | 74       |
| low level                          | 74       |
| rising edge                        | 74       |
| TX test                            |          |
| DiglConf user                      | 120      |
| EX-IQ-BOX BBIN - signal            | 121, 279 |
| EX-IQ-BOX BBIN - sine amplitude    | 123, 280 |
| EX-IQ-BOX BBIN - sine frequency    | 123, 281 |
| EX-IQ-BOX BBIN - state             | 121, 281 |
| EX-IQ-BOX BBOUT - signal           | 121, 279 |
| EX-IQ-BOX BBOUT - sine amplitude   | 123, 280 |
| EX-IQ-BOX BBOUT - sine frequency   | 123, 281 |
| EX-IQ-BOX BBOUT - state            | 121, 281 |
| PRBS test signal - user            | 121, 279 |
| signal - user defined              | 121, 279 |
| sine amplitude - user defined      | 123, 280 |
| sine frequency - user defined      | 123, 281 |
| state - user defined               | 121, 281 |
| test signal - user                 | 121, 279 |
| user defined                       | 120      |
| TYCO Z-DOK                         | 355      |
| TYCO Z-Dok adapter board connector | 31       |
| <b>U</b>                           |          |
| Uninstalling                       | 38       |
| Update firmware                    | 68       |
| Uplink                             |          |
| CPRI                               | 170, 329 |
| USB                                |          |
| Slave                              | 33       |
| type B                             | 33       |
| USB IN                             | 33       |
| USB interface                      | 33       |
| user defined                       |          |
| CPRI standard                      | 175, 350 |
| User defined                       |          |
| catalog                            | 261      |
| Clock subsystem                    | 266      |
| data subsystem                     | 271      |
| delete                             | 262      |

|                         |     |
|-------------------------|-----|
| load                    | 262 |
| main controls           | 258 |
| protocol commands       | 263 |
| recall                  | 262 |
| Remote control commands | 257 |
| save                    | 262 |
| settings subsystem      | 261 |
| SPI subsystem           | 283 |
| SSI subsystem           | 283 |
| state                   | 261 |
| test subsystem          | 277 |
| trigger                 | 119 |
| Trigger subsystem       | 281 |
| User defined:save       | 100 |
| User defined:state      | 99  |
| User defined state      |     |
| DiglConf                | 261 |
| User interface          | 31  |
| CPRI breakout board     | 141 |
| Pin assignment          | 355 |
| Pin description         | 355 |
| User Interface          | 355 |
| Connector               | 355 |

**V**

|                      |               |
|----------------------|---------------|
| Vector diagram       | 76            |
| Vendor               |               |
| CPRI word width      | 202           |
| Vendor data          |               |
| CPRI                 | 200, 203, 352 |
| CPRI REC downlink    | 201, 353      |
| CPRI REC uplink      | 201, 353      |
| CPRI RE downlink     | 201, 353      |
| CPRI RE uplink       | 201, 353      |
| Vendor data table    |               |
| CPRI                 | 203           |
| Vendor word width    |               |
| CPRI                 | 353           |
| View                 |               |
| CPRI recorder        | 212           |
| Visa resource string | 214           |

**W**

|                          |          |
|--------------------------|----------|
| Wait for trigger         |          |
| CPRI recording status    | 210      |
| Wave file                |          |
| CPRI                     | 176, 338 |
| Waveform file            |          |
| CPRI                     | 205, 289 |
| Waveform memory          | 19       |
| WiMAX                    |          |
| CPRI standard            | 175, 350 |
| Word address (AxC table) |          |
| CPRI                     | 188, 336 |
| Word alignment           | 109      |
| DiglConf                 | 109, 272 |
| Word Alignment           | 272      |
| LSB                      | 109, 272 |
| MSB                      | 109, 272 |
| word Size                | 275      |
| Word size                | 109, 275 |
| DiglConf                 | 109, 275 |
| SSI                      | 124      |
| Word width               |          |
| CPRI vendor data         | 202, 353 |