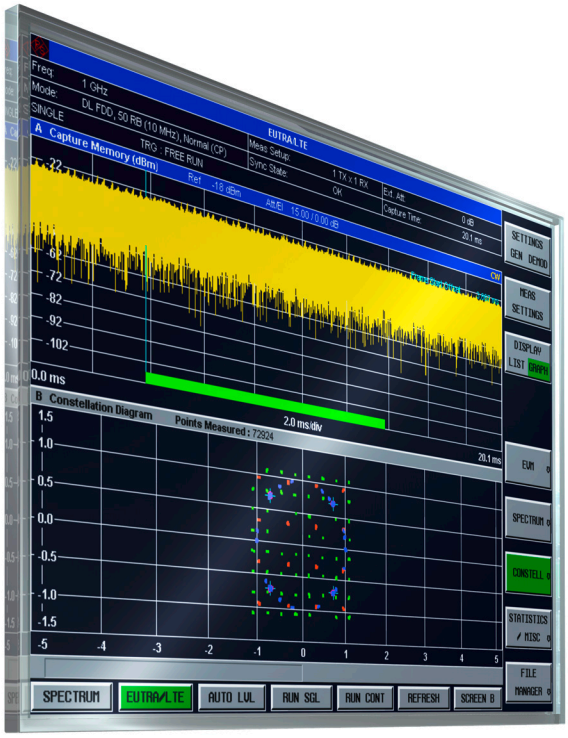
R&S®FSQ-K100/ -K102/ -K104 EUTRA / LTE Downlink Measurement Application

User Manual



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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual describes the following software applications:

- R&S FSQ-K100 EUTRA / LTE FDD Downlink Measurement Application (1308.9006.02)
- R&S FSQ-K102 EUTRA / LTE MIMO Downlink Measurement Application (1309.9000.02)
- R&S FSQ-K104 EUTRA / LTE TDD Downlink Measurement Application (1309.9422.02)

Muehldorfstr. 15, 81671 Munich, Germany
Phone: +49 89 41 29 - 0
Fax: +49 89 41 29 12 164
E-mail: info@rohde-schwarz.com
Internet: http://www.rohde-schwarz.com
Printed in Germany – Subject to change – Data without tolerance limits is not binding.

The following abbreviations are used throughout this manual: R&S®FSQ-K100/-K102/-K104 is abbreviated as R&S FSQ-K100/K102/-K104.

Basic Safety Instructions

Always read through and comply with the following safety instructions!

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

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

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

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

Symbols and safety labels

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

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

Tags and their meaning

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

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

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

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

indicates the possibility of incorrect operation which can result in damage to the product.
In the product documentation, the word ATTENTION is used synonymously.

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

Operating states and operating positions

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

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

Electrical safety

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

1. Prior to switching on the product, always ensure that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
2. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with an earthing contact and protective earth connection.
3. Intentionally breaking the protective earth connection either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
4. If the product does not have a power switch for disconnection from the AC supply network, the plug of the connecting cable is regarded as the disconnecting device. In such cases, always ensure that the power plug is easily reachable and accessible at all times (corresponding to the length of connecting cable, approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply network. If products without power switches are integrated into racks or systems, a disconnecting device must be provided at the system level.
5. Never use the product if the power cable is damaged. Check the power cable on a regular basis to ensure that it is in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, you can ensure that the cable will not be damaged and that no one can be hurt by, for example, tripping over the cable or suffering an electric shock.
6. The product may be operated only from TN/TT supply networks fused with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
7. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket. Otherwise, sparks that result in fire and/or injuries may occur.
8. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
9. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
10. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC60950-1/EN60950-1 or IEC61010-1/EN 61010-1 standards that apply in each case.
11. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
12. If a product is to be permanently installed, the connection between the PE terminal on site and the product's PE conductor must be made first before any other connection is made. The product may be installed and connected only by a licensed electrician.
13. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.

14. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the person operating the product will be exposed to the danger of an electric shock.
15. Any object that is not designed to be placed in the openings of the housing must not be used for this purpose. Doing so can cause short circuits inside the product and/or electric shocks, fire or injuries.
16. Unless specified otherwise, products are not liquid-proof (see also section "Operating states and operating positions", item 1. Therefore, the equipment must be protected against penetration by liquids. If the necessary precautions are not taken, the user may suffer electric shock or the product itself may be damaged, which can also lead to personal injury.
17. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product has been moved from a cold to a warm environment. Penetration by water increases the risk of electric shock.
18. Prior to cleaning the product, disconnect it completely from the power supply (e.g. AC supply network or battery). Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluents for cellulose lacquers.

Operation

1. Operating the products requires special training and intense concentration. Make sure that persons who use the products are physically, mentally and emotionally fit enough to do so; otherwise, injuries or material damage may occur. It is the responsibility of the employer/operator to select suitable personnel for operating the products.
2. Before you move or transport the product, read and observe the section titled "Transport".
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens) such as nickel cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties) when using a Rohde & Schwarz product, consult a physician immediately to determine the cause and to prevent health problems or stress.
4. Before you start processing the product mechanically and/or thermally, or before you take it apart, be sure to read and pay special attention to the section titled "Waste disposal", item 1.
5. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn babies require increased protection, pregnant women must be protected by appropriate measures. Persons with pacemakers may also be exposed to risks from electromagnetic radiation. The employer/operator must evaluate workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the potential danger.
6. Should a fire occur, the product may release hazardous substances (gases, fluids, etc.) that can cause health problems. Therefore, suitable measures must be taken, e.g. protective masks and protective clothing must be worn.
7. If a laser product (e.g. a CD/DVD drive) is integrated into a Rohde & Schwarz product, absolutely no other settings or functions may be used as described in the product documentation. The objective is to prevent personal injury (e.g. due to laser beams).

Repair and service

1. The product may be opened only by authorized, specially trained personnel. Before any work is performed on the product or before the product is opened, it must be disconnected from the AC supply network. Otherwise, personnel will be exposed to the risk of an electric shock.
2. Adjustments, replacement of parts, maintenance and repair may be performed only by electrical experts authorized by Rohde & Schwarz. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, PE conductor test, insulation resistance measurement, leakage current measurement, functional test). This helps ensure the continued safety of the product.

Batteries and rechargeable batteries/cells

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

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

Transport

1. The product may be very heavy. Therefore, the product must be handled with care. In some cases, the user may require a suitable means of lifting or moving the product (e.g. with a lift-truck) to avoid back or other physical injuries.

2. Handles on the products are designed exclusively to enable personnel to transport the product. It is therefore not permissible to use handles to fasten the product to or on transport equipment such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport or lifting. Observe the safety regulations of the manufacturer of the means of transport or lifting. Noncompliance can result in personal injury or material damage.
3. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely and properly. The manufacturer assumes no responsibility for accidents or collisions. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident.

Waste disposal

1. If products or their components are mechanically and/or thermally processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.
2. If handling the product releases hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation. The improper disposal of hazardous substances or fuels can cause health problems and lead to environmental damage.

Informaciones elementales de seguridad

Es imprescindible leer y observar las siguientes instrucciones e informaciones de seguridad!

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

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

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

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

Símbolos y definiciones de seguridad

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

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

Palabras de señal y su significado

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

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

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

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

AVISO indica la posibilidad de utilizar mal el producto y, como consecuencia, dañarlo.
En la documentación del producto se emplea de forma sinónima el término CUIDADO.

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

Estados operativos y posiciones de funcionamiento

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

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

Seguridad eléctrica

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

1. Antes de la puesta en marcha del producto se deberá comprobar siempre que la tensión preseleccionada en el producto coincida con la de la red de alimentación eléctrica. Si es necesario modificar el ajuste de tensión, también se deberán cambiar en caso dado los fusibles correspondientes del producto.
2. Los productos de la clase de protección I con alimentación móvil y enchufe individual solamente podrán enchufarse a tomas de corriente con contacto de seguridad y con conductor de protección conectado.
3. Queda prohibida la interrupción intencionada del conductor de protección, tanto en la toma de corriente como en el mismo producto. La interrupción puede tener como consecuencia el riesgo de que el producto sea fuente de choques eléctricos. Si se utilizan cables alargadores o regletas de enchufe, deberá garantizarse la realización de un examen regular de los mismos en cuanto a su estado técnico de seguridad.
4. Si el producto no está equipado con un interruptor para desconectarlo de la red, se deberá considerar el enchufe del cable de conexión como interruptor. En estos casos se deberá asegurar que el enchufe siempre sea de fácil acceso (de acuerdo con la longitud del cable de conexión, aproximadamente 2 m). Los interruptores de función o electrónicos no son aptos para el corte de la red eléctrica. Si los productos sin interruptor están integrados en bastidores o instalaciones, se deberá colocar el interruptor en el nivel de la instalación.
5. No utilice nunca el producto si está dañado el cable de conexión a red. Compruebe regularmente el correcto estado de los cables de conexión a red. Asegúrese, mediante las medidas de protección y de instalación adecuadas, de que el cable de conexión a red no pueda ser dañado o de que nadie pueda ser dañado por él, p. ej. al tropezar o por un choque eléctrico.
6. Solamente está permitido el funcionamiento en redes de alimentación TN/TT aseguradas con fusibles de 16 A como máximo (utilización de fusibles de mayor amperaje solo previa consulta con el grupo de empresas Rohde & Schwarz).
7. Nunca conecte el enchufe en tomas de corriente sucias o llenas de polvo. Introduzca el enchufe por completo y fuertemente en la toma de corriente. La no observación de estas medidas puede provocar chispas, fuego y/o lesiones.
8. No sobrecargue las tomas de corriente, los cables alargadores o las regletas de enchufe ya que esto podría causar fuego o choques eléctricos.
9. En las mediciones en circuitos de corriente con una tensión U_{eff} > 30 V se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
10. Para la conexión con dispositivos informáticos como un PC o un ordenador industrial, debe comprobarse que éstos cumplan los estándares IEC60950-1/EN60950-1 o IEC61010-1/EN 61010-1 válidos en cada caso.
11. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. Esto pone a descubierto los cables y componentes eléctricos y puede causar lesiones, fuego o daños en el producto.

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

Funcionamiento

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

5. Ciertos productos, como p. ej. las instalaciones de radiocomunicación RF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. Deben tomarse todas las medidas necesarias para la protección de las mujeres embarazadas. También las personas con marcapasos pueden correr peligro a causa de la radiación electromagnética. El empresario/operador tiene la obligación de evaluar y señalizar las áreas de trabajo en las que exista un riesgo elevado de exposición a radiaciones.
6. Tenga en cuenta que en caso de incendio pueden desprenderse del producto sustancias tóxicas (gases, líquidos etc.) que pueden generar daños a la salud. Por eso, en caso de incendio deben usarse medidas adecuadas, como p. ej. máscaras antigás e indumentaria de protección.
7. En caso de que un producto Rohde & Schwarz contenga un producto láser (p. ej. un lector de CD/DVD), no debe usarse ninguna otra configuración o función aparte de las descritas en la documentación del producto, a fin de evitar lesiones (p. ej. debidas a irradiación láser).

Reparación y mantenimiento

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

Baterías y acumuladores o celdas

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

1. No deben desmontarse, abrirse ni triturarse las celdas.
2. Las celdas o baterías no deben someterse a calor ni fuego. Debe evitarse el almacenamiento a la luz directa del sol. Las celdas y baterías deben mantenerse limpias y secas. Limpiar las conexiones sucias con un paño seco y limpio.
3. Las celdas o baterías no deben cortocircuitarse. Es peligroso almacenar las celdas o baterías en estuches o cajones en cuyo interior puedan cortocircuitarse por contacto recíproco o por contacto con otros materiales conductores. No deben extraerse las celdas o baterías de sus embalajes originales hasta el momento en que vayan a utilizarse.
4. Mantener baterías y celdas fuera del alcance de los niños. En caso de ingestión de una celda o batería, avisar inmediatamente a un médico.
5. Las celdas o baterías no deben someterse a impactos mecánicos fuertes indebidos.

6. En caso de falta de estanqueidad de una celda, el líquido vertido no debe entrar en contacto con la piel ni los ojos. Si se produce contacto, lavar con agua abundante la zona afectada y avisar a un médico.
7. En caso de cambio o recarga inadecuados, las celdas o baterías que contienen electrolitos alcalinos (p. ej. las celdas de litio) pueden explotar. Para garantizar la seguridad del producto, las celdas o baterías solo deben ser sustituidas por el tipo Rohde & Schwarz correspondiente (ver lista de recambios).
8. Las baterías y celdas deben reciclarse y no deben tirarse a la basura doméstica. Las baterías o acumuladores que contienen plomo, mercurio o cadmio deben tratarse como residuos especiales. Respete en esta relación las normas nacionales de eliminación y reciclaje.

Transporte

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

Eliminación

1. Si se trabaja de manera mecánica y/o térmica cualquier producto o componente más allá del funcionamiento previsto, pueden liberarse sustancias peligrosas (polvos con contenido de metales pesados como p. ej. plomo, berilio o níquel). Por eso el producto solo debe ser desmontado por personal especializado con formación adecuada. Un desmontaje inadecuado puede ocasionar daños para la salud. Se deben tener en cuenta las directivas nacionales referentes a la eliminación de residuos.
2. En caso de que durante el trato del producto se formen sustancias peligrosas o combustibles que deban tratarse como residuos especiales (p. ej. refrigerantes o aceites de motor con intervalos de cambio definidos), deben tenerse en cuenta las indicaciones de seguridad del fabricante de dichas sustancias y las normas regionales de eliminación de residuos. Tenga en cuenta también en caso necesario las indicaciones de seguridad especiales contenidas en la documentación del producto. La eliminación incorrecta de sustancias peligrosas o combustibles puede causar daños a la salud o daños al medio ambiente.

Qualitätszertifikat
Certificate of quality
Certificat de qualité

Certified Quality System
ISO 9001

Certified Environmental System
ISO 14001

Sehr geehrter Kunde,
Sie haben sich für den Kauf eines Rohde&Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde&Schwarz-Qualitätsmanagementsystem ist u.a. nach ISO 9001 und ISO 14001 zertifiziert.

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

Dear Customer,
You have decided to buy a Rohde&Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards. The Rohde&Schwarz quality management system is certified according to standards such as ISO 9001 and ISO 14001.

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

Cher client,
Vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité. Le système de gestion qualité de Rohde&Schwarz a été homologué, entre autres, conformément aux normes ISO 9001 et ISO 14001.

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

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Customer Support

Technical support – where and when you need it

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

Up-to-date information and upgrades

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

Europe, Africa, Middle East

Phone +49 89 4129 12345
customersupport@rohde-schwarz.com

North America

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

Latin America

Phone +1-410-910-7988
customersupport.la@rohde-schwarz.com

Asia/Pacific

Phone +65 65 13 04 88
customersupport.asia@rohde-schwarz.com

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Contents

1 Typographical Conventions

The following text markers are used throughout this documentation:

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

2 Introduction

The R&S FSQ-K100/-K104 EUTRA/LTE Downlink Measurement Application uses the I/Q capture functionality of the R&S FSQ spectrum analyzer to enable EUTRA/LTE TX measurements in line with the EUTRA specification.

This manual supports the user in working with this software. It describes how to prepare, execute, and evaluate a measurement and gives many helpful hints and examples.

2.1 EUTRA / LTE

Currently, UMTS networks worldwide are being upgraded to high speed downlink packet access (HSDPA) in order to increase data rate and capacity for downlink packet data. In the next step, high speed uplink packet access (HSUPA) will boost uplink performance in UMTS networks. While HSDPA was introduced as a 3GPP Release 5 feature, HSUPA is an important feature of 3GPP Release 6. The combination of HSDPA and HSUPA is often referred to as HSPA.

However, even with the introduction of HSPA, the evolution of UMTS has not reached its end. HSPA+ will bring significant enhancements in 3GPP Release 7. The objective is to enhance the performance of HSPA-based radio networks in terms of spectrum efficiency, peak data rate and latency, and to exploit the full potential of WCDMAbased 5 MHz operation. Important features of HSPA+ are downlink multiple input multiple output (MIMO), higher order modulation for uplink and downlink, improvements of layer 2 protocols, and continuous packet connectivity.

In order to ensure the competitiveness of UMTS for the next 10 years and beyond, concepts for UMTS long term evolution (LTE) have been investigated. The objective is a high-data-rate, low-latency and packet-optimized radio access technology. Therefore, a study item was launched in 3GPP Release 7 on evolved UMTS terrestrial radio access (EUTRA) and evolved UMTS terrestrial radio access network (EUTRAN). LTE/EUTRA will then form part of 3GPP Release 8 core specifications.

This introduction focuses on LTE/EUTRA technology. In the following, the terms LTE or EUTRA are used interchangeably.

requirements, e.g. targets for data rate, capacity, spectrum efficiency, and latency. Also commercial aspects such as costs for installing and operating the network were considered. Based on these requirements, technical concepts for the air interface transmission schemes and protocols were studied. Notably, LTE uses new multiple access schemes on the air interface: orthogonal frequency division multiple access (OFDMA) in downlink and single carrier frequency division multiple access (SC-FDMA) in uplink. Furthermore, MIMO antenna schemes form an essential part of LTE. In an attempt to simplify protocol architecture, LTE brings some major changes to the existing UMTS protocol concepts. Impact on the overall network architecture including the core network is being investigated in the context of 3GPP system architecture evolution (SAE).

2.1.1 Requirements for UMTS Long-Term Evolution

LTE is focusing on optimum support of packet switched (PS) services. Main requirements for the design of an LTE system are documented in 3GPP TR 25.913 [1] and can be summarized as follows:

- Data Rate: Peak data rates target 100 Mbps (downlink) and 50 Mbps (uplink) for 20 MHz spectrum allocation, assuming two receive antennas and one transmit antenna are at the terminal.
- Throughput: The target for downlink average user throughput per MHz is three to four times better than Release 6. The target for uplink average user throughput per MHz is two to three times better than Release 6.
- Spectrum efficiency: The downlink target is three to four times better than Release 6. The uplink target is two to three times better than Release 6.
- Latency: The one-way transit time between a packet being available at the IP layer in either the UE or radio access network and the availability of this packet at IP layer in the radio access network/UE shall be less than 5 ms. Also C-plane latency shall be reduced, e.g. to allow fast transition times of less than 100 ms from camped state to active state.
- Bandwidth: Scaleable bandwidths of 5 MHz, 10 MHz, 15 MHz, and 20 MHz shall be supported. Also bandwidths smaller than 5 MHz shall be supported for more flexibility.
- Interworking: Interworking with existing UTRAN/GERAN systems and non-3GPP systems shall be ensured. Multimode terminals shall support handover to and from UTRAN and GERAN as well as inter-RAT measurements. Interruption time for handover between EUTRAN and UTRAN/GERAN shall be less than 300 ms for realtime services and less than 500 ms for non-realtime services.
- Multimedia broadcast multicast services (MBMS): MBMS shall be further enhanced and is then referred to as E-MBMS.
- Costs: Reduced CAPEX and OPEX including backhaul shall be achieved. Costeffective migration from Release 6 UTRA radio interface and architecture shall be possible. Reasonable system and terminal complexity, cost, and power consumption shall be ensured. All the interfaces specified shall be open for multivendor equipment interoperability.
- Mobility: The system should be optimized for low mobile speed (0 to 15 km/h), but higher mobile speeds shall be supported as well, including high speed train environment as a special case.
- Spectrum allocation: Operation in paired (frequency division duplex / FDD mode) and unpaired spectrum (time division duplex / TDD mode) is possible.
- Co-existence: Co-existence in the same geographical area and co-location with GERAN/UTRAN shall be ensured. Also, co-existence between operators in adjacent bands as well as cross-border co-existence is a requirement.
- Quality of Service: End-to-end quality of service (QoS) shall be supported. VoIP should be supported with at least as good radio and backhaul efficiency and latency as voice traffic over the UMTS circuit switched networks.
- Network synchronization: Time synchronization of different network sites shall not be mandated.

2.1.2 Long-Term Evolution Downlink Transmission Scheme

2.1.2.1 OFDMA

The downlink transmission scheme for EUTRA FDD and TDD modes is based on conventional OFDM. In an OFDM system, the available spectrum is divided into multiple carriers, called subcarriers, which are orthogonal to each other. Each of these subcarriers is independently modulated by a low rate data stream.

OFDM is used as well in WLAN, WiMAX and broadcast technologies like DVB. OFDM has several benefits including its robustness against multipath fading and its efficient receiver architecture.

figure 2-1 shows a representation of an OFDM signal taken from 3GPP TR 25.892 [2]. In this figure, a signal with 5 MHz bandwidth is shown, but the principle is of course the same for the other EUTRA bandwidths. Data symbols are independently modulated and transmitted over a high number of closely spaced orthogonal subcarriers. In EUTRA, downlink modulation schemes QPSK, 16QAM, and 64QAM are available.

In the time domain, a guard interval may be added to each symbol to combat inter-OFDM-symbol-interference due to channel delay spread. In EUTRA, the guard interval is a cyclic prefix which is inserted prior to each OFDM symbol.

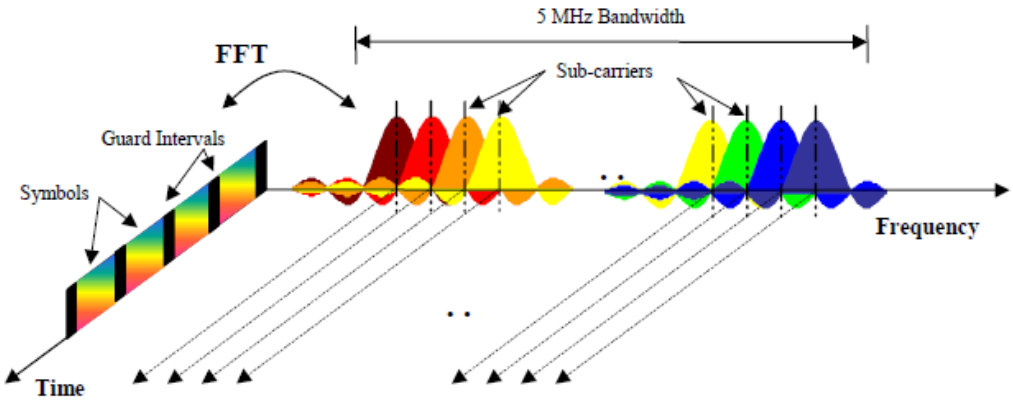


Fig. 2-1: Frequency-Time Representation of an OFDM Signal

In practice, the OFDM signal can be generated using the inverse fast Fourier transform (IFFT) digital signal processing. The IFFT converts a number N of complex data symbols used as frequency domain bins into the time domain signal. Such an N-point IFFT is illustrated in figure 2-2, where a(mN+n) refers to the n^{th} subchannel modulated data symbol, during the time period $mT_u < t \leq (m+1)T_u$.

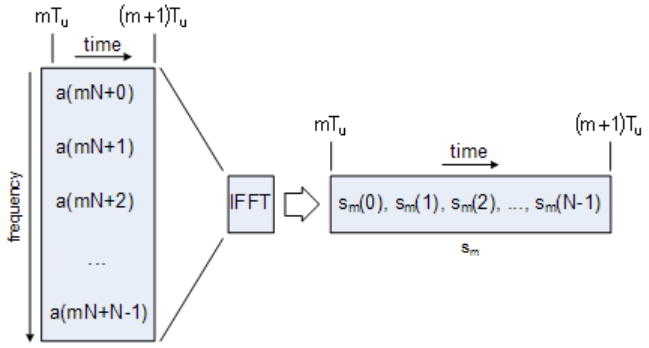


Fig. 2-2: OFDM useful symbol generation using an IFFT

The vector s_m is defined as the useful OFDM symbol. It is the time superposition of the N narrowband modulated subcarriers. Therefore, from a parallel stream of N sources of data, each one independently modulated, a waveform composed of N orthogonal subcarriers is obtained, with each subcarrier having the shape of a frequency sinc function (see figure 2-1).

figure 2-3 illustrates the mapping from a serial stream of QAM symbols to N parallel streams, used as frequency domain bins for the IFFT. The N-point time domain blocks obtained from the IFFT are then serialized to create a time domain signal. Not shown in figure 2-3 is the process of cyclic prefix insertion.

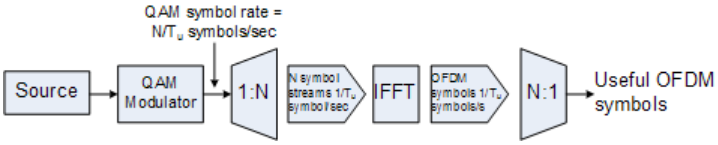


Fig. 2-3: OFDM Signal Generation Chain

In contrast to an OFDM transmission scheme, OFDMA allows the access of multiple users on the available bandwidth. Each user is assigned a specific time-frequency resource. As a fundamental principle of EUTRA, the data channels are shared channels, i.e. for each transmission time interval of 1 ms, a new scheduling decision is taken regarding which users are assigned to which time/frequency resources during this transmission time interval.

2.1.2.2 OFDMA Parameterization

A generic frame structure is defined for both EUTRA FDD and TDD modes. Additionally, an alternative frame structure is defined for the TDD mode only. The EUTRA frame structures are defined in 3GPP TS 36.211. For the generic frame structure, the 10 ms radio frame is divided into 20 equally sized slots of 0.5 ms. A subframe consists of two consecutive slots, so one radio frame contains 10 subframes. This is illustrated in figure 2-4 (T_s expresses the basic time unit corresponding to 30.72 MHz).

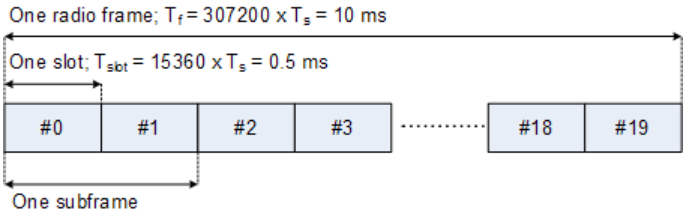


Fig. 2-4: Generic Frame Structure in EUTRA Downlink

figure 2-5 shows the structure of the downlink resource grid for the duration of one downlink slot. The available downlink bandwidth consists of N^{DL}_{BW} subcarriers with a spacing of Δf = 15 kHz. In the case of multi-cell MBMS transmission, a subcarrier spacing of Δf = 7.5 kHz is also possible. N^{DL}_{BW} can vary in order to allow for scalable bandwidth operation up to 20 MHz. Initially, the bandwidths for LTE were explicitly defined within layer 1 specifications. Later on a bandwidth agnostic layer 1 was introduced, with N^{DL}_{BW} for the different bandwidths to be specified by 3GPP RAN4 to meet performance requirements, e.g. for out-of-band emission requirements and regulatory emission limits.

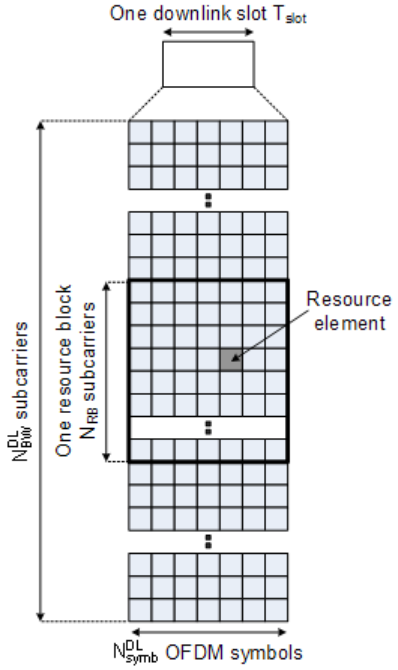


Fig. 2-5: Downlink Resource Grid

One downlink slot consists of N^{DL}_{Symb} OFDM symbols. To each symbol, a cyclic prefix (CP) is appended as guard time, compare figure 2-1. N^{DL}_{Symb} depends on the cyclic prefix length. The generic frame structure with normal cyclic prefix length contains N^{DL}_{Symb} = 7 symbols. This translates into a cyclic prefix length of T_{CP}≈5.2µs for the first symbol and T_{CP}≈4.7µs for the remaining 6 symbols. Additionally, an extended cyclic prefix is defined in order to cover large cell scenarios with higher delay spread and MBMS transmission. The generic frame structure with extended cyclic prefix of $T_{CP\text{-}E}$≈16.7µs contains N^{DL}_{Symb} = 6 OFDM symbols (subcarrier spacing 15 kHz). The generic frame structure with extended cyclic prefix

of T_{CP-E}≈33.3µs contains N_{symb}^{DL} = 3 symbols (subcarrier spacing 7.5 kHz). table 2-1 gives an overview of the different parameters for the generic frame structure.

Table 2-1: Parameters for Downlink Generic Frame Structure

Configuration	Number of Symbols N_{symb}^{DL}	Cyclic Prefix Length in Samples	Cyclic Prefix Length in µs
Normal cyclic prefix Δf=15 kHz	7	160 for first symbol 144 for other symbols	5.2 µs for first symbol 4.7 µs for other symbols
Extended cyclic prefix Δf=15 kHz	6	512	16.7 µs
Extended cyclic prefix Δf=7.5 kHz	3	1024	33.3 µs

2.1.2.3 Downlink Data Transmission

Data is allocated to the UEs in terms of resource blocks. A physical resource block consists of 12 (24) consecutive subcarriers in the frequency domain for the Δf=15 kHz (Δf=7.5 kHz) case. In the time domain, a physical resource block consists of DL N_{symb} consecutive OFDM symbols, see figure 2-5. N_{symb}^{DL} is equal to the number of OFDM symbols in a slot. The resource block size is the same for all bandwidths, therefore the number of available physical resource blocks depends on the bandwidth. Depending on the required data rate, each UE can be assigned one or more resource blocks in each transmission time interval of 1 ms. The scheduling decision is done in the base station (eNodeB). The user data is carried on the physical downlink shared channel (PDSCH). Downlink control signaling on the physical downlink control channel (PDCCH) is used to convey the scheduling decisions to individual UEs. The PDCCH is located in the first OFDM symbols of a slot.

2.1.2.4 Downlink Reference Signal Structure and Cell Search

The downlink reference signal structure is important for cell search, channel estimation and neighbor cell monitoring. figure 2-6 shows the principle of the downlink reference signal structure for one-antenna, two-antenna, and four-antenna transmission. Specific predefined resource elements in the time-frequency domain carry the reference signal sequence. Besides first reference symbols, there may be a need for second reference symbols. The different colors in figure 2-6 represent the sequences transmitted from up to four transmit antennas.

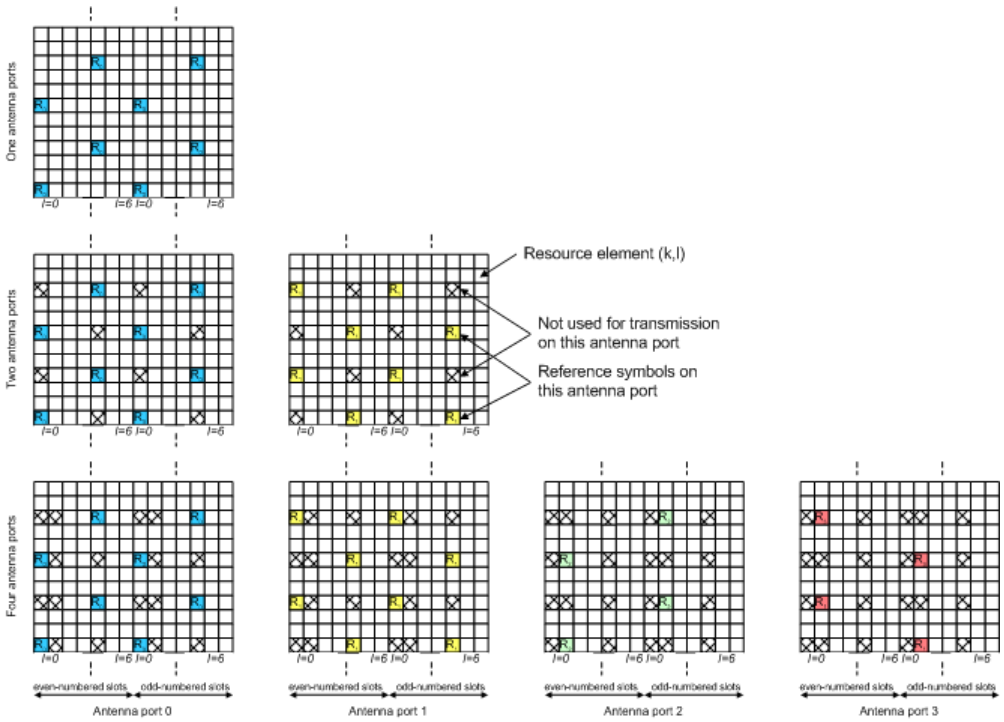


Fig. 2-6: Downlink Reference Signal Structure (Normal Cyclic Prefix)

The reference signal sequence carries the cell identity. Each reference signal sequence is generated as a symbol-by-symbol product of an orthogonal sequence r^{OS} (three of them existing) and a pseudo-random sequence r^{PRS} (170 of them existing). Each cell identity corresponds to a unique combination of one orthogonal sequence r^{OS} and one pseudo-random sequence r^{PRS}, allowing 510 different cell identities.

Frequency hopping can be applied to the downlink reference signals. The frequency hopping pattern has a period of one frame (10 ms).

During cell search, different types of information need to be identified by the handset: symbol and radio frame timing, frequency, cell identification, overall transmission bandwidth, antenna configuration, and cyclic prefix length.

Besides the reference symbols, synchronization signals are therefore needed during cell search. EUTRA uses a hierarchical cell search scheme similar to WCDMA. This means that the synchronization acquisition and the cell group identifier are obtained from different synchronization signals. Thus, a primary synchronization signal (P-SYNC) and a secondary synchronization signal (S-SYNC) are assigned a predefined structure. They are transmitted on the 72 center subcarriers (around the DC subcarrier) within the same predefined slots (twice per 10 ms) on different resource elements, see figure 2-7.

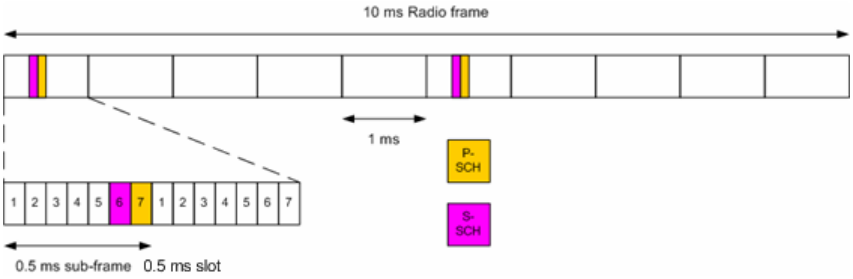


Fig. 2-7: P-SYNC and S-SYNC Structure

As additional help during cell search, a common control physical channel (CCPCH) is available which carries BCH type of information, e.g. system bandwidth. It is transmitted at predefined time instants on the 72 subcarriers centered around the DC subcarrier.

In order to enable the UE to support this cell search concept, it was agreed to have a minimum UE bandwidth reception capability of 20 MHz.

2.1.2.5 Downlink Physical Layer Procedures

For EUTRA, the following downlink physical layer procedures are especially important:

- **Cell search and synchronization**
  See above.
- **Scheduling**
  Scheduling is done in the base station (eNodeB). The downlink control channel PDCCH informs the users about their allocated time/frequency resources and the transmission formats to use. The scheduler evaluates different types of information, e.g. quality of service parameters, measurements from the UE, UE capabilities, and buffer status.
- **Link adaptation**
  Link adaptation is already known from HSDPA as adaptive modulation and coding. Also in EUTRA, modulation and coding for the shared data channel is not fixed, but rather is adapted according to radio link quality. For this purpose, the UE regularly reports channel quality indications (CQI) to the eNodeB.
- **Hybrid automatic repeat request (ARQ)**
  Downlink hybrid ARQ is also known from HSDPA. It is a retransmission protocol. The UE can request retransmissions of incorrectly received data packets.

2.2 EUTRA / LTE Test & Measurement Assumption made by Rohde & Schwarz

The following assumptions are valid for all current implementations on R&S signal generators and R&S signal analyzers.

OFDMA Parameterization

In order to configure the bandwidth of the signal to be generated and analyzed, the desired number of resource blocks can be specified in a range from 6 to 110 resource blocks with a granularity of 1. This results in bandwidths from 1.08 MHz…19.8 MHz.

The resulting FFT size is derived from the following formula:

$$N_{FFT} = 2^{nextpow2(\lceil 1.4 \cdot (12n+1) \rceil)}$$

- n is the selected number of resource blocks
- nextpow2(N) returns the first P such that 2^P >= abs(N)
- ⌈ ⌉ rounds up to the next highest integer

2.3 Performing Time Alignment Measurements

The R&S FSQ-K102 provides the possibility to perform time alignment measurements between the different antennas for 2 or 4 TX antenna MIMO configurations. The time alignment error values represent the time offset between the considered antenna and antenna 1 and will be displayed in the result summary. The figure below shows a schematic description of the results.

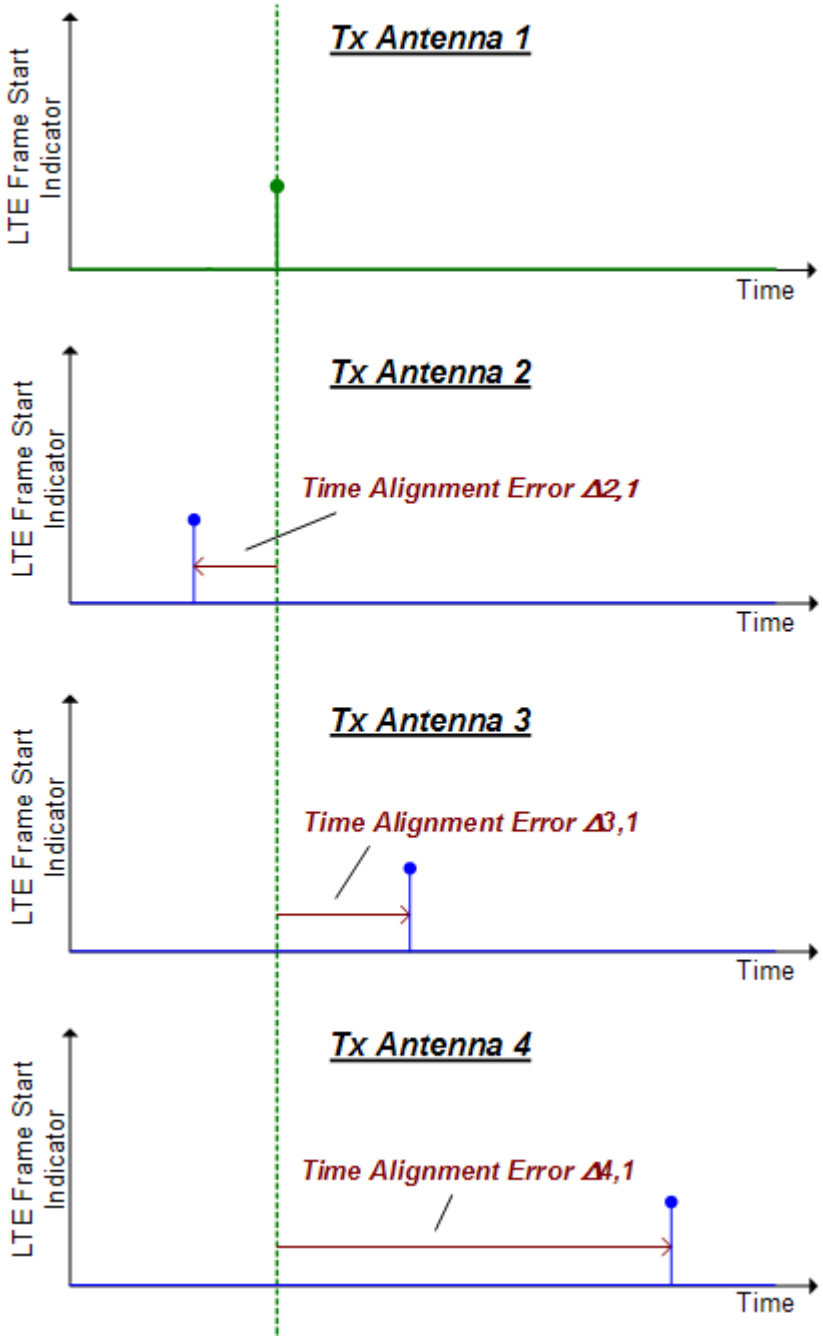


Fig. 2-8: Schematic description of the time alignment results

The figure below shows the test setup for the time alignment measurement (the dashed connections are only required for 4 TX antenna MIMO configuration). For best measurement result accuracy it is recommended to use cables of the same length and identical combiners as adders.

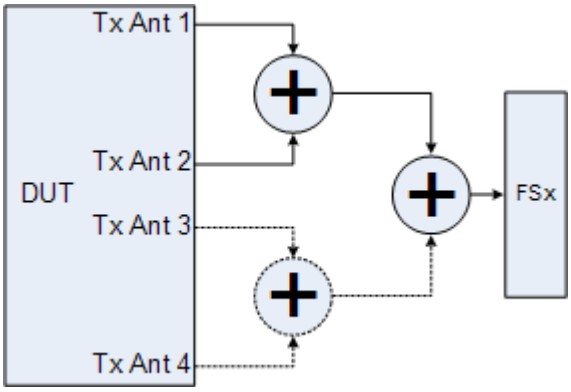
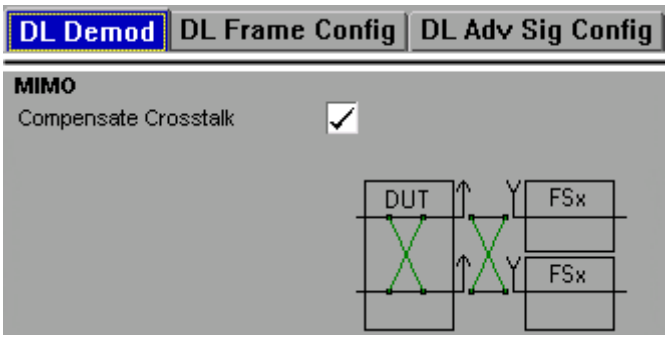


Fig. 2-9: Time alignment measurement hardware setup

For a successful time alignment measurement, make sure to set up the measurement correctly.

- the subframe selection in the general settings menu must be set to "All"
- enable "Compensate Crosstalk" in the demodulation settings, see screenshot below

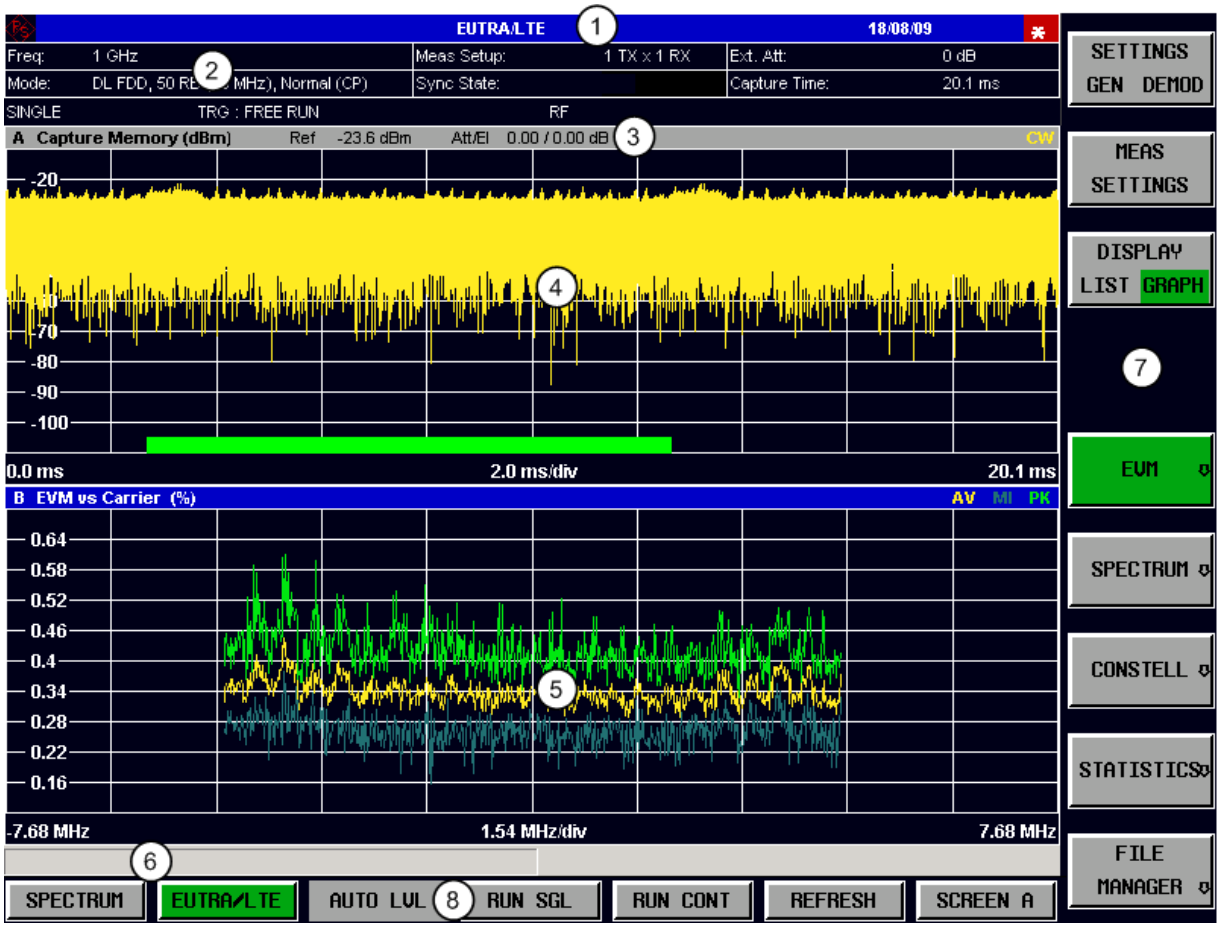


Note that the time alignment measurement only uses the reference signal and therefore ignores any PDSCH settings (e.g. it does not have an influence on this measurement if the PDSCH MIMO scheme is set to transmit diversity or spatial multiplexing).

The EVM will usually be very high for this measurement. This does not effect the accuracy of the time alignment error measurement result.

3 Screen Layout

After starting the application, the screen takes on the following layout:



1 = Title Bar: shows the currently active measurement application
2 = Table Header: shows basic measurement information, e.g. the frequency
3 = Result Display Header: shows information about the display trace
4 = Result Display Screen A: shows the measurement results
5 = Result Display Screen B: shows the measurement results
6 = Status Bar: shows the measurement progress, software messages and errors
7 = Softkeys: open settings dialogs and select result displays
8 = Hotkeys: control the measurement process (e.g. running a measurement)

Title Bar and Status Bar

The title bar at the very top of the screen shows the name of the application currently running.

The status bar is located at the bottom of the display. It shows the current measurement status and its progress in a running measurement. The status bar also shows warning and error messages. Error messages are generally highlighted.

Display of Measurement Settings

The header table above the result display shows information on hardware and measurement settings.

The header table includes the following information

- **Freq**
  The analyzer RF frequency.
- **Mode**
  Link direction, duplexing, cyclic prefix and maximum number of physical resource blocks (PRBs) / signal bandwidth.
- **Meas Setup**
  Shows number of transmitting and receiving antennas.
- **Sync State**
  The following synchronization states may occur:
  – **OK** The synchronization was successful.
  – **FAIL (C)** The cyclic prefix correlation failed.
  – **FAIL (P)** The P-SYNC correlation failed.
  – **FAIL (S)** The S-SYNC correlation failed.

  Any combination of C, P and S may occur.
  SCPI Command:
  `[SENSe]:SYNC[:STATe]` on page 108
- **Ext. Att**
  External attenuation in dB.
- **Capture Time**
  Capture length in ms.

4 Configuring Measurements

Before you can start a measurement, you have to configure the R&S FSQ in order to get valid measurement results. The following topics contain detailed information on all settings of the application.

You can access the two main settings dialog boxes via the "Settings (Gen Demod)" softkey. Pressing the softkey once opens the "General Settings" dialog box. The "Gen" label in the softkey turns green to indicate an active "General Settings" dialog box. Pressing the softkey again opens the "Demod Settings" dialog box. When the "Demod Settings" dialog box is active, the "Demod" label in the softkey turns green.

In addition, you can set up general measurement parameters in the "Measurement Settings" dialog box. Special settings for SEM and ACLR measurements are provided by the corresponding dialog boxes.

4.1 General Settings

In the General Settings dialog box, you can set all parameters that are related to the overall measurement. The dialog box is made up of three tabs, one for general settings, one for MIMO settings and one for advanced settings. By default, the "General" tab is the active one. You can switch between the tabs with the cursor keys.

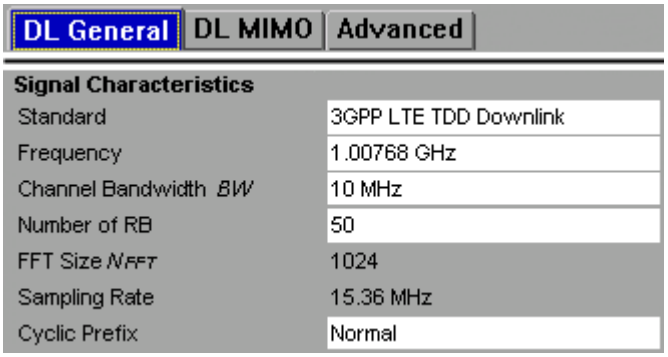
4.1.1 General

The "DL General" settings contain basic measurement and signal settings.

4.1.1.1 Signal Characteristics

Signal characteristics include settings to describe the basic physical attributes of the LTE signal.

You can find the signal characteristics in the "General Settings" dialog box.



Standard
The choices you have depend on the configuration of the R&S FSQ.

- option R&S FSQ-K100 enables testing of 3GPP LTE FDD signals on the downlink
- option R&S FSQ-K101 enables testing of 3GPP LTE FDD signals on the uplink
- option R&S FSQ-K104 enables testing of 3GPP LTE TDD signals on the downlink
- option R&S FSQ-K105 enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are duplexing methods.

- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the transmission path.

- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

SCPI command:

`CONFigure[:LTE]:LDIRection` on page 86

`CONFigure[:LTE]:DUPLexing` on page 86

Frequency

Sets the frequency of the signal and thus the center frequency of the R&S FSQ.

The available frequency range depends on the hardware configuration of the R&S FSQ you have in use.

The header table shows the current center frequency.

SCPI command:

`[SENSe]:FREQuency:CENTer` on page 105

Channel Bandwidth and Number of Resource Blocks

Specifies the channel bandwidth and the number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. If you enter one, the R&S FSQ automatically calculates and adjusts the other.

Currently, the LTE standard recommends six bandwidths (see table below).

If you enter a value different to those recommended by the standard, the R&S FSQ labels the parameter as "User", but still does the calculations.

The R&S FSQ also calculates the FFT size, sampling rate, occupied bandwidth and occupied carriers from the channel bandwidth. Those are read only.

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100
Sample Rate [MHz]	1.92	3.84	7.68	15.36	23.04	30.72
FFT Size	128	256	512	1024	2048	2048

For more information on the calculation method of the FFT size see E-UTRA / LTE Test & Measurement Assumption made by Rohde & Schwarz.

SCPI command:
CONFigure[:LTE]:DL:BW on page 76
CONFigure[:LTE]:DL:NORB on page 78

Cyclic Prefix
The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

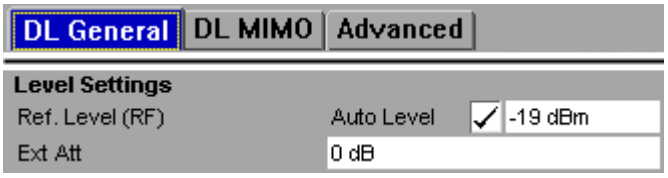
- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- Auto
  The application automatically detects the cyclic prefix mode in use.

SCPI command:
CONFigure[:LTE]:DL:CYCPrefix on page 77

4.1.1.2 Level Settings

Level settings include general parameters necessary to adjust the R&S FSQ to the power level of the signal.

You can find the level settings in the "General Settings" dialog box.



Reference Level
Sets the reference level of the R&S FSQ.

The reference level is the power level the R&S FSQ expects at the RF input. Keep in mind that the power level at the RF input is the peak enevelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the R&S FSQ displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can either specify the RF reference level (in dBm) or baseband reference level (in V), depending on the input sourceInput Source.

You can also turn on automatic detection of the reference level with the "Auto Level" function.

If active, the R&S FSQ measures and sets the reference level to its ideal value before each sweep. However, measurement time will increase slightly.

Automatic level detection also optimizes RF attenuation.

SCPI command:
Manual
`CONFigure:POWer:EXPected:RF<analyzer>` on page 86
Automatic
`[SENSe]:POWer:AUTO<analyzer>[:STATe]` on page 106

External Attenuation
Sets an external attenuation or gain.

If you attenuate or amplify the RF signal externally, the R&S FSQ adjusts the numeric and graphical results accordingly. In case of graphical power result displays, it moves the trace(s) vertically by the specified value.

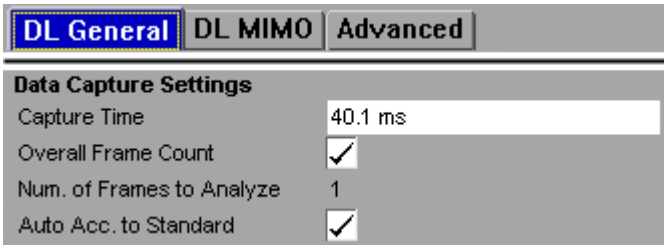
Positive values correspond to an attenuation and negative values correspond to an amplification.

SCPI command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 87

4.1.1.3 Configuring the Data Capture

Data capture includes all functionality that controls the amount and the way the R&S FSQ records the LTE signal data.

You can find the data capture settings in the "General Settings" dialog box.



Capture Time
Sets the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the R&S FSQ captures during one sweep.

SCPI command:
`[SENSe]:SWEep:TIME` on page 108

Overall Frame Count
Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep.

If the overall frame count is inactive, the R&S FSQ analyzes all complete LTE frames currently in the capture buffer.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt:STATe` on page 102

Number of Frames to Analyze
Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single sweep, the R&S FSQ continues the measurement until all frames have been captured.

The parameter is read only if

- the overall frame count is inactive,
- the data is captured according to the standard (Auto According to Standard).

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt` on page 101

Auto According to Standard
Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the R&S FSQ evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

This parameter is not available if the overall frame count is inactive.

SCPI command:
`[SENSe][:LTE]:FRAMe:COUNt:AUTO` on page 101

4.1.1.4 Triggering Measurements

The trigger settings include all parameters necessary to describe conditions for triggering measurements.

You can find the trigger settings in the "General Settings" dialog box.

Trigger Mode
Selects the source that triggers a measurement.

The R&S FSQ supports several trigger modes.

- **Free Run**
  When Free Run is active, the measurement starts immediately.

- **External**
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/Gate" input.
- **IF Power**
  The trigger event is the IF power level. The measurement starts when the IF power meets or exceeds a specified power trigger level.

SCPI command:
`TRIGger[:SEQuence]:MODE` on page 115

Trigger Offset
Specifies the delay between the trigger event and the start of the sweep. A negative trigger offset defines a pretrigger.

The trigger offset is unavailable for free run measurements.

SCPI command:
`TRIGger[:SEQuence]:HOLDoff<analyzer>` on page 115

Trigger Level
Specifies the trigger level for an external or IF power trigger.

The name and contents of the field depend on the selected trigger mode. It is available only in combination with the corresponding trigger mode.

SCPI command:
`TRIGger[:SEQuence]:LEVel<analyzer>[:EXTernal]` on page 115

4.1.2 Advanced

The "Advanced" settings contain parameters to configure more complex measurement setups.

4.1.2.1 I/Q Settings

I/Q settings are all settings that define the way the R&S FSQ captures I/Q data.

You can find the I/Q settings in the "General Settings" dialog box.

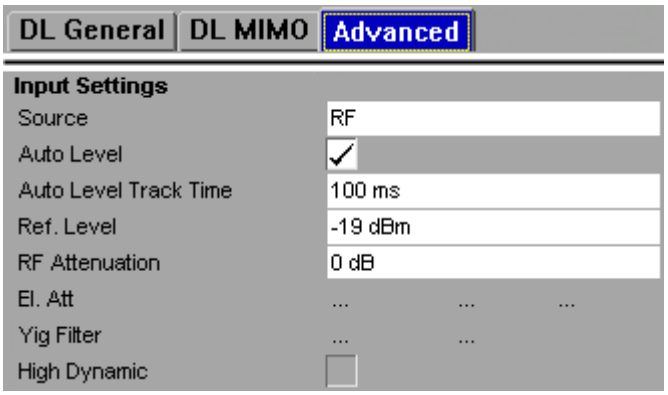
Swap I/Q
Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

SCPI command:
`[SENSe]:SWAPiq` on page 108

4.1.2.2 Input Settings

The input settings provide all functions necessary to control the input source.

You can find the input settings in the "General Settings" dialog box.



Source
Selects the input source of the data.

By default, the R&S FSQ uses its RF input.

With hardware options R&S FSQ-B71 and -B17 you can use the analog and digital baseband input respectively. For more information on using analog and digital baseband data see the manual of the R&S FSQ.

If the data has been recorded and saved already, you can also read the data from a file and analyze it on the R&S FSQ. For more information on how to import I/Q data see chapter 7, "File Management", on page 64.

SCPI command:
`INPut:SELect` on page 99

Reference Level
Sets the reference level of the R&S FSQ.

The reference level is the power level the R&S FSQ expects at the RF input. Keep in mind that the power level at the RF input is the peak enevelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the R&S FSQ displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can either specify the RF reference level (in dBm) or baseband reference level (in V), depending on the input sourceInput Source.

You can also turn on automatic detection of the reference level with the "Auto Level" function.

If active, the R&S FSQ measures and sets the reference level to its ideal value before each sweep. However, measurement time will increase slightly.

Automatic level detection also optimizes RF attenuation.

SCPI command:
Manual
CONFigure:POWer:EXPected:RF<analyzer> on page 86
Automatic
[SENSe]:POWer:AUTO<analyzer>[:STATe] on page 106

RF Attenuation
Sets the mechanical attenuation of the RF signal at the RF input.

RF attenuation is independent of the reference level. It is in the range from 0 dB to 75 dB in steps of 5 dB.

RF attenuation is available if automatic reference level detection is inactive.

For more information on attenuation see the manual of the R&S FSQ.

SCPI command:
INPut:ATTenuation<analyzer> on page 96

El Att
Configures the electronic attenuator.

The process of configuring the electronic attenuator consist of three steps.

- **Selecting the mode**
  You can select either manual or automatic control of the electronic attenuator.
- **Selecting the state**
  Turns the electronic attenuator on and off.
- **Setting the attenuation**
  Sets the degree of electronic attenuation.

If you have selected automatic attenuation mode, the R&S FSQ automatically calculates the electronic attenuation. State and degree of attenuation are not available in that case.

If you turn the attenuator off, the degree of attenuation is not available.

Electronic attenuation is available only with option R&S FSQ-B25 and if the frequency range does not exceed the specification of the electronic attenuator.

SCPI command:
INPut:EATT:AUTO on page 97

Yig Filter
Configures the YIG filter.

If you want to measure broadband signals, you can configure the YIG filter for a greater bandwidth.

The process of configuring the YIG filter consist of two steps.

- **Selecting the mode**
  You can select either manual or automatic control of the YIG filter.
- **Selecting the state**
  Turns the YIG filter on and off.

If inactive, you can use the maximum bandwidth. However, image frequency rejection is no longer ensured.

If you have selected automatic YIG filter control, the R&S FSQ automatically resolves whether to use the YIG filter or not. Manual selection of the YIG filter state is not available in that case.

Note that the R&S FSQ uses the YIG filter only for frequencies greater than 3.6 GHz. If the frequency is smaller, these settings have no effect.

SCPI command:

`INPut:FILTer:YIG[:STATe]` on page 97

`INPut:FILTer:YIG:AUTO` on page 98

High Dynamic

Turns the bypass of the bandwidth extension R&S FSQ-B72 on and off if you are using a wideband filter. The signal instead passes through the normal signal path.

If active, high dynamic results in a higher resolution because the normal signal path uses a 14-bit ADC. However, all signals to the left or right of the spectrum of interest are folded into the spectrum itself.

The high dynamic functionality is available only if R&S FSQ-B72 is installed and the sample rate is in the range from 20.4 MHz to 40.8 MHz.

SCPI command:

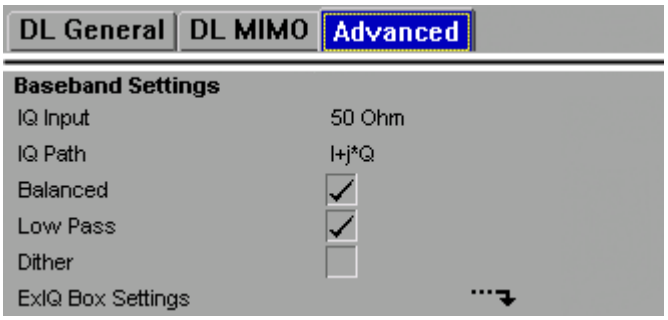
`TRACe:IQ:FILTer:FLATness` on page 114

4.1.2.3 Baseband Settings

The baseband settings define settings related to the baseband input source.

The baseband settings are available only if you have installed option R&S FSQ-B71.

For more information on the analog baseband input see the manual for the R&S FSQ-B71 that is available for download on the product homepage.



I/Q Input

Selects the impedance of the baseband inputs.

Depending on the configuration of the baseband input, you can select an impedance of 50 Ω and 1 kΩ or 1 MΩ

The I/Q input is available only if you have selected a baseband input source.

SCPI command:
INPut:IQ:IMPedance on page 98

I/Q Path
Selects the input path for baseband inputs.

You can either select a single input (I **or** Q) or a dual input (I **and** Q).

If you are using single input, swapping the I and Q branches becomes unavailable.

The I/Q path selection is available only if you have selected a baseband input source.

SCPI command:
INPut:IQ:TYPE on page 98

Balanced
Turns symmetric (or balanced) input on and off.

If active, a ground connection is not necessary. If you are using an assymetrical (unbalanced) setup, the ground connection runs through the shield of the coaxial cable that is used to connect the DUT

This parameter is available only if you have selected a baseband input source.

SCPI command:
INPut:IQ:BALanced[:STATe] on page 98

Low Pass
Turns an anti-aliasing low pass filter on and off.

The filter has a cut-off frequency of 36 MHz and prevents frequencies above from being mixed into the usable frequency range. Note that if you turn the filter off, harmonics or spurious emissions of the DUT might be in the frequency range above 36 MHz and might be missed.

You can turn it off for measurement bandwidths greater than 30 MHz.

The low pass filter is available only if you have selected a baseband input source.

SCPI command:
[SENSe]:IQ:LPASs[:STATe] on page 106

Dither
Adds a noise signal into the signal path of the baseband input.

Dithering improves the linearity of the A/D converter at low signals levels or low modulation. Improving the linearity also improves the accuracy of the displayed signal levels.

The signal has a bandwidth of 2 MHz with a center frequency of 38.93 MHz.

Dithering is available only if you have selected a baseband input source.

SCPI command:
[SENSe]:IQ:DITHer[:STATe] on page 106

ExIQ Box Settings
Opens a dialog box and softkey menu to configure the R&S ExIQ Box. For details refer to the manual of the R&S ExIQ Box that is available for download on the product homepage.

4.1.2.4 Digital I/Q Settings

The digital I/Q settings define settings related to the digital baseband input.

The digital baseband settings are available only if you have installed option R&S FSQ-B17.

Digital Input Data Rate
Selects the data sample rate at the digital baseband input.

The sample rate is available only if you have selected the digital baseband input source.

SCPI command:
`INPut:DIQ:SRATe` on page 97

Full Scale Level
Sets the voltage corresponding to the maximum input value of the digital baseband input.

The full scale level is available only if you have selected the digital baseband input source.

SCPI command:
`INPut:DIQ:RANGe[:UPPer]` on page 97

4.1.3 MIMO

The "MIMO" settings control measurements in a MIMO setup.

4.1.3.1 MIMO Configuration

The MIMO Configuration parameters define essential settings related to the antenna configuration of a DUT.

DUT MIMO Configuration
Selects the number of transmission antennas of the DUT.

The application supports measurements on 1-, 2- and 4-antenna systems.

SCPI command:
`CONFigure[:LTE]:DL:MIMO:CONFig` on page 78

Tx Antenna Selection
Selects a specific antenna under test in case of MIMO systems.

The number of available antennas depends on the MIMO configuration.

SCPI command:
`CONFigure[:LTE]:DL:MIMO:ASELection` on page 77

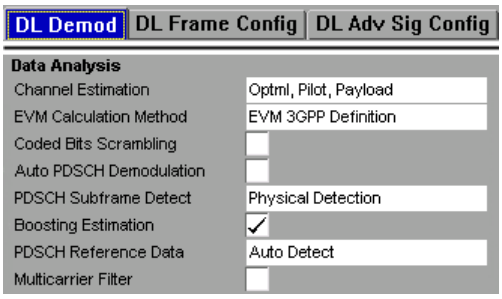
4.2 Demodulation Settings for Downlink Measurements

In the Demod Settings dialog box you can set up the measurement in detail, e.g. the demodulation configuration. The dialog box is made up of three tabs, one for configuring the signal configuration, one for setting up the frame configuration and one for configuring the control channels and miscellaneous settings. By default, the "DL Demod" tab is the active one. You can switch between the tabs with the cursor keys.

4.2.1 DL Demod

In the DL Demod tab you can set the signal processing configuration with respect to how the signal is to be measured.

4.2.1.1 Data Analysis Settings



Channel Estimation
Selects the method of channel estimation.

- **EVM 3GPP Definition**
  Channel estimation according to 3GPP TS 36.141. This method is based on averaging in frequency direction and linear interpolation. Examines the reference signal only.
- **Optimal, Pilot only**
  Optimal channel estimation method. Examines the reference signal only.
- **Optimal, Pilot and Payload**

Optimal channel estimation method. Examines both the reference signal and the payload resource elements.

SCPI command:
[SENSe][:LTE]:DL:DEMod:CESTimation on page 102

EVM Calculation Method
Selects the method to calculate the EVM.

- **EVM 3GPP Definition**
  Calculation of the EVM according to 3GPP TS 36.141. Evaluates the EVM at two trial timing positions and then uses the maximum EVM of the two.
- **At Optimal Timing Position**
  Calculates the EVM using the optimal timing position.

SCPI command:
[SENSe][:LTE]:DL:DEMod:EVMCalc on page 103

Scrambling of Coded Bits
Turns the scrambling of coded bits for all physical channels like PDSCH or PHICH on and off.

The scrambling of coded bits affects the bitstream results.

SCPI command:
[SENSe][:LTE]:DL:DEMod:CBSCrambling on page 102

Auto PDSCH Demodulation
Turns automatic demodulation for the PDSCH on and off.

If active, the R&S FSQ automatically detects the PDSCH resource allocation by analyzing the signal or the protocol information in the PDCCH.

You can set the way the R&S FSQ identifies the resource allocation with PDSCH Subframe Configuration Detection.

SCPI command:
[SENSe][:LTE]:DL:DEMod:AUTO on page 102

PDSCH Subframe Configuration Detection
Selects the method of identifying the PDSCH resource allocation.

- Off
  Uses the user configuration to demodulate the PDSCH subframe. If the user configuration does not match the frame that was measured, a bad EVM will result.
- PDCCH protocol
  Sets the PDSCH configuration according to the data in the protocol of the PDCCH DCIs.
- Physical detection
  If manual PDSCH configuration is active, the R&S FSQ compares the demodulated LTE frame to the user configuration. Only if both configurations are the same, the R&S FSQ will analyze the frame.
  Physical detection makes measurements on TDD E-TMs without a 20 ms trigger signal possible.

If automatic detection of the PDSCH configuration is active, the R&S FSQ identifies the configuration from the modulation of the signal.

SCPI command:
[SENSe][:LTE]:DL:FORMat:PSCD on page 104

Boosting Estimation
Turns boosting estimation on and off.

If active, the R&S FSQ automatically sets the relative power settings of all physical channels and the P-/S-SYNC by analyzing the signal.

SCPI command:
[SENSe][:LTE]:DL:DEMod:BESTimation on page 102

PDSCH Reference Data
Selects the type of reference data to calculate the EVM for the PDSCH.

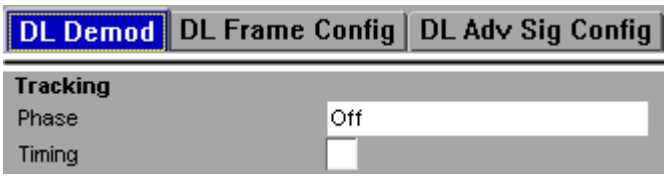
- Auto detect
  Automatically identifies the reference data for the PDSCH by analyzing the signal.
- All 0 (E-TM)
  Sets the PDSCH reference data to a fixed value of 0. This value is according to the test model definition.
  To get valid results, you have to use a DUT that transmits an all-zero data vector. This setting is a good way if you are expecting signals with a high EVM because the automatic detection will not be reliable in that case.

SCPI command:
[SENSe][:LTE]:DL:DEMod:PRData on page 103

Multicarrier Filter
Turns the suppression of interference of neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

SCPI command:
[SENSe][:LTE]:DL:DEMod:MCFilter on page 103

4.2.1.2 Tracking



Phase
Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

- **Off**
  Phase tracking is not applied.
- **Pilot only**

Only the reference signal is used.

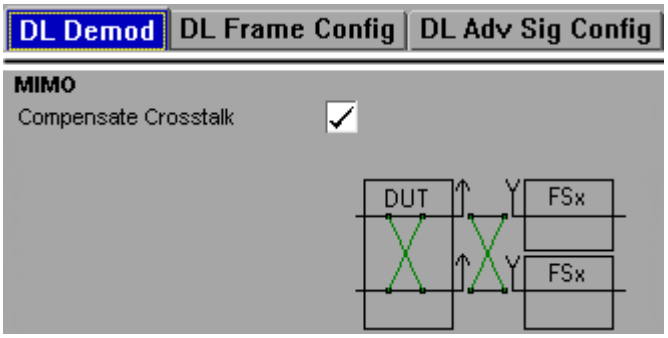
- **Pilot and Payload**
  Both reference signal and payload resource elements are used.

SCPI command:
[SENSe][:LTE]:DL:TRACking:PHASe on page 104

Timing
Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

SCPI command:
[SENSe][:LTE]:DL:TRACking:TIME on page 104

4.2.1.3 MIMO Settings



Compensate Crosstalk
Specifies if crosstalk produced by the device under test will be compensated or not. The crosstalk compensation must be activated for Time Alignment Error measurements.

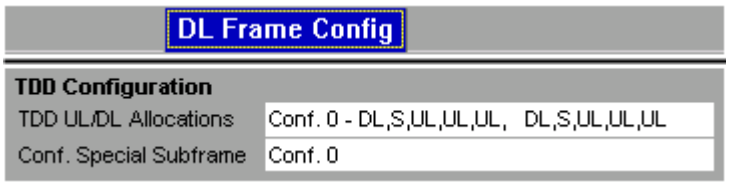
SCPI command:
CONFigure[:LTE]:DL:MIMO:CROSstalk on page 78

4.2.2 DL Frame Config

In the DL Frame Config tab you can set the structure of the signal.

4.2.2.1 Configuring TDD Frames

Note that you need firmware application R&S FSQ-K104 to perform measurements on TDD signals.



Configuring TDD Frames

TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

TDD UL/DL Allocations

Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

Configuration	Subframe Number and Usage									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

U = uplink
D = downlink
S = special subframe

Conf. of Special Subframe

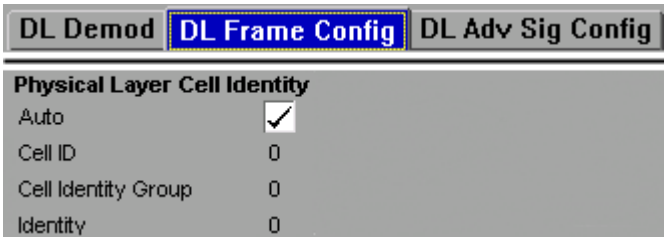
In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS
  The DwPTS is the downlink part of the special subframe. It is used to transmit downlink data.
- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 9 different configurations for the special subframe. However, configurations 7 and 8 only work for a normal cyclic prefix. If you select it using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

SCPI command:
Subframe
`CONFigure[:LTE]:DL:TDD:UDConf` on page 85
Special Subframe
`CONFigure[:LTE]:DL:TDD:SPSC` on page 85

4.2.2.2 Configuring the Physical Layer Cell Identity



Configuring the Physical Layer Cell Identity
The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the R&S FSQ automatically updates the other two.

For automatic detection of the cell ID, turn the "Auto" function on.

Before it can establish a connection, the user equipment must synchronize to the radio cell it is in. For this purpose, two synchronization signals are transmitted on the downlink. These two signals are reference signals whose content is defined by the "Physical Layer Identity" and the "Cell Identity Group".

The first signal is one of 3 possible Zadoff-Chu sequences. The sequence that is used is defined by the physical layer identity. It is contained in the P-SYNC.

The second signal is one of 168 unique sequences. The sequence is defined by the cell identity group. This sequence is contained in the S-SYNC.

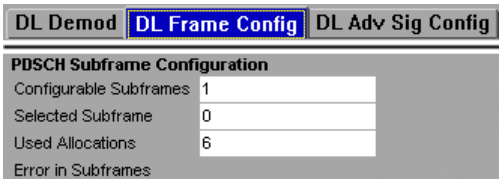
In addition to the synchronization information, the cell ID also determines

- the cyclic shifts for PCFICH, PHICH and PDCCH mapping,
- the frequency shifts of the reference signal.

4.2.2.3 Configuring PDSCH Subframes

The application allows you to configure individual subframes that are used to carry the information of the PDSCH. The PDSCH (Physical Downlink Shared Channel) primarily carries all general user data. It therefore takes up most of the space in a radio frame.

If you turn "Auto Demodulation" on, the appplication automatically determines the subframe configuration for the PDSCH. In the default state, automatic configuration is on.



Every LTE frame (FDD and TDD) contains 10 subframes. Each downlink subframe consists of one or more (resource) allocations. The R&S FSQ shows the contents for each subframe in the configuration table. In the configuration table, each row corresponds to one allocation.

ID / N_RNTI	Code Word	Modulation	Number of RB	Offset RB	Rho A (Power)/dB	Confl.
0	1/1	QPSK	4	6	0 dB	
1	1/1	QPSK	2	10	0 dB	
2	1/1	QPSK	4	0	0 dB	
3	1/1	QPSK	2	5	0 dB	
4	1/1	QPSK	2	12	0 dB	
5	1/1	QPSK	1	14	0 dB	

If there are any errors or conflicts between allocations in one or more subframes, the R&S FSQ shows the number of errors and the number of the corrupt subframe in the "Error in Subframes" field. It does not show the kind of error.

Before you start to work on the contents of each subframe, you should define the number of subframes you want to customize with the "Configurable Subframes" parameter. The application supports the configuration of up to 40 subframes.

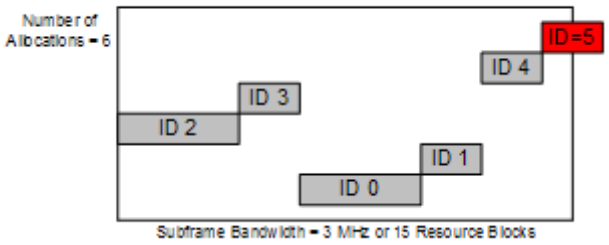
Then you can select a particular subframe that you want to customize in the "Selected Subframe" field. Enter the number of the subframe (starting with 0). The R&S FSQ will update the contents of the configuration table to the selected subframe.

In the default state, each subframe contains one allocation. You can add allocations with the "Used Allocations" parameter. The R&S FSQ will expand the configuration table accordingly with one row representing one allocation. You can define a different number of allocations for each subframe you want to configure and configure up to 100 allocations in every subframe.

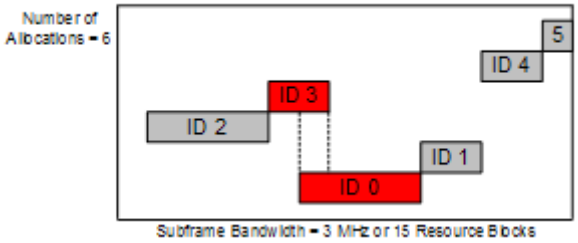
The configuration table contains the settings to configure the allocations.

- ID/N_RNTI
  Selects the allocation's ID. The ID corresponds to the N_RNTI.
  By default, the application assigns consecutive numbers starting with 0.
  The ID, or N_RNTI, is the user equipment identifier for the corresponding allocation and is a number in the range from 0 to 65535. The order of the numbers is irrelevant. You can combine allocations by assigning the same number more than once. Combining allocations assigns those allocations to the same user. Allocations with the same N_RNTI share the same modulation scheme and power settings.
- Code Word
  Shows the code word of the allocation.
  The code word is made up out of two numbers. The first number is the number of the code word in the allocation. The second number is the total number of code words that the allocation includes. Thus, a table entry of "1/2" would mean that the row corresponds to code word 1 out of 2 code words in the allocation.

- Modulation
  Selects the modulation scheme for the corresponding allocation.
  The modulation scheme for the PDSCH is either QPSK, 16QAM or 64QAM.
- Number of RB
  Sets the number of resource blocks the allocation covers. The number of resource blocks defines the size or bandwidth of the allocation.
  If you allocate too many resource blocks compared to the bandwidth you have set, the R&S FSQ will show an error message in the "Conflicts" column and the "Error in Subframes" field.
- Offset RB
  Sets the resource block at which the allocation begins.
  A wrong offset for any allocation would lead to an overlap of allocations. In that case the R&S FSQ will show an error message.
- Power [dB]
  Sets the boosting of the allocation. Boosting is the allocation's power relative to the reference signal power.
- Conflict
  If there is a conflict between allocations in the displayed subframe, this column shows the type of conflict and the ID of the allocations that are affected. Possible errors are:
  – bandwidth error (">BW")
    A bandwidth error occurs when the number of resource blocks in the subframe exceeds the bandwidth you have set.



  – RB overlap errors
    An RB overlap error occurs if one or more allocations overlap. In that case, check if the length and offset values of the allocations are correct.



SCPI command:
Configurable Subframes
CONFigure[:LTE]:DL:CSUBframes on page 77
Used Allocations
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount on page 83
Modulation
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<cw>]:MODulation on page 84
Number of RB
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount on page 83
Offset RB
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset on page 84
Power
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer on page 83

4.2.3 DL Advanced Signal Configuration

In the DL Adv Sig Config tab you can describe the advanced structure of the signal.

Note that the power settings of the channels are in relation to the power of the reference signal.

4.2.3.1 Global Settings

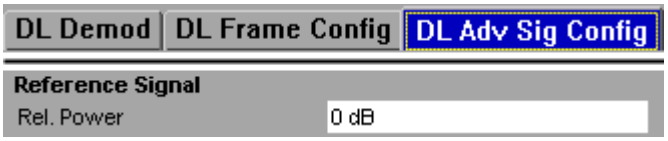
PRB Symbol Offset
PRB Symbol Offset specifies the symbol offset of the PDSCH allocations relative to the subframe start. This setting applies to all subframes in a frame.

With this settings, the number of OFDM symbols used for control channels is defined, too. For example, if this parameter is set to 2 and the PDCCH is enabled, the number of OFDM symbols actually used by the PDCCH is 2.

Special control channels like the PCFICH or PHICH require a minimum number of control channel OFDM symbols at the beginning of each subframe. If PRB Symbol Offset is lower than the required value, the control channel data then overwrite some resource elements of the PDSCH.

SCPI command:
CONFigure[:LTE]:DL:PSOFfset on page 82

4.2.3.2 Defining the Structure of the Reference Signal

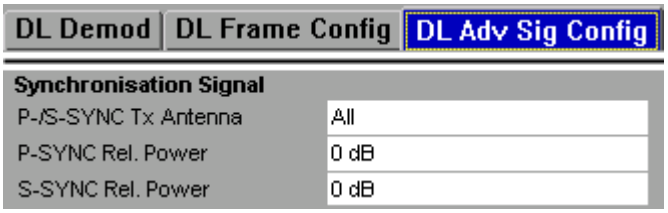


Rel Power
Defines the relative power of the reference signal compared to all the other physical signals and physical channels.

Note that this setting gives you an offset to all other relative power settings.

SCPI command:
`CONFigure[:LTE]:DL:REFSig:POWer` on page 82

4.2.3.3 Configuring the Synchronization Signal



P-/S-SYNC Tx Antenna
Selects the antenna that transmits the P-SYNC and the S-SYNC.

When selecting the antenna, you implicitly select the synchronization method. If the selected antenna transmits no synchronization signal, the R&S FSQ uses the reference signal to synchronize. Note that automatic cell ID detection is not available if synchronization is based on the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:SYNC:ANTenna` on page 84

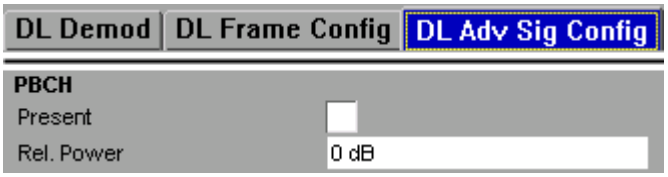
P-SYNC Relative Power
Relative power of the P-SYNC signals.

SCPI command:
`CONFigure[:LTE]:DL:SYNC:PPOWer` on page 84

S-SYNC Relative Power
Relative power of the S-SYNC signals.

SCPI command:
`CONFigure[:LTE]:DL:SYNC:SPOWer` on page 85

4.2.3.4 Configuring the PBCH



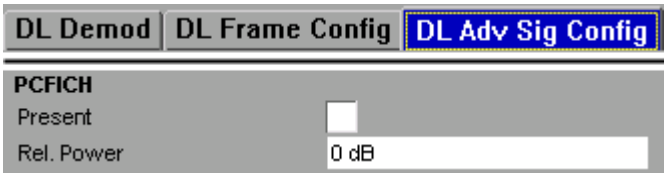
Present
PBCH Present specifies whether the physical broadcast channel is present or not.

SCPI command:
`CONFigure[:LTE]:DL:PBCH:STAT` on page 79

Rel Power
Relative Power of the PBCH.

SCPI command:
`CONFigure[:LTE]:DL:PBCH:POWer` on page 79

4.2.3.5 Configuring the PCFICH



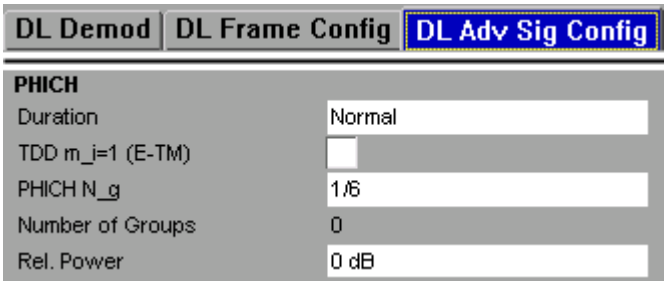
Present
PCFICH Present specifies whether the physical control format channel is present or not.

SCPI command:
`CONFigure[:LTE]:DL:PCFich:STAT` on page 79

Rel Power
Relative Power of the PCFICH.

SCPI command:
`CONFigure[:LTE]:DL:PCFich:POWer` on page 79

4.2.3.6 Configuring the PHICH



Duration
Selects the duration of the PHICH. Normal and extended duration are supported.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:DURation` on page 80

TDD m_i=1 (E-TM)
Turns the special setting of the PHICH for the enhanced test models on and off.

The special setting is defined in 36.141 V9.0.0, 6.1.2.6: "For frame structure type 2 the factor m_i shall not be set as per TS36.211, Table 6.9-1, but instead shall be set to m_i=1 for all transmitted subframes."

The parameter is available if you have selected TDD.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:MITM` on page 80

PHICH N_g
Sets the variable N_g.

N_g in combination with the number of resource blocks defines the number of PHICH groups in a downlink subframe. The standard specifies several values for N_g that you can select from the dropdown menu.

If you need a customized configuration, you can set the number of PHICH groups in a subframe by selecting the "Custom" menu item and set a number of PHICH groups directly with Number Of Groups.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:NGParameter` on page 81

Number Of Groups
Sets the number of PHICH groups contained in a subframe.

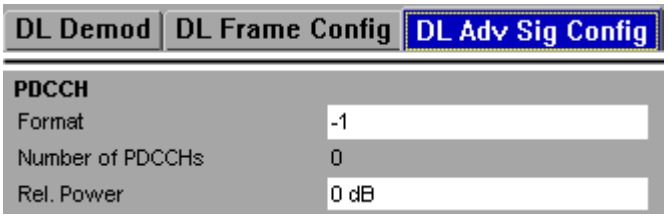
To select a number of groups, you have to set the PHICH N_g to "Custom".

SCPI command:
`CONFigure[:LTE]:DL:PHICh:NOGRoups` on page 81

Rel Power
Relative Power of the PHICH.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:POWer` on page 81

4.2.3.7 Configuring the PDCCH



PDCCH Format
Defines the format of the PDCCH (physical downlink control channel).

Note that PDCCH format "-1" is not defined in the standard. This format corresponds to the transmission of one PDCCH on all available resource element groups. As a special case for this PDCCH format, the center of the constellation diagram is treated as a valid constellation point.

SCPI command:
`CONFigure[:LTE]:DL:PDCCh:FORMat` on page 79

Number Of PDCCH
Sets the number of physical downlink control channels.

This parameter is available if the PDCCH format is -1.

SCPI command:
`CONFigure[:LTE]:DL:PDCCh:NOPD` on page 80

Rel Power
Relative Power of the PDCCH.

SCPI command:
`CONFigure[:LTE]:DL:PDCCh:POWer` on page 80

4.3 Measurement Settings

The Measurement Settings are for setting up the result displays. These settings are independent of the signal, they adjust the display of the results. You can open the dialog box via the "Meas Settings" softkey. The corresponding dialog box is made up of three tabs. By default, the "Selection" tab is the active one. You can switch between the tabs with the cursor keys.

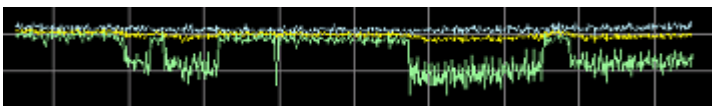
4.3.1 Selection

In the Selection tab you can select specific parts of the signal you want to analyze.

Subframe Selection
With the Subframe Selection, subframe-specific measurement results can be selected. This setting applies to the following measurements: Result Summary, EVM vs. Carrier, EVM vs. Symbol, Channel Flatness, Channel Group Delay, Channel Flatness Difference, Constellation diagram, Allocation Summary list and Bit Stream. If ---All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Example

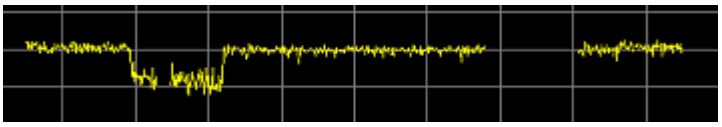
If you select --All---, the R&S FSQ shows the minimum / mean / maximum statistic.



with AV MI PK

- PK: peak value
- AV: average value
- MI: minimum value

If you instead select a specific subframe, the R&S FSQ shows only the results of that subframe.



SCPI command:
`[SENSe][:LTE]:SUBFrame:SELect` on page 105

4.3.2 Units

In the Units tab you can define the unit for various measurements.

EVM Unit
The EVM Unit setting allows you to display EVM results in the graphs and the numerical results in dB or %.

SCPI command:
`UNIT:EVM` on page 116

4.3.3 Misc

In the Misc tab you can set miscellaneous parameters.

Bit/Symbols Format
The Bit/Symbols Format setting allows you to display the bit stream as symbols (the bits belonging to one symbol are shown as hexadecimal numbers, always with two digits) or raw bits.

Examples:

B Bit Stream Subframe(s) ALL

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PBCH	1/1	QPSK	0	02 00 00 00 01 00 00 02 00 03 00 00 02 01 03 00
0	PBCH	1/1	QPSK	16	02 02 02 03 00 00 03 01 03 02 02 01 02 03 02 01
0	PBCH	1/1	QPSK	32	00 01 01 00 00 02 02 03 01 00 03 03 03 01 02 01
0	PBCH	1/1	QPSK	48	00 02 01 01 02 03 03 03 00 02 01 02 02 02 01 02

Fig. 4-1: Bit stream display in downlink application if the bit stream format is set to "symbols"

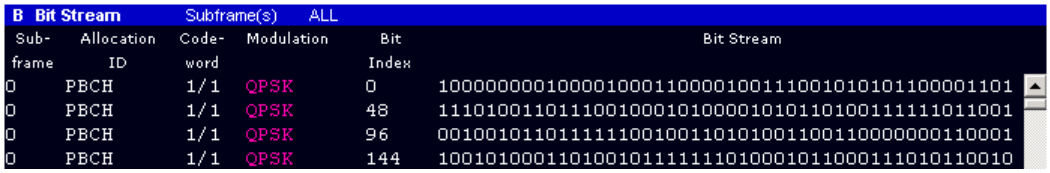


Fig. 4-2: Bit stream display in downlink application if the bit stream format is set to "bits"

SCPI command:
`UNIT:BSTR` on page 116

4.4 ACLR Settings

The ACLR Settings are parameters for configuring the Adjacent Channel Leakage Ratio measurement.

The ACLR settings become available in the side menu of the measurement menu after you have turned the ACLR measurement on.

1. Press the MEAS key.
2. Press the "ACLR" softkey.

   The R&S FSQ starts the ACLR measurement.
3. Press the NEXT key.

   The R&S FSQ opens the side menu.
4. Press the "ACLR Settings" softkey.

Assumed Adjacent Channel Carrier
Selects the assumed adjacent channel carrier for the ACLR measurement. The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

SCPI command:
`[SENSe]:POWer:ACHannel:AACHannel` on page 106

Noise Correction
Turns noise correction on and off.

For more information see the manual of the R&S FSQ.

Note that the input attenuator makes a clicking noise after every sweep if you are using the noise correction in combination with the auto leveling process.

SCPI command:
[SENSe]:POWer:NCORrection on page 107

4.5 SEM Settings

The SEM Settings are parameters for configuring the Spectrum Emission Mask measurement.

The SEM settings become available in the side menu of the measurement menu after you have turned the SEM measurement on.

1. Press the MEAS key.
2. Press the "SEM" softkey.

   The R&S FSQ starts the SEM measurement.
3. Press the NEXT key.

   The R&S FSQ opens the side menu.
4. Press the "SEM Settings" softkey.

Channel
Selects the Category (A or B) to be used for the Spectrum Emission Mask measurement.

SCPI command:
[SENSe]:POWer:SEM:CATegory on page 107

4.6 Display and Printer Settings

The layout of the display can be controlled using the display menu. The DISP key opens the display softkey menu.

In the display menu, you can switch between split and full screen mode with the "Screen Size" softkey. In split screen mode, you can select screen A or screen B with the "Screen A" / "Screen B" hotkey. The "Screen A" / "Screen B" hotkey also toggles screen A and B in full screen mode.

The HCOPY key opens the print menu. Any open settings dialog boxes are closed when the print menu is displayed.

The print functions are the same as those provided in the base unit. Refer to the operating manual of the R&S FSQ for details on the softkey functionality.

5 Result Displays

This chapter provides a detailed description of all available result displays of the LTE measurement application.

Press the MEAS key to access the result display menu. There you can select the required result display by pressing the corresponding softkey.

Note that some softkeys include more than one result display. The currently selected result display is highlighted on the corresponding softkey.

5.1 Numerical Results

In addition to graphical result displays, the R&S FSQ also provides a table containing numerical results. You can switch between numerical and graphical results with the "Display (List Graph)" softkey.

Display (List Graph)
Press the Display (List Graph) softkey so that the "List" element turns green to start the Result Summary result display. This result display summarizes all relevant measurement results in one table.

Result Summary						
Frame Result 1/1	Min	Mean	Limit	Max	Limit	Unit
EVM PDSCH QPSK		0.35	17.50			%
EVM PDSCH 16QAM			12.50			%
EVM PDSCH 64QAM			8.00			%
Time Alignment Error 2,1						ns
Time Alignment Error 3,1						ns
Time Alignment Error 4,1						ns
Results for Selection	Subframe(s) ALL	Selection	Antenna 1	Frame Result 1/1		
EVM All	0.34	0.35		0.36		%
EVM Phys. Channel	0.34	0.35		0.36		%
EVM Phys. Signal	0.33	0.35		0.36		%
Frequency Error	- 35.44	- 35.36		- 35.26		Hz
Sampling Error	- 0.07	- 0.04		- 0.01		ppm
IQ Offset	- 68.33	- 67.16		- 66.53		dB
IQ Gain Imbalance	- 0.00	- 0.00		- 0.00		dB
IQ Quadrature Error	0.02	0.02		0.02		°
RSTP	- 57.96	- 57.95		- 57.95		dBm
OSTP	- 30.17	- 30.17		- 30.17		dBm
Power	- 30.25	- 30.23		- 30.22		dBm
Crest Factor		10.05				dB

The table is split in two parts. The first part shows results that refer to the complete frame. For each result, the minimum, mean and maximum values are displayed. It also provides limit checking for result values in accordance with the selected standard. 'Pass' results are green and 'Fail' results are red.

- **EVM PDSCH QPSK**

Shows the EVM for all QPSK-modulated resource elements of the PDSCH channel in the analyzed frame.
FETCh:SUMMary:EVM:DSQP[:AVERage] on page 89

- **EVM PDSCH 16QAM**
  Shows the EVM for all 16QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
  FETCh:SUMMary:EVM:DSST[:AVERage] on page 90
- **EVM PDSCH 64QAM**
  Shows the EVM for all 64QAM-modulated resource elements of the PDSCH channel in the analyzed frame.
  FETCh:SUMMary:EVM:DSSF[:AVERage] on page 90
- **Time Alignment Error 2,1 / 3,1 / 4,1**
  Shows the timing difference in MIMO setups between antenna 1 and another antenna (2, 3 or 4).
  FETCh:SUMMary:TAE<antenna> on page 94

By default, all EVM results are in %. However, you can change the EVM unit in the EVM Unit field.

The second part of the table shows results that refer to a specifc selection of the frame. The header row of the second section of the table shows the selected subframe.

Note that in some cases it is not possible to measure the IQ Gain Imbalance and IQ Quadrature Error. Try to step through the subframes using the Subframe Selection to find a subframe where the measurement is available. If subframe selection is set to "All", a measurement result is available only if there are valid results in all subframes.

- **EVM All**
  Shows the EVM for all resource elements in the analyzed frame.
  FETCh:SUMMary:EVM[:ALL][:AVERage] on page 91
- **EVM Phys Channel**
  Shows the EVM for all physical channel resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PCHannel[:AVERage] on page 90
- **EVM Phys Signal**
  Shows the EVM for all physical signal resource elements in the analyzed frame.
  FETCh:SUMMary:EVM:PSIGnal[:AVERage] on page 91
- **Frequency Error**
  Shows the difference in the measured center frequency and the reference center frequency.
  FETCh:SUMMary:FERRor[:AVERage] on page 91
- **Sampling Error**
  Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
  FETCh:SUMMary:SERRor[:AVERage] on page 94
- **I/Q Offset**
  Shows the power at spectral line 0 normalized to the total transmitted power.
  FETCh:SUMMary:IQOFfset[:AVERage] on page 92
- **I/Q Gain Imbalance**
  Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
  FETCh:SUMMary:GIMBalance[:AVERage] on page 92
- **I/Q Quadrature Error**

Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.
FETCh:SUMMary:QUADerror[:AVERage] on page 93

- **RSTP**
  Shows the reference signal transmit power as defined in 3GPP TS 36.141.
  FETCh:SUMMary:RSTP[:AVERage] on page 93
- **OSTP**
  Shows the OFDM symbol transmit power as defined in 3GPP TS 36.141.
  FETCh:SUMMary:OSTP[:AVERage] on page 92
- **Power**
  Shows the average time domain power of the analyzed signal.
  FETCh:SUMMary:POWer[:AVERage] on page 93
- **Crest Factor**
  Shows the peak-to-average power ratio of captured signal.
  FETCh:SUMMary:CRESt[:AVERage] on page 89

5.2 Power vs Time Result Displays

This chapter contains information on LTE result displays that show the power of the signal over time.

Capture Memory
The capture memory result display shows the complete range of captured data for the last data capture. The x-axis represents the time scale. The maximum value of the x-axis is equal to the capture length that you can set in the General Settings dialog box. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input) or V (baseband input).

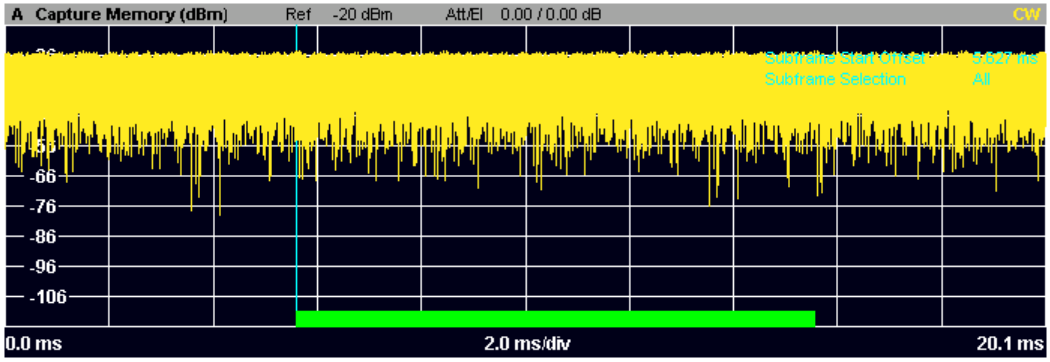


Fig. 5-1: Capture buffer without zoom

The header of the diagram shows the reference level, the mechanical and electrical attenuation and the trace mode.

The green bar at the bottom of the diagram represents the frame that is currently analyzed.

A blue vertical line at the beginning of the green bar in the Capture Buffer display marks the subframe start. Additionally, the graph includes the Subframe Start Offset value (blue text). This value is the time difference between the subframe start and capture buffer start.

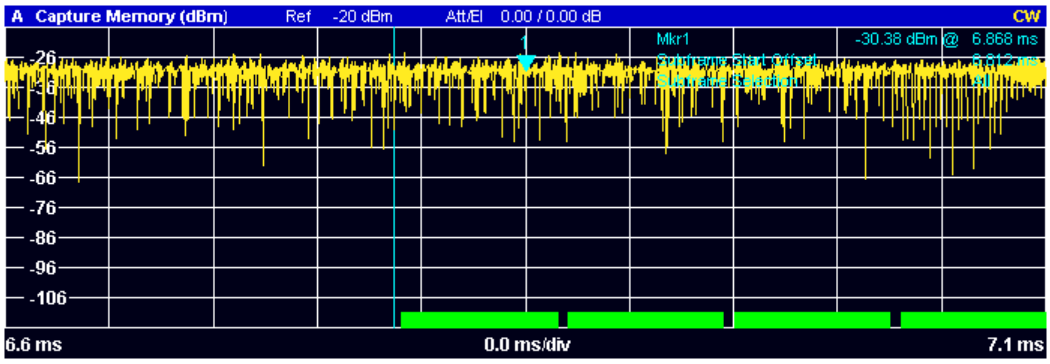


Fig. 5-2: Capture buffer after a zoom has been applied

CALCulate<screenid>:FEED 'PVT:CBUF'

5.3 EVM Results

One of the most important results to determine the quality of a signal is the Error Vector Magnitude or EVM. Refer to chapter 8.1, "Measurements in Detail", on page 66 for details on the mathematical foundations of the EVM measurement.

The R&S FSQ EUTRA/LTE Measurement Application offers various result displays to determine the EVM of the signal on different levels.

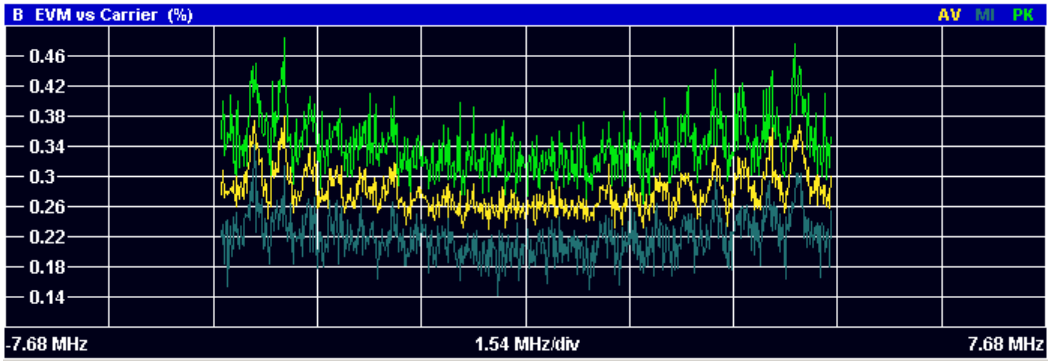
EVM vs Carrier
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

The displayed result is an average over all available OFDM symbols. By default, three traces are shown. One trace shows the average EVM. The second and the third trace show the minimum and maximum EVM values respectively. You can select to display the EVM for a specific subframe. In that case, the application shows the EVM of that subframe only.

For more information seechapter 4.3.1, "Selection", on page 42 .

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on your selection in the Measurement Settings dialog box.



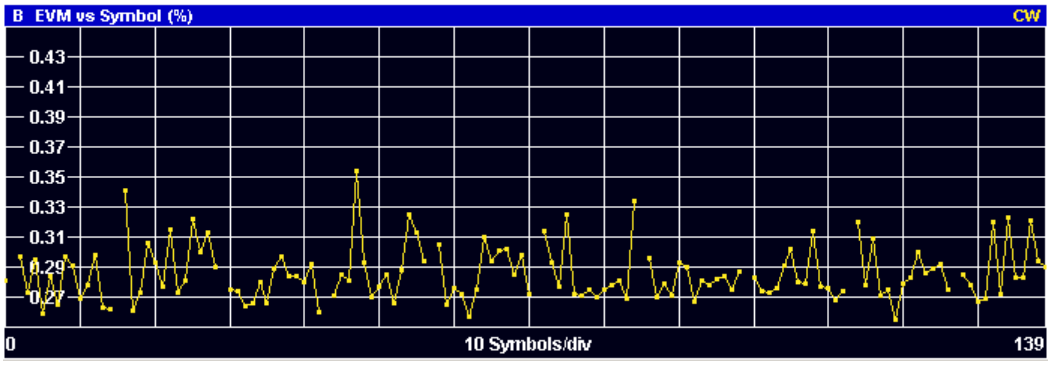
SCPI command:
CALCulate<screenid>:FEED 'EVM:EVCA'

EVM vs Symbol
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) on symbol level. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The result is an average over all subcarriers.

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSQ could not determine the EVM for that symbol. On the y-axis, the EVM is plotted either in % or in dB, depending on your selection in the Measurement Settings dialog box.



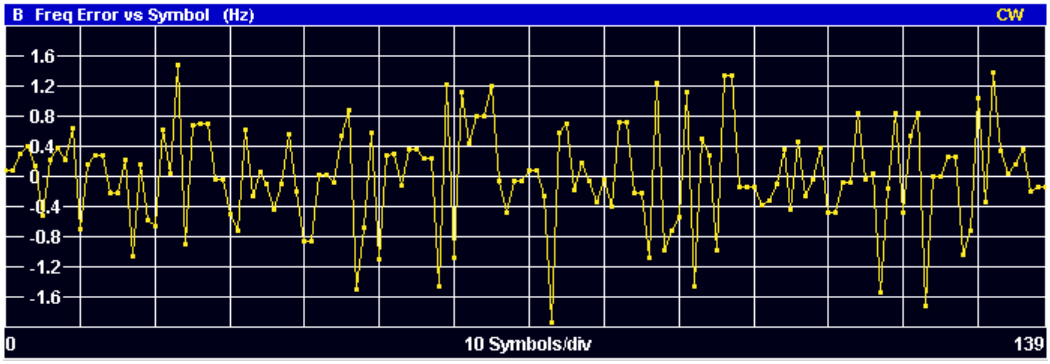
SCPI command:
CALCulate<screenid>:FEED 'EVM:EVSY'

Frequency Error vs Symbol
Starts the Frequency Error vs Symbol result display.

This result display shows the Frequency Error on symbol level. You can use it as a debugging technique to identify any frequency errors within symbols.

The result is an average over all subcarriers.

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSQ could not determine the frequency error for that symbol. On the y-axis, the frequency error is plotted in Hz.



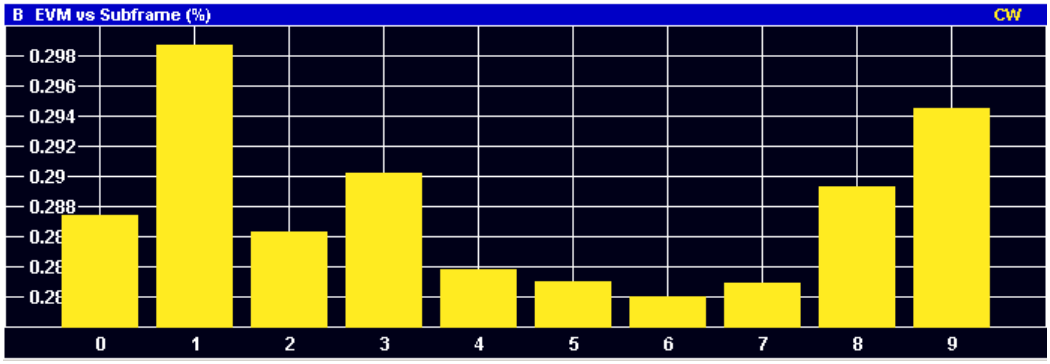
SCPI command:
CALCulate<screenid>:FEED 'EVM:EVVS'

EVM vs Subframe
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10. On the y-axis, the EVM is plotted either in % or in dB, depending on your selection in the Measurement Settings dialog box.



SCPI command:
CALCulate<screenid>:FEED 'EVM:EVSU'

5.4 Spectrum Measurements

This chapter contains the spectrum measurements. Spectrum measurements are separated into the frequency sweep measurements and I/Q measurements.

5.4.1 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available with the R&S FSQ EUTRA/LTE Measurement Application. They do not use the IQ data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an IQ measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurement use different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

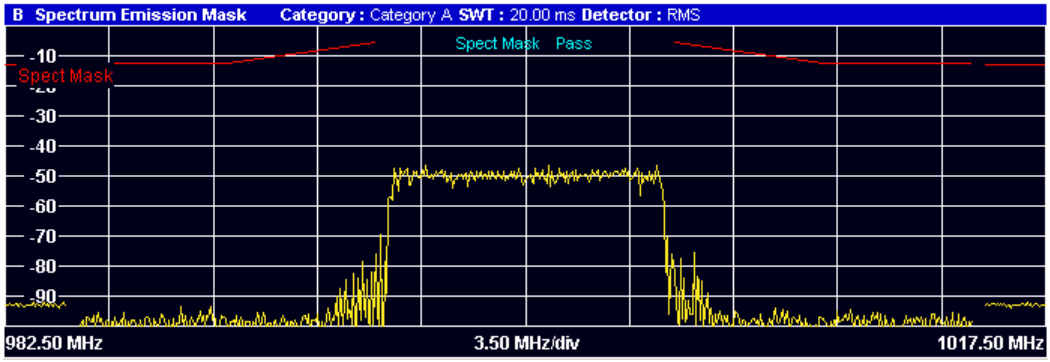
The ACLR and SEM measurements are available if RF input is selected.

Spectrum Emission Mask
Starts the Spectrum Emission Mask (SEM) result display.

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The R&S FSQ puts a label to the limit line to indicate whether the limit check passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.

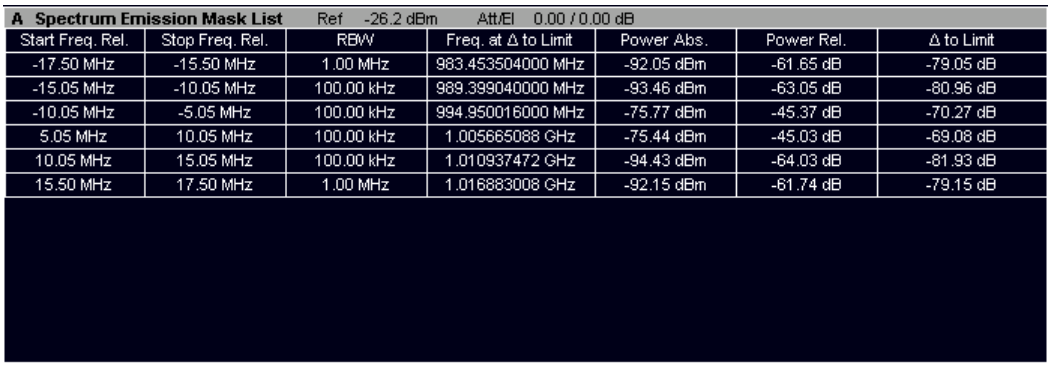


A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**

Shows the absolute power at the frequency whose power measurement being closest to the limit line; for the corresponding frequency segment.

- **Power Rel**
  Shows the power relative to the Reference Power at the frequency closest to the limit line; for the corresponding frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.



Start Freq. Rel.	Stop Freq. Rel.	RBW	Freq. at Δ to Limit	Power Abs.	Power Rel.	Δ to Limit
-17.50 MHz	-15.50 MHz	1.00 MHz	983.453504000 MHz	-92.05 dBm	-61.65 dB	-79.05 dB
-15.05 MHz	-10.05 MHz	100.00 kHz	989.399040000 MHz	-93.46 dBm	-63.05 dB	-80.96 dB
-10.05 MHz	-5.05 MHz	100.00 kHz	994.950016000 MHz	-75.77 dBm	-45.37 dB	-70.27 dB
5.05 MHz	10.05 MHz	100.00 kHz	1.005665088 GHz	-75.44 dBm	-45.03 dB	-69.08 dB
10.05 MHz	15.05 MHz	100.00 kHz	1.010937472 GHz	-94.43 dBm	-64.03 dB	-81.93 dB
15.50 MHz	17.50 MHz	1.00 MHz	1.016883008 GHz	-92.15 dBm	-61.74 dB	-79.15 dB

SCPI command:
CALCulate<screenid>:FEED 'SPEC:SEM'

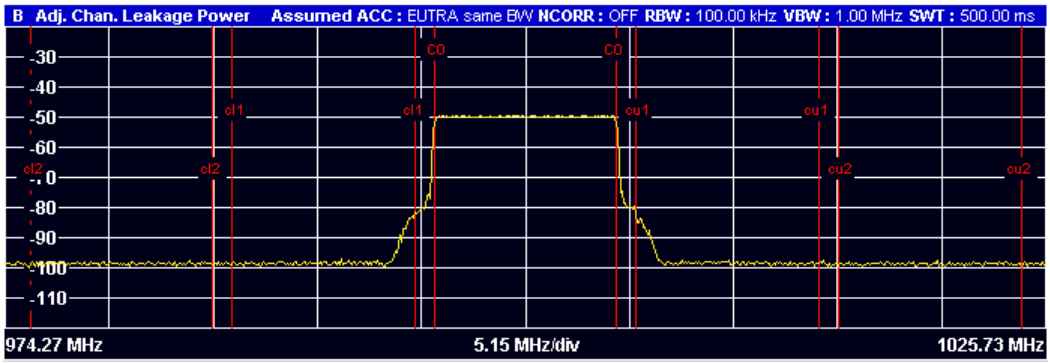
ACLR
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The Adjacent Channel Leakage Ratio measures the power of the TX channel and the power of adjacent and alternate channels to the left and right side of the TX channel. In this way, you can get information about the power of the channels adjacent to the transmission channel and the leakage into adjacent channels.

The results show the relative power measured in the two nearest channels either side of the transmission channel.

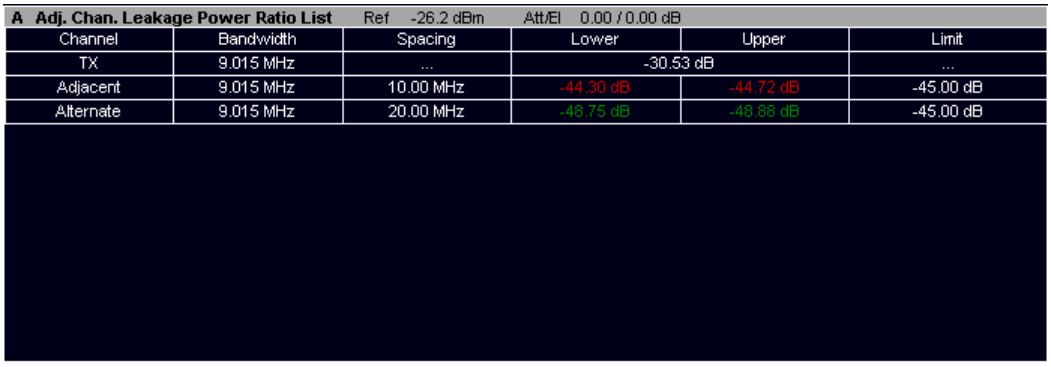
By default the ACLR Settings are derived from the LTE Channel Bandwidth setting of the Demodulation Settings Panel. You can change the assumed adjacent channel carrier type and the noise correction via the ACLR Settings.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent bandwidths. On the y-axis, the power is plotted in dBm.



A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
- **Bandwidth**
  Shows the bandwidth of the channel.
- **Spacing**
  Shows the channel spacing.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels
- **Limit**
  Shows the limit of that channel, if one is defined.



Channel	Bandwidth	Spacing	Lower	Upper	Limit
TX	9.015 MHz	...	-30.53 dB		...
Adjacent	9.015 MHz	10.00 MHz	-44.30 dB	-44.72 dB	-45.00 dB
Alternate	9.015 MHz	20.00 MHz	-48.75 dB	-48.88 dB	-45.00 dB

SCPI command:
CALCulate<screenid>:FEED 'SPEC:ACP'

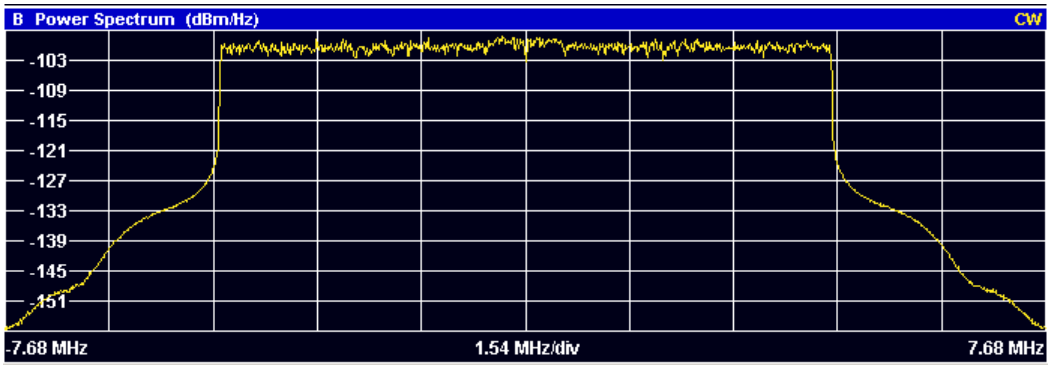
5.4.2 I/Q Result Displays

Power Spectrum
Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz. The displayed bandwidth depends on bandwidth or number of resource blocks you have set.

For more information see "Channel Bandwidth and Number of Resource Blocks" on page 20.

The x-axis represents the frequency. On the y-axis the power level is plotted.



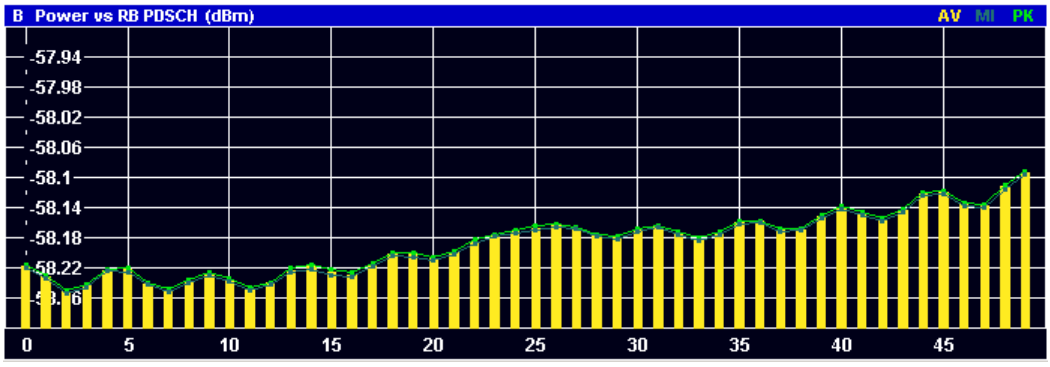
SCPI command:
CALCulate<screenid>:FEED 'SPEC:PSPE'

Power vs Resource Block PDSCH
Starts the Power vs Resource Block PDSCH result display.

This result display shows the power of the physical downlink shared channel per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the powers of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



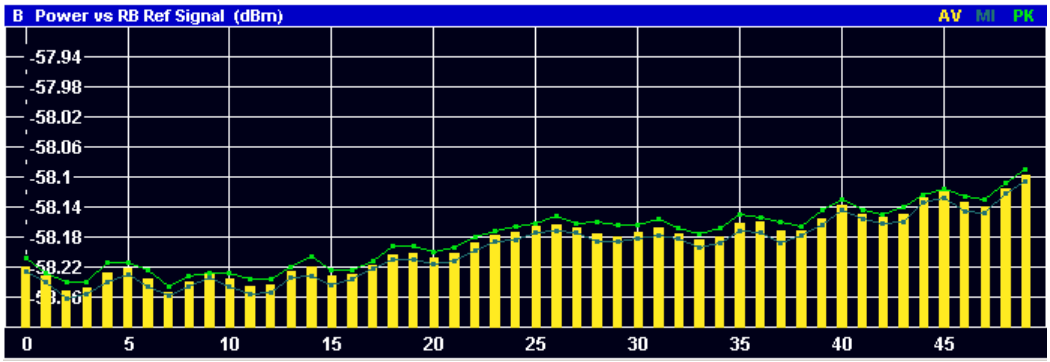
SCPI command:
CALCulate<screenid>:FEED 'SPEC:PVRP'

Power vs Resource Block RS
Starts the Power vs Resource Block RS result display.

This result display shows the power of the reference signal per resource block.

By default, three traces are shown. One trace shows the average power. The second and the third trace show the minimum and maximum powers respectively. You can select to display the power for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the power of that subframe only.

The x-axis represents the resource blocks. The displayed number of resource blocks depends on the channel bandwidth or number of resource blocks you have set. On the y-axis, the power is plotted in dBm.



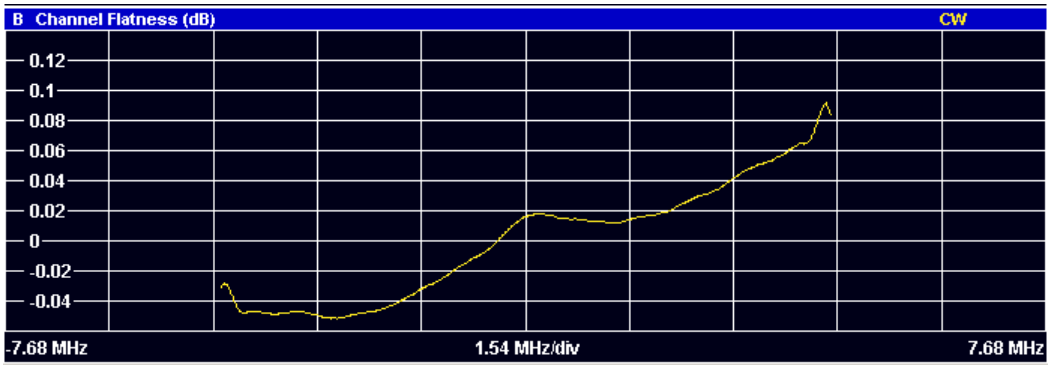
SCPI command:
CALCulate<screenid>:FEED 'SPEC:PVRR'

Channel Flatness
Starts the Channel Flatness result display.

This result display shows the amplitude of the channel transfer function.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection in the Measurement Settings dialog box.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.



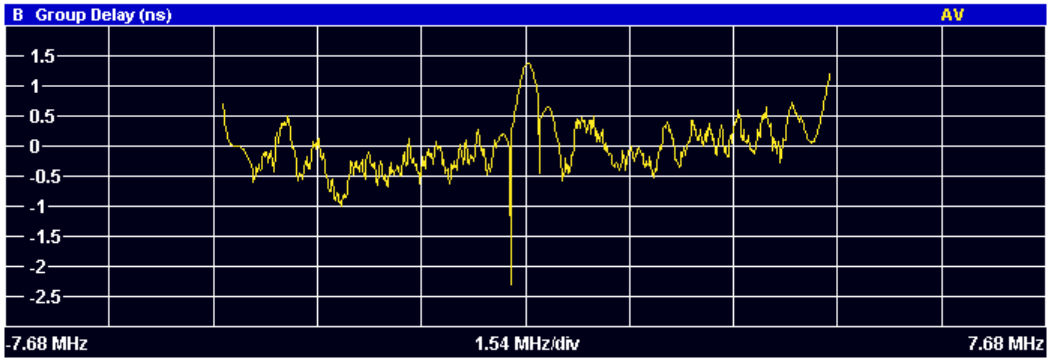
SCPI command:
CALCulate<screenid>:FEED 'SPEC:FLAT'

Channel Group Delay
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection in the Measurement Settings dialog box.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.



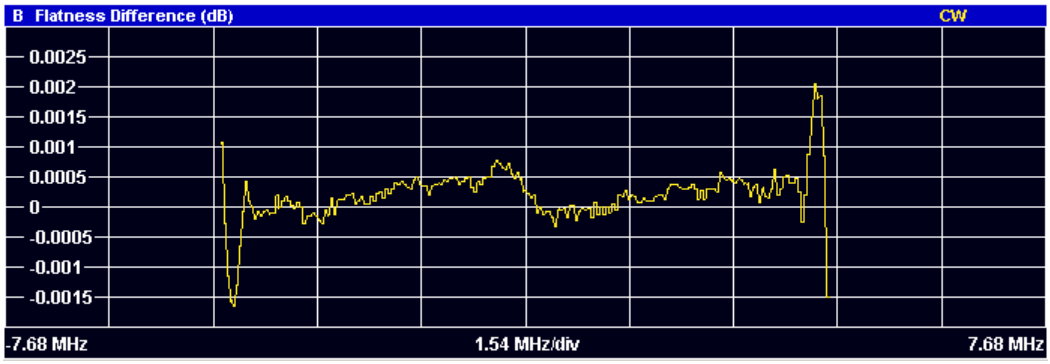
SCPI command:
CALCulate<screenid>:FEED 'SPEC:GDEL'

Channel Flatness Difference
Starts the Channel Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection in the Measurement Settings dialog box.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.



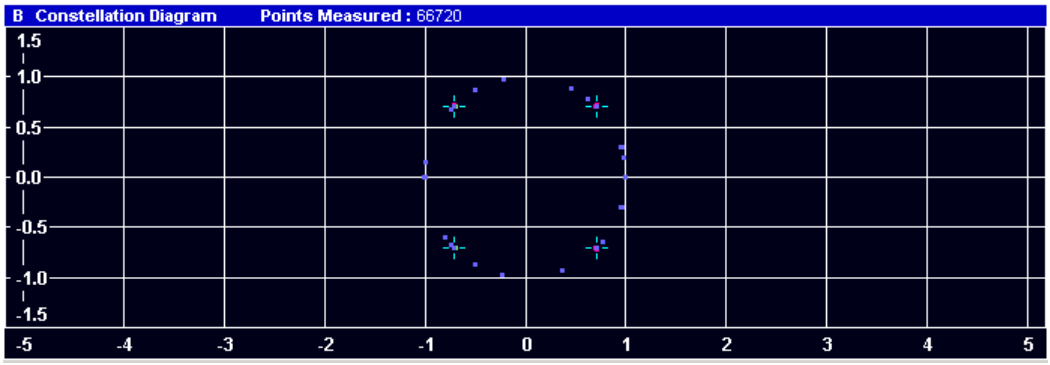
SCPI command:
CALCulate<screenid>:FEED 'SPEC:FDIF'

5.5 Constellation Diagrams

Constellation Diagram
Starts the Constellation Diagram result display.

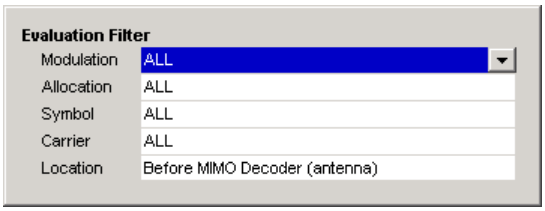
This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal. The result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

The ideal points for the selected modulation scheme are displayed for reference purposes.



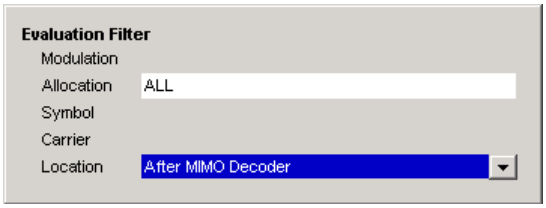
SCPI command:
CALCulate<screenid>:FEED 'CONS:CONS'

Constellation Selection
Opens a dialog box to filter the displayed results. You can filter the results by any combination of modulation, allocation ID, symbol, carrier or location. The results are updated as soon as any change to the constellation selection parameters is made.



You can filter the results by the following parameters:

- **Modulation**
  Filter by modulation scheme.
- **Allocation**
  Filter by allocation ID.
- **Symbol**
  Filter by OFDM symbol.
- **Carrier**
  Filter by subcarrier.
- **Location**
  Selects whether the R&S FSQ generates the constellation diagram before or after the MIMO decoder.
  If you use Spatial Multiplexing, symbols of different encoding schemes are merged in the MIMO encoder. Thus you get a mix of different modulation alphabets. Filter these symbols in the field "Modulation" with the value "MIXTURE". You get the mixed symbols only if "Location" is set to "Before MIMO decoder".
  If the location is "After MIMO Decoder", filters "Symbol" and "Carrier" are not available.



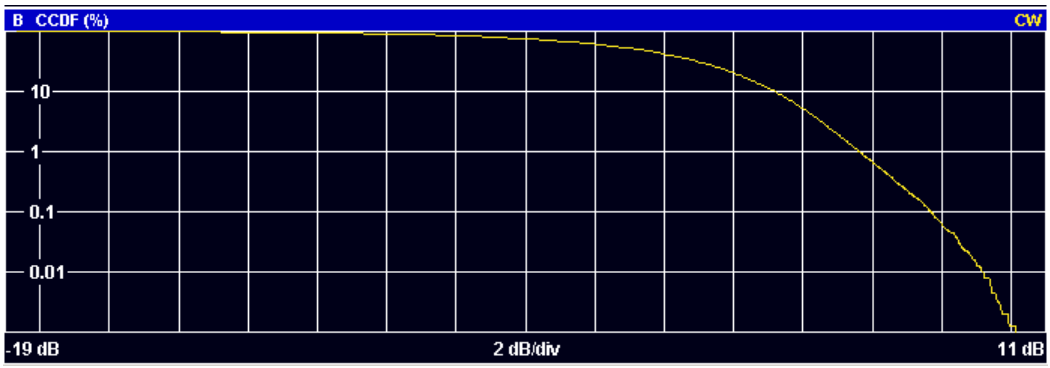
5.6 Statistical and Miscellaneous Results

CCDF

Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.



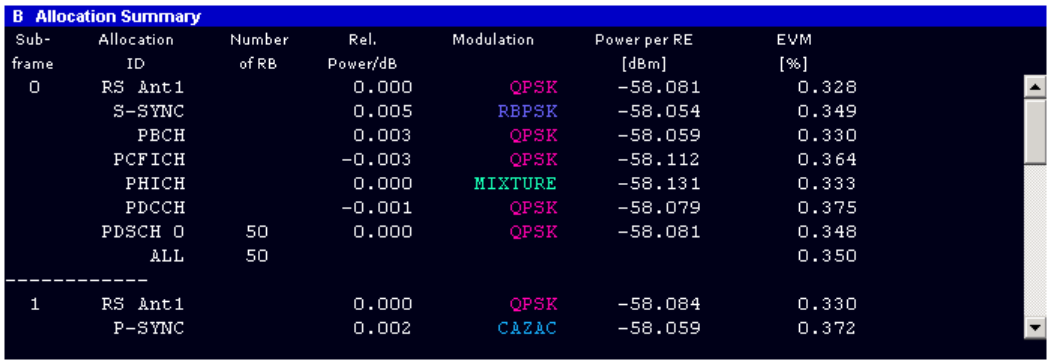
SCPI command:

CALCulate<screenid>:FEED 'STAT:CCDF'

Allocation Summary

Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.



The rows in the table represent the allocations, with allocation ALL being a special allocation that summarizes all allocations that are part of the subframe. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the follwing information:

The rows in the table represent the allocations. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the follwing information:

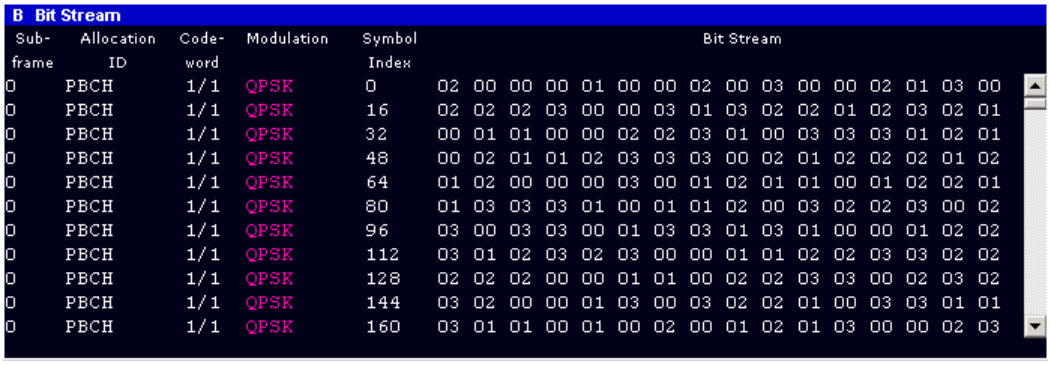
- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Rel. Power/dB**
  Shows the relative power of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power per RE [dBm]**
  Shows the power of each resource element in dBm.
- **EVM**
  Shows the EVM of the allocation. You can change the unit of the EVM in the Measurement Settings dialog box.

SCPI command:
CALCulate<screenid>:FEED 'STAT:ASUM'

Bit Stream
Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit/Symbols Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belonging to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.


B Bit Stream

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PBCH	1/1	QPSK	0	02 00 00 00 01 00 00 02 00 03 00 00 02 01 03 00
0	PBCH	1/1	QPSK	16	02 02 02 03 00 00 03 01 03 02 02 01 02 03 02 01
0	PBCH	1/1	QPSK	32	00 01 01 00 00 02 02 03 01 00 03 03 03 01 02 01
0	PBCH	1/1	QPSK	48	00 02 01 01 02 03 03 03 00 02 01 02 02 02 01 02
0	PBCH	1/1	QPSK	64	01 02 00 00 00 03 00 01 02 01 01 00 01 02 02 01
0	PBCH	1/1	QPSK	80	01 03 03 03 01 00 01 01 02 00 03 02 02 03 00 02
0	PBCH	1/1	QPSK	96	03 00 03 03 00 01 03 03 01 03 01 00 00 01 02 02
0	PBCH	1/1	QPSK	112	03 01 02 03 02 03 00 00 01 01 02 02 03 03 02 02
0	PBCH	1/1	QPSK	128	02 02 02 00 00 01 01 00 02 02 03 03 00 02 03 02
0	PBCH	1/1	QPSK	144	03 02 00 00 01 03 00 03 02 02 01 00 03 03 01 01
0	PBCH	1/1	QPSK	160	03 01 01 00 01 00 02 00 01 02 01 03 00 00 02 03

The table contains the following information:

- **Subframe**
  Number of the subframe the bits belong to.

- **Allocation ID**
  Channel the bits belong to.
- **Codeword**
  Code word of the allocation.
- **Modulation**
  Modulation type of the channels.
- **Bit Index**
- **Bit Stream**
  The actual bit stream.

SCPI command:
CALCulate<screenid>:FEED 'STAT:BSTR'

6 Using the Marker

The firmware application provides a marker to work with. You can use a marker to mark specific points on traces or to read out measurement results.

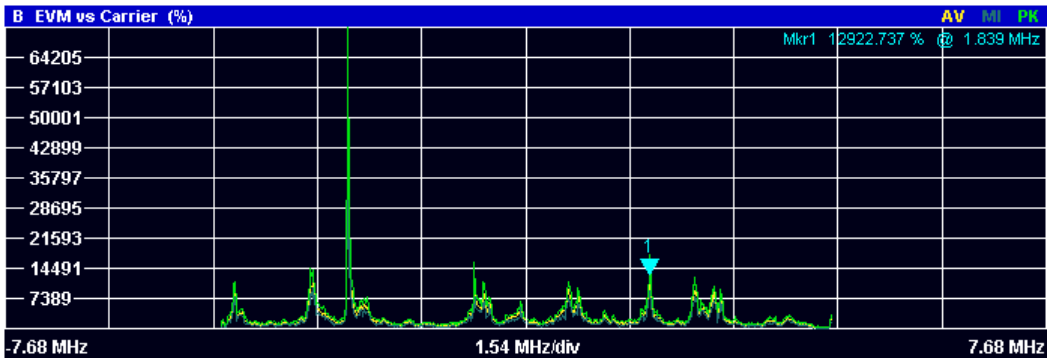


Fig. 6-1: Example: Marker

The MKR key opens the corresponding submenu. You can activate the marker with the "Marker 1" softkey. After pressing the "Marker 1" softkey, you can set the position of the marker in the marker dialog box by entering a frequency value. You can also shift the marker position by turning the rotary knob. The current marker frequency and the corresponding level is displayed in the upper right corner of the trace display.

The "Marker 1" softkey has three possible states:

If the "Marker 1" softkey is grey, the marker is off.

After pressing the "Marker 1" softkey it turns red to indicate an open dialog box and the the marker is active. The dialog box to specify the marker position on the frequency axis opens.

After closing the dialog box, the "Marker 1" softkey turns green. The marker stays active.

Pressing the "Marker 1" softkey again deactivates the marker. You can also turn off the marker by pressing the "Marker Off" softkey.

If you'd like to see the area of the spectrum around the marker in more detail, you can use the Marker Zoom function. Press the "Marker Zoom" softkey to open a dialog box in

which you can specify the zoom factor. The maximum possible zoom factor depends on the result display. The "Unzoom" softkey cancels the marker zoom.

Note that the zoom function is not available for all result displays.

If you have more than one active trace, it is possible to assign the marker to a specific trace. Press the "Marker -> Trace" softkey in the marker to menu and specify the trace in the corresponding dialog box.

CALCulate<n>:MARKer<m>[:STATe] on page 74

CALCulate<n>:MARKer<m>:AOFF on page 74

CALCulate<n>:MARKer<m>:TRACe on page 75

CALCulate<n>:MARKer<m>:X on page 75

CALCulate<n>:MARKer<m>:Y on page 75

7 File Management

7.1 File Manager

The root menu of the application includes a File Manager with limited functions for quick access to file management functionality.

Loading a Frame Setup

The frame setup or frame description describes the complete modulation structure of the signal, such as bandwidth, modulation, etc.

The frame setup is stored as an XML file. XML files are very commonly used to describe hierarchical structures in an easy-to-read format for both humans and PC.

A typical frame setup file would look like this:

```
<?xml version="1.0" encoding="utf-8"?>
<FrameDefinition LinkDirection="downlink" TDDULDLAllocationConfiguration="0" RessourceBlocks="50"
CP="auto" RefSigSubcarrierOffset="Auto" PSYNCBoostingdB="0" SSYNCBoostingdB="0"
ReferenceSignalBoostingdB="0" PBCHSymbolOffset="7" PBCHLength="4" PCFICHIsPresent="false"
PHICHNumGroups="0" PHICHDuration="Normal" PHICHBoostingdB="0" PDCCHIsPresent="false"
PSSYNCRepetitionPeriod="10" DataSymbolOffsetSubFrame="2" MIMOConfiguration="1 Tx Antenna"
MIMOAntennaSelection="Antenna 1" PhysLayCellIDGrp="Auto" PhysLayID="Auto"
RefSignal3GPPVersion="2" N_c_fastforward="0">
  <Frame>
    <Subframe>
      <PRBs>
        <PRB Start="0" Length="6" Boosting="0" Modulation="QPSK" Precoding="None" Layers="1"
Codebook="0" CDD="0"/>
      </PRBs>
    </Subframe>
  </Frame>
  <stControl PhaseTracking="1" TimingTracking="0" ChannelEstimation="1" EVMCalculationMethod="1"
EnableScrambling="1" AutoDemodulation="1"/>
</FrameDefinition>
```

All settings that are available in the "Demod Settings" dialog box are also in the frame setup file. You can enter additional allocations by adding additional PRB entries in the PRBs list.

Note that at least one PRB must exist.

To load a frame setup, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load Demod Setup" button.

Loading an I/Q File

The R&S FSQ is able to process I/Q data that has been captured with a R&S FSQ directly as well as data stored in a file. You can store I/Q data in various file formats in order to be able to process it with other external tools or for support purposes.

I/Q data can be formatted either in binary form or as ASCII files. The data is linearly scaled using the unit Volt (e.g. if a correct display of Capture Buffer power is required). For **binary** format, data is expected as 32-bit floating point data, Little Endian format (also

known as LSB Order or Intel format). An example for binary data would be: 0x1D86E7BB in hexadecimal notation is decoded to -7.0655481E-3. The order of the data is either IQIQIQ or II...IQQ...Q.

For ASCII format, data is expected as I and Q values in alternating rows, separated by new lines: <I value 1>, <Q value 1>, <I value 2>, <Q value 2>, ...

To use data that has been stored externally, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load IQ Data" button.

7.2 SAVE/RECALL Key

Besides the file manager in the root menu, you can also manage the data via the SAVE/RECALL key.

The corresponding menu offers full functionality for saving, restoring and managing the files on the R&S FSQ. The save/recall menu is the same as that of the spectrum mode. For details on the softkeys and handling of this file manager, refer to the operating manual of the R&S FSQ.

8 Further Information

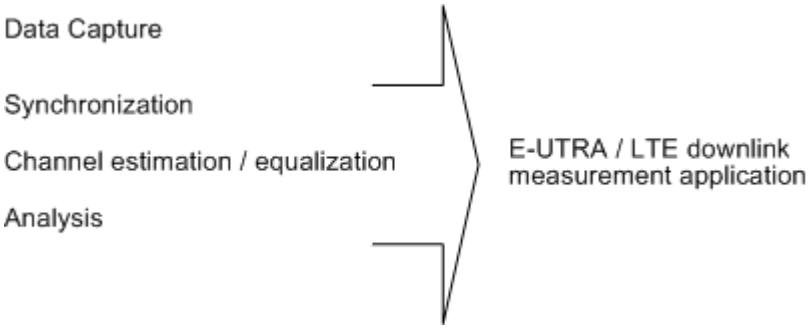
8.1 Measurements in Detail

This section provides a detailed explanation of the measurements provided by R&S FSQ-K100/-K104 and provides help for using R&S FSQ-K100/-K104 to measure the characteristics of specific types of DUT.

$a_{l,k}\hat{a}_{l,k}$	data symbol (actual, decided)
$b_{l,k}$	boosting factor
Δf, $\Delta \hat{f}_{coarse}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{l,k}$, $\hat{H}_{l,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{i}_{coarse}$, $\hat{i}_{fine}$	timing estimate (coarse, fine)
k	subcarrier index
l	OFDM symbol index
N_{FFT}	length of FFT
N_g	number of samples in cyclic prefix (guard interval)
N_s	number of Nyquist samples
N_{sc}	number of subcarriers
n	subchannel index, subframe index
$n_{l,k}$	noise sample
Φ_l	common phase error
r(i)	received sample in the time domain
$r_{l,k}$, $r'_{l,k}$, $r''_{l,k}$	received sample (uncompensated, partially compensated, equalized) in the frequency domain
T	useful symbol time
T_g	guard time
T_s	symbol time

8.1.1 Introduction

The following description provides a brief overview of the digital signal processing used in the R&S FSQ's EUTRA/LTE measurement application. Between the received IF signal as the point of origin to the actual analysis results such as EVM, the digital signal processing can be divided into four major groups:



The remainder of this description is structured accordingly.

8.1.2 Signal Processing

Data Capturing

The block diagram in figure 8-1 shows the R&S FSQ hardware from the IF section to the processor running the E-UTRA/LTE measurement application. The selectable IF filter bandwidth ranges from 300 kHz to 50 MHz. The A/D converter samples the IF signal at a rate of 81.6 MHz. The digital signal is converted down to the complex baseband, is lowpass-filtered, and is resampled to the nearest multiple of the target sampling rate. The decimation filters suppress the aliasing frequencies arising from the subsequent downsampling to the target rate. Up to 16 M samples of the now available I/Q data can be stored in the capture buffer.

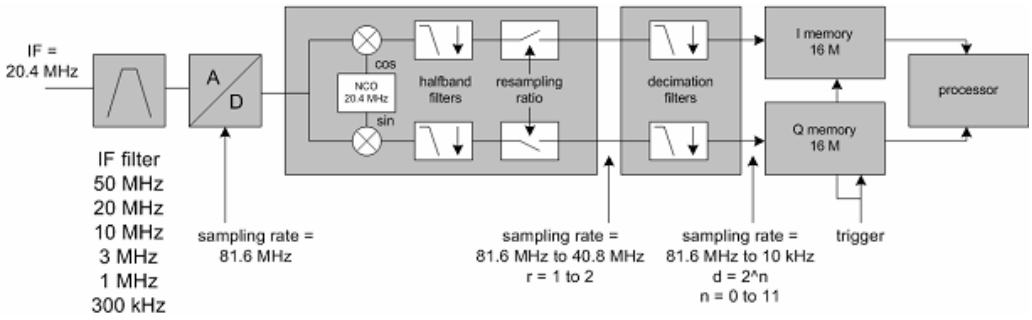


Fig. 8-1: Data Capturing Mechanism of the R&S FSQ

8.1.3 E-UTRA / LTE Downlink Measurement Application

The block diagram in figure 8-2 shows the E-UTRA/LTE downlink measurement application from the capture buffer containing the I/Q data to the actual analysis block. The

outcome of the fully compensated reference path (green) are the estimates $\hat{a}_{l,k}$ of the transmitted data symbols $a_{l,k}$. Depending on the user-defined compensation, the received samples $r''_{l,k}$ of the measurement path (yellow) still contain the transmitted signal impairments of interest. The analysis block reveals these impairments by comparing the reference and the measurement path. Prior to the analysis, diverse synchronization and channel estimation tasks have to be accomplished.

8.1.3.1 Synchronization

The first of the synchronization tasks is to estimate the OFDM symbol timing, which coarsely estimates both timing and carrier frequency offset. The frame synchronization block determines the position of the P-/S-Sync symbol in time and frequency by using the coarse fractional frequency offset compensated capture buffer and the timing estimate $\hat{\imath}_{coarse}$ to position the window of the FFT. If no P-/S-Sync is available in the signal, the reference signal is used for synchronization. The fine timing block prior to the FFT allows a timing improvement and makes sure that the EVM window is centered on the measured cyclic prefix of the considered OFDM symbol. For the 3GPP EVM calculation, the block "window" produces three signals taken at the timing offsets Δc, Δt_l and Δt_h. For the reference path, only the signal taken at the time offset Δc is used.

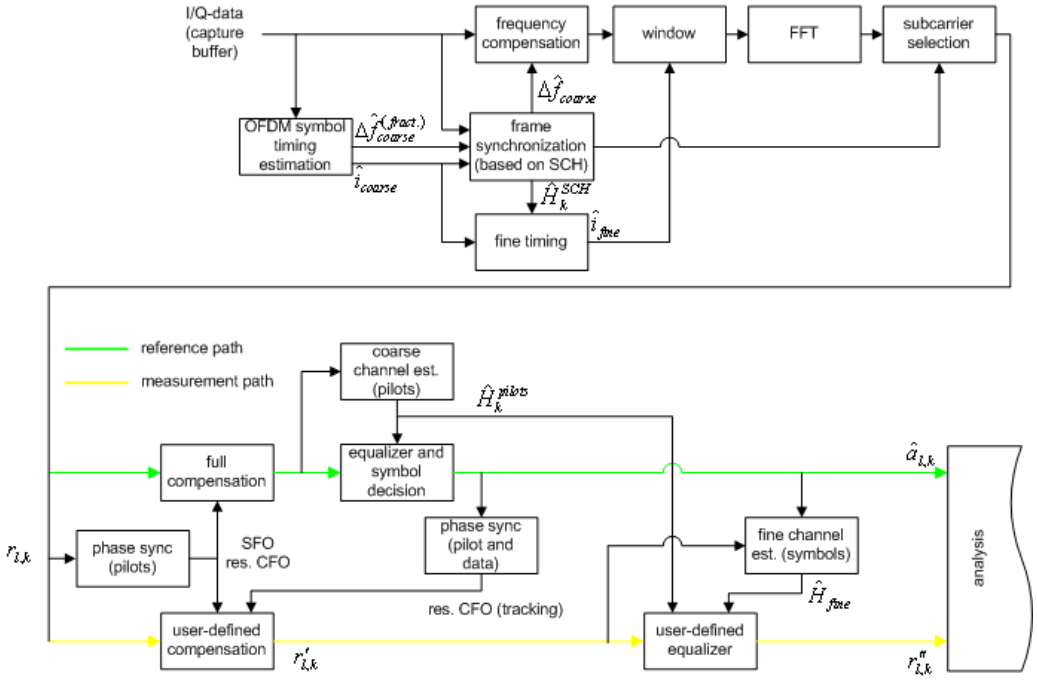


Fig. 8-2: EUTRA/LTE Downlink Measurement Application

After the time to frequency transformation by an FFT of length N_{FFT}, the phase synchronization block is used to estimate the following:

- the relative sampling frequency offset ζ (SFO)
- the residual carrier frequency offset Δf_{res} (CFO)
- the common phase error Φ_l

According to Speth et. al., 1999 [7] and Speth et. al., 2001 [8], the uncompensated samples can be expressed as

$$R_{l,k} = A_{l,k} \cdot H_{l,k} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{l,k}$$

(8 - 1)

where

- the data symbol is $a_{l,k}$, on subcarrier k at OFDM symbol l
- the channel transfer function is $h_{l,k}$
- the number of Nyquist samples is N_s within the symbol time T_s
- the useful symbol time $T=T_s-T_g$
- the independent and Gaussian distributed noise sample is $n_{l,k}$

Within one OFDM symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $r_{l,k}$

Whereas a full compensation is performed in the reference path, the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decided the data symbols in the reference path, an additional phase tracking can be utilized to refine the CPE estimation.

8.1.3.2 Channel Estimation / Equalization

As shown in figure 8-2, there is one coarse and one fine channel estimation block. The reference signal-based coarse estimation is tapped behind the CFO compensation block (SFO compensation can optionally be enabled) of the reference path. The coarse estimation block uses reference signal symbols to determine estimates of the channel transfer function by interpolation in both time and frequency direction. A special channel estimation $\hat{H}_{l,k}$ as defined in [3] is additionally generated. The coarse estimation results are used to equalize the samples of the reference path prior to symbol decision. Based on the decided data symbols, a fine channel estimation is optimally performed and then used to equalize the partially compensated samples of the measurement path.

8.1.3.3 Analysis

The analysis block of the EUTRA/LTE downlink measurement application allows you to compute a variety of measurement variables.

EVM

The error vector magnitude (EVM) measurement results "EVM PDSCH QPSK/16-QAM/ 64-QAM" are calculated according to the specification in [3].

All other EVM measurement results are calculated according to

$$EVM_{l,k} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k} \sqrt{E\left\{ \left| \frac{a_{l,k}}{b_{l,k}} \right|^2 \right\}}}$$

(8 - 2)

on subcarrier k at OFDM symbol l, where $b_{l,k}$, is the boosting factor. Since the average power of all possible constellations is 1 when no boosting is applied, equation 8-2 can be rewritten as

$$EVM_{n,l} = \frac{\left| r''_{l,k} - \hat{a}_{l,k} \right|}{b_{l,k}}$$

(8 - 3)

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{SC}} \sum_{l} \sum_{k_d} EVM_{l,k_d}^2}$$

(8 - 4)

The number of subcarriers taken into account is denoted by N_{sc}.

I/Q Imbalance

The I/Q imbalance can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(8 - 5)

where s(t) is the transmit signal, r(t) is the received signal, and I and Q are the weighting factors. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(8 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(8 - 7)

based on the complex-valued estimate $\Delta\hat{Q}$

Other measurement variables

Without going into detail, the E-UTRA/LTE downlink measurement application additionally provides the following results:

- Total power
- Constellation diagram

- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

8.2 References

[1] 3GPP TS 25.913: Requirements for E-UTRA and E-UTRAN (Release 7)

[2] 3GPP TR 25.892: Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement (Release 6)

[3] 3GPP TS 36.211 v8.3.0: Physical Channels and Modulation (Release 8)

[4] 3GPP TS 36.300: E-UTRA and E-UTRAN; Overall Description; Stage 2 (Release 8)

[5] 3GPP TS 22.978: All-IP Network (AIPN) feasibility study (Release 7)

[6] 3GPP TS 25.213: Spreading and modulation (FDD)

[7] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for Wireless Broad-Band Systems Using OFDM – Part I. IEEE Trans. on Commun. Vol. 47 (1999) No. 11, pp. 1668-1677.

[8] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for OFDM-Based Broadband Transmission – Part II: A Case Study. IEEE Trans. on Commun. Vol. 49 (2001) No. 4, pp. 571-578.

8.3 Support

If you encounter any problems when using the application, you can contact the Rohde & Schwarz support to get help for the problem.

To make the solution easier, use the "R&S Support" softkey to export useful information for troubleshooting. The R&S FSQ stores the information in a number of files that are located in the R&S FSQ directory `C:\R_S\Instr\user\LTE\Support`. If you contact Rohde&Schwarz to get help on a certain problem, send these files to the support in order to identify and solve the problem faster.

9 Remote Control

This section describes all the remote control commands available for the R&S FSQ EUTRA/LTE Measurement Application.

Note that this manual contains only commands that are exclusive to the firmware application. For information on remote control commands that are also available in the base unit, refer to the Operating Manual of the R&S FSQ. Also refer to the Quick Start Guide and the Operating Manual of the base unit for detailed information on working with remote control commands.

9.1 Numeric Suffix Definition

Some of the remote control commands that are described on the following pages have numeric suffixes in their syntax. Numeric suffixes are used 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.

The description of the commands below does not contain the ranges and description of the suffixes. Instead, the syntax contains a variable only. When using the command, replace the variable with the numeric suffixes defined in this section.

<n> = <1...2>

This suffix selects the measurement screen. Possible values are <1...2> with

1 selecting screen A and

2 selecting screen B.

<m> = <1>

This suffix selects the marker. At this point, the application only supports one marker, therefore the possible range is <1>.

<analyzer> = <1...4>

This suffix selects the analyzer the setting applies to. Possible are values are <1...4>.

<subframe> = <0...39>

This suffix selects the subframe that you want to analyze (see chapter 4.2.2.3, "Configuring PDSCH Subframes", on page 35). Depending on your configuration, possible values are <0...9>.

<allocation> = <0...99>

This suffix selects the allocation that you want to analyze (see chapter 4.2.2.3, "Configuring PDSCH Subframes", on page 35). Depending on your configuration, possible values are <0...99>.

9.2 CALCulate Subsystem

CALCulate<n>:FEED <DispType>

This command selects the measurement and result display.

Parameters:

<DispType>

PVT:CBUF (capture buffer result display)
EVM:EVCA (EVM vs carrier result display)
EVM:EVSY (EVM vs symbol result display)
EVM:FEVS (frequency error vs symbol result display)
EVM:EVSU (EVM vs subframe result display)
SPEC:SEM (spectrum emission mask)
SPEC:ACP (ACLR)
SPEC:PSPE (power spectrum result display)
SPEC:PVRP (power vs RB PDSCH result display: downlink only)
SPEC:PVRR (power vs RB RS result display: downlink only)
SPEC:FLAT (spectrum flatness result display)
SPEC:GDEL (group delay result display)
SPEC:FDIF (flatness difference result display)
SPEC:IE (inband emission result display: uplink only)
CONS:CONS (constellation diagram)
CONS:DFTC (DFT precoded constellation diagram: uplink only)
STAT:CCDF (CCDF)
STAT:ASUM (allocation summary)
STAT:BSTR (bitstream)

Example:

```
CALC2:FEED 'PVT:CBUF'
```

Select Capture Buffer to be displayed on screen B.

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?

This command queries the current results of the ACLR measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Return values:

<ACLRResults> The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
• <TXChannelPower> is the power of the transmission channel in dBm
• <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
• <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
• <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
• <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
(...)
• <nLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
• <nLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example: `CALC1:MARK:FUNC:POW:RES?`
Returns the current ACLR measurement results.

Usage: Query only

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers and delta markers off.

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3 or switches to marker mode.

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:

<Trace> **1 to 6**
Trace number the marker is assigned to.

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.
The unit depends on the result display.

Range: The range depends on the current span.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Return values:

<Result> Position of the marker.

Example: `INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

9.3 CONFigure Subsystem

CONFigure[:LTE]:DL:BW <Bandwidth>

This command selects the downlink bandwidth.

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

*RST: BW10_00

Example: `CONF:DL:BW BW1_40`
Sets a signal bandwidth of 1.4 MHz in downlink.

CONFigure[:LTE]:DL:CONS:LOCation <ConstLoc>

This command selects the data source of the constellation diagram for measurements on downlink signals.

Parameters:
<ConstLoc>

AMD
After the MIMO decoder

BMD
Before the MIMO decoder

*RST: BMD

Example: `CONF:DL:CONS:LOC AMD`
Use data from after the MIMO decoder.

CONFigure[:LTE]:DL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the downlink signal.

Parameters:
<NofSubframes>

Range: 0 to 39
*RST: 1

Example: `CONF:DL:CSUB 5`
Sets the number of configurable subframes to 5.

CONFigure[:LTE]:DL:CYCPrefix <PrefixLength>

This command selects the cyclic prefix for downlink signals.

Parameters:
<PrefixLength>

NORM
Normal cyclic prefix length

EXT
Extended cyclic prefix length

AUTO
Automatic cyclic prefix length detection

*RST: AUTO

Example: `CONF:DL:CYCP EXT`
Sets cyclic prefix type to extended.

CONFigure[:LTE]:DL:MIMO:ASELection <AntennaID>

This command selects the antenna for measurements with MIMO setups.

Parameters:

<AntennaID> **ANT1 | ANT2 | ANT3 | ANT4**
Select a single antenna to be analyzed
AUT1
*RST: ANT1

Example: `CONF:DL:MIMO:ASEL ANT3`
Selects antenna 3 to be analyzed.

CONFigure[:LTE]:DL:MIMO:CONFig <NofAntennas>

This command sets the number of antennas in the MIMO setup.

Parameters:

<NofAntennas> TX1 | TX2 | TX4
TX1
Use one Tx-antenna
TX2
Use two Tx-antennas
TX4
Use four Tx-antennas
*RST: TX1

Example: `CONF:DL:MIMO:CONF TX2`
TX configuration with two antennas is selected.

CONFigure[:LTE]:DL:MIMO:CROSstalk <boolean>

This command turns MIMO crosstalk compensation on and off.

Parameters:

<boolean> ON | OFF
*RST: OFF

Example: `CONF:DL:MIMO:CROS ON`
Turns crosstalk compensation on.

CONFigure[:LTE]:DL:NORB <NofRessBlocks>

This command selects the number of resource blocks for downlink signals.

Parameters:

<NofRessBlocks> <numeric value>
*RST: 50

Example: `CONF:DL:NORB 25`
Sets the number of resource blocks to 25.

CONFigure[:LTE]:DL:PBCH:POWer <Power>

This command defines the relative power of the PBCH.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PBCH:POW -1.1`
Sets the relative power to -1.1 dB.

CONFigure[:LTE]:DL:PBCH:STAT <boolean>

This command turns the PBCH on and off.

Parameters:

<boolean> ON | OFF

*RST: ON

Example: `CONF:DL:PBCH:STAT ON`
Activates the PBCH.

CONFigure[:LTE]:DL:PCFich:POWer <Power>

This command defines the relative power of the PCFICH.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PCF:POW 0`
Sets the relative power to 0 dB.

CONFigure[:LTE]:DL:PCFich:STAT <boolean>

This command turns the PCFICH on and off.

Parameters:

<boolean> ON | OFF

*RST: ON

Example: `CONF:DL:PCF:STAT ON`
Activates the PCFICH.

CONFigure[:LTE]:DL:PDCCh:FORMat <Format>

This command selects the PDCCH format.

Parameters:

<Format> -1 | 0 | 1 | 2 | 3

*RST: -1

Example: `CONF:DL:PDCCH:FORM 0`
Sets the PDDCH format to 0.

CONFigure[:LTE]:DL:PDCCh:NOPD <NofPDCCH>

This command sets the number of PDCCHs.

Parameters:

<NofPDCCH> <numeric value>

*RST: 0

Example: `CONF:DL:PDCCH:NOPD 3`
Sets the number of DPCCHs to 3.

CONFigure[:LTE]:DL:PDCCh:POWer <Power>

This command defines the relative power of the PDCCH.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:PDCCH:POW -1.2`
Sets the relative power to -1.2 dB.

CONFigure[:LTE]:DL:PHICh:DURation <Duration>

This command selects the PHICH duration.

Parameters:

<Duration>

NORM
Normal

EXT
Extended

*RST: NORM

Example: `CONF:DL:PHIC:DUR NORM`
Selects normal PHICH duration.

CONFigure[:LTE]:DL:PHICh:MITM <State>

This command includes or excludes the use of the PHICH special setting for enhanced test models.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CONF:DL:PHIC:MITM ON`

Activates PHICH TDD m_i=1 (E-TM)

CONFigure[:LTE]:DL:PHICh:NGParameter <Ng>

This command selects the method that determines the number of PHICH groups in a subframe.

Parameters:

<Ng> NG1_6 | NG1_2 | NG1 | NG2 | NGCUSTOM

Select NG_CUSTOM to customize N_g. You can then define the variable as you like with `CONFigure[:LTE]:DL:PHICh:NOGRoups`.

*RST: NG1_6

Example: `CONF:DL:PHIC:NGP NG1_6`

Sets N_g to 1/6. The number fo PHICH groups in the subframe depends on the number of resource blocks.

`CONF:DL:PHIC:NGP NG_CUSTOM`

Define a customized value for N_g.

`CONF:DL:PHIC:NOGR 5`

Directly sets the number of PHICH groups in the subframe to 5.

CONFigure[:LTE]:DL:PHICh:NOGRoups <NofGroups>

This command sets the number of PHICH groups.

Parameters:

<NofGroups> <numeric value>

*RST: 0

Example: `CONF:DL:PHIC:NOGR 5`

Sets number of PHICH groups to 5.

CONFigure[:LTE]:DL:PHICh:POWer <Power>

This command defines the relative power of the PHICH.

Parameters:

<Power> <numeric value>

*RST: -3.01 dB

Default unit: DB

Example: `CONF:DL:PHIC:POW -1.3`

Sets the relative power to -1.3 dB.

CONFigure[:LTE]:DL:PLCI:CIDGroup <GroupNumber>

This command selects the cell ID group for downlink signals.

Parameters:

<GroupNumber> AUTO | <numeric value>

AUTO
Automatic selection

0...167
Manual selection

*RST: AUTO

Example: `CONF:DL:PLCI:CIDG 134`
Cell identity group number 134 is selected
`CONF:DL:PLCI:CIDG AUTO`
Automatic cell identity group detection is selected

CONFigure[:LTE]:DL:PSOFfset <PRBSymbOffset>

This command defines the symbol offset for PDSCH allocations relative to the start of the subframe.

The offset applies to all subframes.

Parameters:

<PRBSymbOffset>

AUTO
Automatically determines the symbol offset.

<numeric value>
Manual selection of the symbol offset.

Range: 0 to 4
*RST: AUTO

Example: `CONF:DL:PSOF 2`
Sets an offset of 2 symbols.

CONFigure[:LTE]:DL:REFSig:POWer <Power>

This command defines the relative power of the reference signal.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:REFS:POW -1.2`
Sets a relative power of -1.2 dB.

CONFigure[:LTE]:DL:PLCI:PLID <Identity>

This command selects the physical layer identity for downlink signals.

Parameters:

<Identity> AUTO | <numeric value>

AUTO
Automatic selection

0...2
Manual selection

*RST: AUTO

Example: `CONF:DL:PLCI:PLID 2`
Sets the physical layer identity to 2.
`CONF:DL:PLCI:PLID AUTO`
Physical layer ID is selected automatically.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount <NofAllocations>

This command defines the number of allocations in a downlink subframe.

Parameters:

<NofAllocations> <numeric value>

*RST: 1

Example: `CONF:DL:SUBF3:ALC 5`
Sets the number of used allocations in subframe number 3 to 5.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer <Power>

This command defines the (relative) power of an allocation in a downlink subframe.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SUBF8:ALL5:POW -1.3`
Sets the allocation power for allocation 5 in subframe number 8 to -1.3 dB.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount <NofRBs>

This command selects the number of resource blocks of an allocation in a downlink subframe.

Parameters:

<NofRBs> <numeric value>

*RST: 6

Example: `CONF:DL:SUBF2:ALL34:RBC 25`
Sets the number of resource blocks used in allocation 34 in subframe number 2 to 25.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOFfset <RBOffset>

This command defines the resource block offset of an allocation in a downlink subframe.

Parameters:

<RBOffset> <numeric value>

*RST: 0

Example: `CONF:DL:SUBF2:ALL34:RBOF 3`
Sets the resource block offset used in allocation 34 in subframe number 2 to 3.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<cw>]:MODulation <ModType>

This command selects the modulation of an allocation in a downlink subframe.

Suffix:

<cw> 1

Parameters:

<ModType> QPSK | QAM16 | QAM64

QPSK
QPSK modulation

QAM16
16QAM modulation

QAM64
64QAM modulation

*RST: QPSK

Example: `CONF:DL:SUBF4:ALL33:CW2:MOD QAM64`
Sets modulation type of codeword 2 in allocation 33 of subframe number 4 to QAM64.

CONFigure[:LTE]:DL:SYNC:ANTenna <Antenna>

This command selects the antenna that transmits the P-SYNC and the S-SYNC.

Parameters:

<Antenna> ANT1 | ANT2 | ANT3 | ANT4 | ALL | NONE

*RST: ALL

Example: `CONF:DL:SYNC:ANT ALL`
All antennas are used to transmit the P-SYNC and S-SYNC.

CONFigure[:LTE]:DL:SYNC:PPOWer <Power>

This command defines the relative power of the P-SYNC.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SYNC:PPOW 0.5`
Sets a relative power of 0.5 dB.

CONFigure[:LTE]:DL:SYNC:SPOWer <Power>

This command defines the relative power of the S-SYNC.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

Example: `CONF:DL:SYNC:SPOW 0.5`
Sets a relative power of 0.5 dB.

CONFigure[:LTE]:DL:TDD:SPSC <Configuration>

Selects the configuration of a TDD special subframe.

Parameters:

<Configuration> <numeric value>

Numeric value that defines the subframe configuration. Subframe configurations 7 and 8 are only available if the cyclic prefix is normal.

Range: 0 to 8
*RST: 0

Example: `CONF:DL:CYCP NORM`
Selects normal cyclic prefix.
`CONF:DL:TDD:SPSC 7`
Selects subframe configuration 7, available only with a normal cyclic prefix.

CONFigure[:LTE]:DL:TDD:UDConf <AllocConf>

This command selects the UL/DL subframe configuration for downlink signals.

Parameters:

<AllocConf>

Range: 0 to 6
*RST: 0

Example: `CONF:DL:TDD:UDC 2`
Selects allocation configuration number 2.

CONFigure[:LTE]:DUPLexing <DuplType>

This command selects the duplexing mode.

Parameters:

<DuplType> TDD | FDD

TDD
Time division duplex

FDD
Frequency division duplex

*RST: FDD

Example: `CONF:DUPL TDD`
Activates time division duplex.

CONFigure[:LTE]:LDIRection <LinkDir>

This command selects the link direction

Parameters:

<LinkDir> DL | UL

DL
Downlink

UL
Uplink

Example: `CONF:LDIR DL`
EUTRA/LTE option is configured to analyze downlink signals.

CONFigure:POWer:EXPected:IQ<analyzer> <RefLev>

This command defines the reference level when the input source is baseband.

Parameters:

<RefLev> <numeric value>

Range: 31.6 mV to 5.62 V
*RST: 1 V

Example: `CONF:POW:EXP:IQ2 3.61`
Sets the baseband-reference level used by analyzer 2 to 3.61 V.

CONFigure:POWer:EXPected:RF<analyzer> <RefLev>

This command defines the reference level when the input source is RF.

Parameters:

<RefLev> *RST: -30 dBm
Default unit: DBM

Example: CONF:POW:EXP:RF3 -20
Sets the radio frequency reference level used by analyzer 3 to -20 dBm.

9.4 DISPlay Subsystem

DISPlay[:WINDow<n>]:SELect

This command selects the measurement window.

Suffix:
<n> 1...2
WINDow1 selects screen A.
WINDow2 selects screen B.
After a preset or reset, screen A is active.

Example: DISP:WIND2:SEL
Selects screen B.

Usage: Event

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <ExtAtten>

This command selects the external attenuation or gain applied to the RF signal.

Parameters:
<ExtAtten> <numeric value>
*RST: 0
Default unit: dB

Example: DISP:TRAC:Y:RLEV:OFFS 10
Sets an external attenuation of 10 dB.

9.5 FETCh Subsystem

FETCh:CYCPrefix?

This command queries the cyclic prefix type that has been detected.

Return values:

<PrefixType> The command returns -1 if no valid result has been detected yet.

NORM
Normal cyclic prefix length detected

EXT
Extended cyclic prefix length detected

Example: `FETC:CYCP?`
Returns the current cyclic prefix length type.

Usage: Query only

FETCh:PLCI:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup> The command returns -1 if no valid result has been detected yet.
Range: 0 to 167

Example: `FETC:PLCI:CIDG?`
Returns the current cell identity group.

Usage: Query only

FETCh:PLCI:PLID?

This command queries the cell identity that has been detected.

Return values:

<CellIdentity> The command returns -1 if no valid result has been detected yet.
Range: 0 to 2

Example: `FETC:PLCI:PLID?`
Returns the current cell identity.

Usage: Query only

FETCh:SUMMary:CRESt[:AVERage]?

This command queries the average crest factor as shown in the result summary.

Return values:

<CrestFactor> <numeric value>
Crest Factor in dB.

Example: `FETC:SUMM:CRES?`
Returns the current crest factor in dB.

Usage: Query only

FETCh:SUMMary:EVM:DSQP[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a QPSK modulation.

Return values:

<EVM> <numeric value>
EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSQP?`
Returns the PDSCH QSPK EVM.

Usage: Query only

FETCh:SUMMary:EVM:DSSF[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 64QAM modulation.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSSF?`

Returns the PDSCH 64QAM EVM.

Usage: Query only

FETCh:SUMMary:EVM:DSST[:AVERage]?

This command queries the EVM of all resource elements of the PDSCH with a 16QAM modulation.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:DSST?`

Returns the PDSCH 16QAM EVM.

Usage: Query only

FETCh:SUMMary:EVM:PCHannel:MAXimum?
FETCh:SUMMary:EVM:PCHannel:MINimum?
FETCh:SUMMary:EVM:PCHannel[:AVERage]?

This command queries the EVM of all physical channel resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PCH:MAX?`

Returns the maximum value.

`FETC:SUMM:EVM:PCH:MIN?`

Returns the minimum value.

`FETC:SUMM:EVM:PCH?`

Returns the mean value.

Usage: Query only

FETCh:SUMMary:EVM:PSIGnal:MAXimum?
FETCh:SUMMary:EVM:PSIGnal:MINimum?
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?

This command queries the EVM of all physical signal resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PSIG:MAX?`
Returns the maximum value.
`FETC:SUMM:EVM:PSIG:MIN?`
Returns the minimum value.
`FETC:SUMM:EVM:PSIG?`
Returns the mean value.

Usage: Query only

FETCh:SUMMary:EVM[:ALL]:MAXimum?
FETCh:SUMMary:EVM[:ALL]:MINimum?
FETCh:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:MAX?`
Returns the maximum value.
`FETC:SUMM:EVM:MIN?`
Returns the minimum value.
`FETC:SUMM:EVM?`
Returns the mean value.

Usage: Query only

FETCh:SUMMary:FERRor:MAXimum?
FETCh:SUMMary:FERRor:MINimum?
FETCh:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Return values:

<FreqError> <numeric value>

Minimum, maximum or average frequency error, depending on the last command syntax element.

Default unit: Hz

Example: `FETC:SUMM:FERR?`

Returns the average frequency error in Hz.

Usage: Query only

FETCh:SUMMary:GIMBalance:MAXimum?
FETCh:SUMMary:GIMBalance:MINimum?
FETCh:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Return values:

<GainImbalance> <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:GIMB?`

Returns the current gain imbalance in dB.

Usage: Query only

FETCh:SUMMary:IQOFfset:MAXimum?
FETCh:SUMMary:IQOFfset:MINimum?
FETCh:SUMMary:IQOFfset[:AVERage]?

This command queries the I/Q offset.

Return values:

<IQOffset> <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:IQOF?`

Returns the current IQ-offset in dB

Usage: Query only

FETCh:SUMMary:OSTP:MAXimum
FETCh:SUMMary:OSTP:MINimum
FETCh:SUMMary:OSTP[:AVERage]?

This command queries the OSTP.

Return values:

<OSTP> <numeric value>

Minimum, maximum or average OSTP, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:OSTP?`

Returns the current average OSTP value.

Usage: Query only

FETCh:SUMMary:POWer:MAXimum?
FETCh:SUMMary:POWer:MINimum?
FETCh:SUMMary:POWer[:AVERage]?

This command queries the total power.

Return values:

<Power> <numeric value>

Minimum, maximum or average power, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:POW?`

Returns the total power in dBm

Usage: Query only

FETCh:SUMMary:QUADerror:MAXimum?
FETCh:SUMMary:QUADerror:MINimum?
FETCh:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Return values:

<QuadError> <numeric value>

Minimum, maximum or average quadrature error, depending on the last command syntax element.

Default unit: deg

Example: `FETC:SUMM:QUAD?`

Returns the current mean quadrature error in degrees.

Usage: Query only

FETCh:SUMMary:RSTP:MAXimum
FETCh:SUMMary:RSTP:MINimum
FETCh:SUMMary:RSTP[:AVERage]?

This command queries the reference signal transmit power (RSTP).

Return values:

<RSTP> <numeric value>

Minimum, maximum or average OSTP, depending on the last command syntax element.

Default unit: dBm

Example: `FETC:SUMM:RSTP?`

Returns the current average RSTP value.

Usage: Query only

FETCh:SUMMary:SERRor:MAXimum?
FETCh:SUMMary:SERRor:MINimum?
FETCh:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Return values:

<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: `FETC:SUMM:SERR?`

Returns the current mean sampling error in ppm.

Usage: Query only

FETCh:SUMMary:TAE<antenna>?

This command queries the time alignment error.

Suffix:

<antenna> 2..4

Number of the antenna you want to compare to antenna 1.

Return values:

<TimeAlignError>

Time alignment error of antenna 1 and another antenna.

Usage: Query only

FETCh:SUMMary:TFRame?

This command queries the trigger to frame result for downlink signals and the trigger to subframe result for uplink signals.

Return values:

<TrigToFrame> <numeric value>

Default unit: s

Example: FETC:SUMM:TFR?
Returns the trigger to frame value.

Usage: Query only

9.6 FORMat Subsystem

FORMat[:DATA] [<Format>]

Specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:
<Format> ASCii | REAL
*RST: ASCii

Return values:
<BitLen>

Example: FORM REAL
The software will send binary data in Real32 data format.

9.7 INITiate Subsystem

INITiate[:IMMediate]

This command initiates a new measurement sequence.

With a frame count > 0, this means a restart of the corresponding number of measurements.

In single sweep mode, you can synchronize to the end of the measurement with *OPC. In continuous sweep mode, synchronization to the end of the sweep is not possible.

Example: INIT
Initiates a new measurement.

Usage: Event

INITiate:CONTinuous <boolean>

This command controls the sweep mode.

Parameters:

<boolean> ON | OFF

ON
Continuous sweep

OFF
Single sweep

*RST: OFF

Example: `INIT:CONT OFF`
Switches the sequence to single sweep.
`INIT:CONT ON`
Switches the sequence to continuous sweep.

INITiate:REFResh

This command updates the current I/Q measurement results to reflect the current measurement settings.

No new I/Q data is captured. Thus, measurement settings apply to the I/Q data currently in the capture buffer.

The command applies exclusively to I/Q measurements. It requires I/Q data.

Example: `INIT:REFR`
The application updates the IQ results

Usage: Event

9.8 INPut Subsystem

INPut:ATTenuation<analyzer> <Attenuation>

This command sets the RF attenuation for an analyzer in the test setup.

Parameters:

<Attenuation> <numeric value>

*RST: 5 dB
Default unit: dB

INPut:DIQ:RANGe[:UPPer] <ScaleLevel>

This command defines the full scale level for a digital I/Q signal source.

Parameters:

<ScaleLevel> Numeric value

*RST: 1 V
Default unit: V

Example: `INP:DIQ:RANG 0.7`
Sets the full scale level to 0.7 V.

INPut:DIQ:SRATe <SampleRate>

This command defines the sampling rate for a digital I/Q signal source.

Parameters:

<SampleRate> *RST: 10 MHz
Default unit: Hz

INPut:EATT:AUTO <State>

Switches the automatic behaviour of the electronic attenuator on or off. If activated, electronic attenuation is used to reduce the operation of the mechanical attenuation whenever possible.

This command is only available with option R&S FSQ-B25, but not if R&S FSQ-B17 is active.

Parameters:

<State> ON | OFF

*RST: ON

Example: `INP1:EATT:AUTO OFF`

Mode: all

INPut:FILTer:YIG[:STATe] <boolean>

This command removes or adds the YIG filter from the signal path.

If you remove the filter, you can use the maximum bandwidth, but image frequency rejection is no longer ensured.

Parameters:

<boolean> ON | OFF

*RST: ON

Example: `INP:FILT:YIG OFF`
Removes the YIG filter from the signal path.

INPut:FILTer:YIG:AUTO <boolean>

This command turns automatic control of the YIG filter on and off.

Parameters:

<boolean> ON | OFF

*RST: ON

Example: `INP:FILT:YIG:AUTO ON`

Activates automatic control of the YIG filter.

INPut:IQ:BALanced[:STATe] <boolean>

This command selects if the I/Q inputs are symmetrical (balanced) or asymmetrical (unbalanced)

This command requires option R&S FSQ-B71.

Parameters:

<boolean> ON | OFF

*RST: ON

Example: `INP:IQ:BAL ON`

Specifies symmetrical (balanced) IQ inputs.

INPut:IQ:IMPedance <Impedance>

This command selects the input impedance for I/Q inputs.

This command requires option R&S FSQ-B71.

Parameters:

<Impedance> LOW | HIGH

*RST: LOW

Example: `INP:IQ:IMP LOW`

Specifies low input impedance for IQ inputs.

INPut:IQ:TYPE <Path>

This command selects the input path for baseband input.

Parameters:

<Path> IQ | I | Q

IQ
I+j*Q

I
I only

Q
Q only

Example: `INP:IQ:TYPE I`
Uses I input as the baseband path.

INPut:SELect <InputType>

This command selects the data source.

Parameters:
<InputType>

RF
Selects the RF input as the data source.

AIQ
Selects the analog baseband input as the data source. This source is available only with option R&S FSQ-B71.

DIQ
Selects the digital baseband input as the data source. This source is available only with option R&S FSQ-B17.

9.9 INSTrument Subsystem

INSTrument[:SELect] <Mode>

This command selects the measurement mode by means of text parameters.

Parameters:
<Mode>

SANalyzer
Spectrum mode

LTE
LTE measurement application (uplink and downlink)

*RST: SANalyzer

Example: `INST SAN`
Switches the instrument to "Spectrum" mode.

INSTrument:NSELect <Mode>

This command selects the measurement mode by means of numbers.

Parameters:
<Mode>

1
Spectrum mode

100
LTE measurement application (uplink and downlink)

*RST: 1

Example: `INST:NSEL 1`
Switches the instrument to "Spectrum" mode.

9.10 MMEMory Subsystem

MMEMory:LOAD:DEModsettings <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Setting parameters:

<Path> String containing the path and name of the file.

Example: `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

Usage: Setting only

MMEMory:LOAD:TMOD:DL <TestModel>

This command loads an EUTRA test model (E-TM).

The test models are in accordance with 3GPP TS 36.141.

Setting parameters:

<TestModel>

'E-TM1_1__10MHz'
EUTRA Test Model 1.1 (E-TM1.1)

'E-TM1_2__10MHz'
EUTRA Test Model 1.2 (E-TM1.2)

'E-TM2__10MHz'
EUTRA Test Model 2 (E-TM2)

'E-TM3_1__10MHz'
EUTRA Test Model 3.1 (E-TM3.1)

'E-TM3_2__10MHz'
EUTRA Test Model 3.2 (E-TM3.2)

'E-TM3_3__10MHz'
EUTRA Test Model 3.3 (E-TM3.3)

Example: `MMEM:LOAD:TMOD:DL 'E-TM2__10MHz'`
Selects test model 2 for a 10 MHz bandwidth.

Usage: Setting only

9.11 SENSe Subsystem

[SENSe][:LTE]:FRAMe:COUNt <NofSF>

This command sets the number of frames you want to analyze.

Parameters:

<NofSF> <numeric value>

*RST: 1

Example: `FRAM:COUN:STAT ON`

Activates manual input of frames to be analyzed.

`FRAM:COUN 20`

Analyzes 20 frames.

[SENSe][:LTE]:FRAMe:COUNt:AUTO <boolean>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<boolean> **ON**

Selects the number of frames to analyze according to the LTE standard.

OFF

Turns manual selection of the frame number on.

Example: `FRAM:COUN:AUTO ON`

Turns automatic selection of the analyzed frames on.

[SENSe][:LTE]:FRAMe:COUNt:STATe <boolean>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<boolean> **ON**
You can set the number of frames to analyze.
OFF
The R&S FSQ analyzes a single sweep.
*RST: ON

Example: `FRAM:COUN:STAT ON`
Turns manual setting of number of frames to analyze on.

[SENSe][:LTE]:DL:DEMod:AUTO <boolean>

This command turns automatic demodulation for downlink signals on and off.

Parameters:

<boolean> ON | OFF
*RST: ON

Example: `SENS:DL:DEM:AUTO ON`
Activates the auto-demodulation for DL.

[SENSe][:LTE]:DL:DEMod:BESTimation <State>

This command turns boosting estimation for downlink signals on and off.

Parameters:

<State> ON | OFF
*RST: ON

Example: `DL:DEM:BEST ON`
Turns boosting estimation on.

[SENSe][:LTE]:DL:DEMod:CBSCrambling <boolean>

This command turns scrambling of coded bits for downlink signals on and off.

Parameters:

<boolean> ON | OFF
*RST: ON

Example: `SENS:DL:DEM:CBSC ON`
Activate scrambling of coded bits.

[SENSe][:LTE]:DL:DEMod:CESTimation <RefType>

This command selects the channel estimation type for downlink signals.

Parameters:

<RefType>

TGPP
3GPP EVM definition

PIL
Optimal, pilot only

PILP
Optimal, pilot and payload

*RST: TGPP

Example: `SENS:DL:DEM:CEST TGPP`
Use 3GPP EVM definition for channel estimation.

[SENSe][:LTE]:DL:DEMod:EVMCalc <CalcType>

This command selects the EVM calculation method for downlink signals.

Parameters:

<CalcType> TGPP | OTP

TGPP
3GPP definition

OTP
Optimal timing position

*RST: TGPP

Example: `SENS:DL:DEM:EVMC TGPP`
Use 3GPP method.

[SENSe][:LTE]:DL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State> ON | OFF

*RST: OFF

Example: `DL:DEM:MCF ON`
Turns suppression on of neighboring carriers on.

[SENSe][:LTE]:DL:DEMod:PRData <ReferenceData>

This command the type of reference data to calculate the EVM for the PDSCH.

Parameters:

<ReferenceData> AUTO | ALL0

AUTO
Automatic identification of reference data.

ALL0
Reference data is 0, according to the test model definition.

Example: `DL:DEM:PRD ALL0`
Sets the reference data of the PDSCH to 0.

[SENSe][:LTE]:DL:FORMat:PSCD <PSCDFormat>

This command selects the method of identifying the PDSCH resource allocation.

Parameters:
<PSCDFormat>

OFF
Applies the user configuration of the PDSCH subframe regardless of the signal characteristics.

PDCCH
Identifies the configuration according to the data in the PDCCH DCIs.

PHYDET
Manual PDSCH configuration: analysis only if the actual subframe configuration matches the configured one.
Automatic PDSCH configuration: physical detection of the configuration.

*RST: PHYD

Example: `DL:FORM:PSCD OFF`
Applies the user configuration and does not check the received signal

---

[SENSe][:LTE]:DL:TRACking:PHASe <TrackType>

This command selects the phase tracking type for downlink signals.

Parameters:
<TrackType> OFF | PIL | PILP

OFF
Deactivate phase tracking

PIL
Pilot only

PILP
Pilot and payload

*RST: OFF

Example: `SENS:DL:TRAC:PHAS PILPAY`
Use pilots and payload for phase tracking.

[SENSe][:LTE]:DL:TRACking:TIME <TrackTime>

This command turns timing tracking for downlink signals on and off.

Parameters:
<TrackTime> ON | OFF

*RST: OFF

Example: SENS:DL:TRAC:TIME ON
Activates timing tracking.

[SENSe][:LTE]:SLOT:SELect <SlotSelection>

This command selects the slot to analyze.

Parameters:

<SlotSelection> ALL | S0 | S1

S0
Slot 0

S1
Slot 1

ALL
Both slots

*RST: ALL

Example: SLOT:SEL S1
Selects slot 1 for analysis.

[SENSe][:LTE]:SUBFrame:SELect <SFSelection>

This command selects the subframe to be analyzed.

Parameters:

<SFSelection> ALL | <numeric value>

ALL
Select all subframes

0...39
Select a single subframe

*RST: ALL

Example: SENS:SUBF:SEL ALL
Select all subframes for analysis.

[SENSe]:FREQuency:CENTer <Frequency>

This command sets the center frequency for RF measurements.

Parameters:

<Frequency> <numeric value>

Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

Example: SENS:FREQ:CENT 2GHZ
Set the center frequency to 2 GHz.

[SENSe]:IQ:DITHer[:STATe] <boolean>

This command adds or removes a noise signal into the signal path (dithering).

Parameters:

<boolean> ON | OFF

*RST: OFF

Example: `SENS:IQ:DITH ON`

Activate input dithering.

[SENSe]:IQ:LPASs[:STATe] <boolean>

This command turns a baseband input lowpass filter on and off.

Parameters:

<boolean> ON | OFF

*RST: ON

Example: `SENS:IQ:LPAS ON`

Activate the input lowpass.

[SENSe]:POWer:ACHannel:AACHannel <AssumedChan>

This command selects the assumed adjacent channel carrier for ACLR measurements.

Parameters:

<AssumedChan> EUTRA | UTRA128 | UTRA384 | UTRA768

EUTRA
Selects an EUTRA signal of the same bandwidth like the TX channel as assumed adjacent channel carrier.

UTRA128
Selects an UTRA signal with a bandwidth of 1.28MHz as assumed adjacent channel carrier.

UTRA384
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

UTRA768
Selects an UTRA signal with a bandwidth of 7.68MHz as assumed adjacent channel carrier.

*RST: EUTRA

Example: `SENS:POW:ACH:AACH UTRA384`

Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

[SENSe]:POWer:AUTO<analyzer>[:STATe] <State>

This command initiates a process that determines the ideal reference level.

Parameters:

<State> ON | OFF | ONCE

OFF
Performs no automatic reference level detection.

ON
Performs an automatic reference level detection before each measurement.

ONCE
Performs an automatic reference level once.

*RST: ON

Example: `SENS:POW:AUTO2 ON`
Activate auto level for analyzer number 2.

[SENSe]:POWer:AUTO<analyzer>:TIME <Time>

This command defines the track time for the auto level process.

Parameters:

<Time> <numeric value>

*RST: 100 ms
Default unit: s

Example: `SENS:POW:AUTO:TIME 200ms`
An auto level track time of 200 ms gets set.

[SENSe]:POWer:NCORrection <boolean>

This command turns noise correction for ACLR measurements on and off.

Parameters:

<boolean> ON | OFF

*RST: OFF

Example: `SENS:POW:NCOR ON`
Activates noise correction.

[SENSe]:POWer:SEM:CATegory <Category>

This command selects the SEM category as defines in 3GPP TS 36.104.

Parameters:

<Category> A | B

*RST: A

Example: `SENS:POW:SEM:CAT B`
Selects category B for all SEM measurements.

[SENSe]:SWAPiq <boolean>

This command turns a swap of the I and Q branches on and off.

Parameters:

<boolean> ON | OFF

*RST: OFF

Example: `SENS:SWAP ON`

Activate IQ-swapping.

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength> Numeric value in seconds.

Default unit: s

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:

<SyncState> The string contains the following information.
- <OFDMSymbolTiming> is the coarse symbol timing
- <P-SYNCSynchronization> is the P-SYNC synchronization state
- <S-SYNCSynchronization> is the S-SYNC synchronization state

A zero represents a failure and a one represents a successful synchronization.

Example: `SENS:SYNC:STAT?`

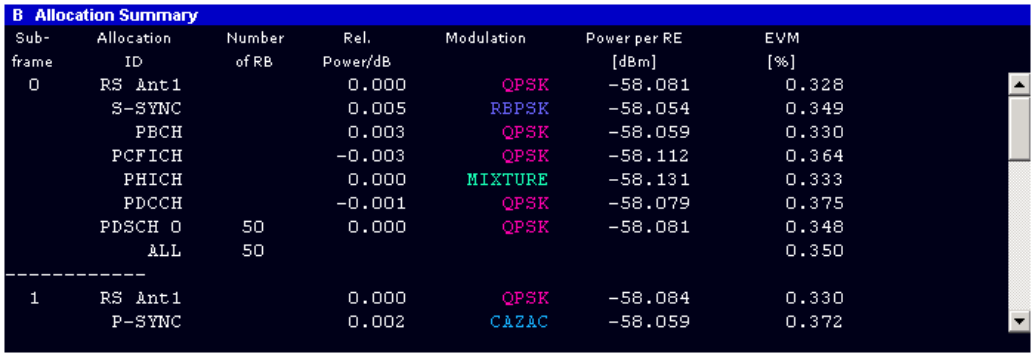
Returns "1,1,0" if coarse timing and P-SYNC were successful but S-SYNC failed.

Usage: Query only

9.12 TRACe Subsystem

Example for querying the results of the allocation summary result display

This section shows an example of what the R&S FSQ will return when the Allocation Summary result display is queried with the TRACe[:DATA] command.



B Allocation Summary

Sub-frame	Allocation ID	Number of RB	Rel. Power/dB	Modulation	Power per RE [dBm]	EVM [%]
0	RS Ant1		0.000	QPSK	-58.081	0.328
	S-SYNC		0.005	RBPSK	-58.054	0.349
	PBCH		0.003	QPSK	-58.059	0.330
	PCFICH		-0.003	QPSK	-58.112	0.364
	PHICH		0.000	MIXTURE	-58.131	0.333
	PDCCH		-0.001	QPSK	-58.079	0.375
	PDSCH 0	50	0.000	QPSK	-58.081	0.348
	ALL	50				0.350
1	RS Ant1		0.000	QPSK	-58.084	0.330
	P-SYNC		0.002	CAZAC	-58.059	0.372

Fig. 9-1: Display of the allocation summary

The TRACe[:DATA] command would return this:

```
<subframe>, <allocation ID>, <number of RB>, <relative power>,
<modulation>, <power in dBm>, <EVM in dB or %>, ...
```

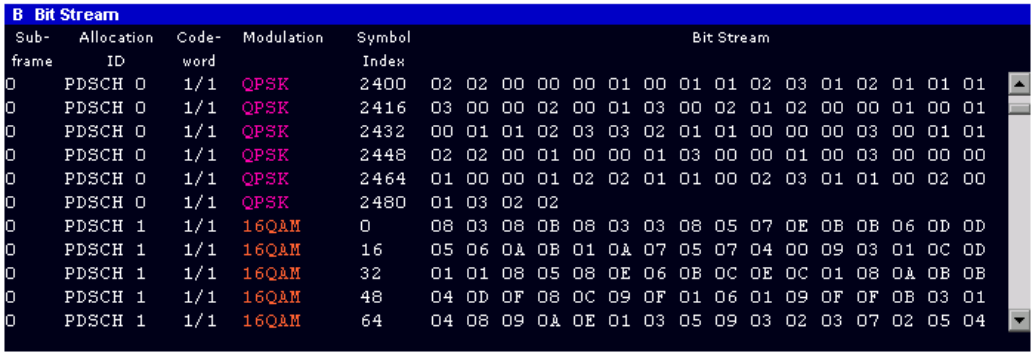
Each line in this example corresponds to one set of values.

```
0,-5,,,0,-17.0926996097583,8.44728660354122E-06,
0,-3,,,0,-17.742108013101,8.49192574037261E-06,
0,-4,,,0,-17.7421077124897,8.50963104426228E-06,
0,-12,,,2,-17.092699868618,7.81896929424875E-06,
0,0,3,0,4,-17.1774446884892,8.54281765327869E-06,
0,1,1,3,3,-17.1688944558343,9.53971195372105E-06,...

<continues like this until the end of data is reached>
```

Example for querying the results of the bitstream result display

This section shows an example of what the R&S FSQ will return when the Bitstream result display is queried with the TRACe[:DATA] command.



B Bit Stream

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PDSCH 0	1/1	QPSK	2400	02 02 00 00 00 01 00 01 01 02 03 01 02 01 01 01
0	PDSCH 0	1/1	QPSK	2416	03 00 00 02 00 01 03 00 02 01 02 00 00 01 00 01
0	PDSCH 0	1/1	QPSK	2432	00 01 01 02 03 03 02 01 01 00 00 00 03 00 01 01
0	PDSCH 0	1/1	QPSK	2448	02 02 00 01 00 00 01 03 00 00 01 00 03 00 00 00
0	PDSCH 0	1/1	QPSK	2464	01 00 00 01 02 02 01 01 00 02 03 01 01 00 02 00
0	PDSCH 0	1/1	QPSK	2480	01 03 02 02
0	PDSCH 1	1/1	16QAM	0	08 03 08 0B 08 03 03 08 05 07 0E 0B 0B 06 0D 0D
0	PDSCH 1	1/1	16QAM	16	05 06 0A 0B 01 0A 07 05 07 04 00 09 03 01 0C 0D
0	PDSCH 1	1/1	16QAM	32	01 01 08 05 08 0E 06 0B 0C 0E 0C 01 08 0A 0B 0B
0	PDSCH 1	1/1	16QAM	48	04 0D 0F 08 0C 09 0F 01 06 01 09 0F 0F 0B 03 01
0	PDSCH 1	1/1	16QAM	64	04 08 09 0A 0E 01 03 05 09 03 02 03 07 02 05 04

Fig. 9-2: Display of the bitstream

The TRACe[:DATA] command would return this:

```
<subframe>, <allocation ID>, <codeword>, <modulation>, <number of
symbols or bits>, <hexadecimal or binary numbers>, ...
```

Each line in this example corresponds to one set of values.

```
0,-12,0,2,239,01,00,02,01,01,00,00,00,00,00,01,01,
01,00,00,00,03,00,01,01,01,02,01,00,03,03,00,01,01,02,02,...

<continues like this until the next data block starts or the end of data is reached>

...,0,0,0,4,413,1D,2B,27,03,24,07,35,05,1F,22,20,15,
17,0C,21,34,10,2C,09,32,19,03,11,36,19,2A,05,0A,0F,0F,04,...

<continues like this till next datablock starts or end of data reached>
```


TRACe[:DATA]? <TraceNumber> | LIST

This command returns the trace data for the current measurement or result display. You can change the format of the returned data with the FORMat[:DATA] command.

ASCII format (FORMat ASCII): In ASCII format, a list of values separated by commas is returned (Comma Separated Values = CSV). Empty fields will return NAN.

Binary format (FORMat REAL,32): If the transmission takes place using the binary format (REAL,32), the data are transferred in block format (Definite Length Block Data according to IEEE 488.2). They are arranged in succeeding lists of I and Q data of 32 Bit IEEE 754 floating point numbers.

The returned values are scaled in the current measurement unit. For some measurements the unit may change depending on the unit set with UNIT:EVM.

The format of the data that is returned is specific to each result display and is specified below.

- **Capture Buffer**
  For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer. The unit is dBm.
- **EVM vs Carrier**
  For the EVM vs Carrier result display, the command returns one value for each subcarrier. The unit is either dB or %, depending on the unit you have set.
  <EVM in dB | EVM in %>, ...
  The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
  TRACE1: Mean EVM (averaged over all subframes)
  TRACE2: Minimum EVM or nothing if a single subframe is selected
  TRACE3: Maximum EVM or nothing if a single subframe is selected
- **EVM vs Symbol**
  For the EVM vs Symbol result display, the command returns a value for each OFDM symbol. If you select a single subframe (`[SENSe][:LTE]:SUBFrame:SELect`), the command returns only the symbols of that subframe. The unit is either dB or %, depending on the unit you have set.
  <EVM in dB | EVM in %>, ...
  The command returns data only for parameter TRACE1.
- **Frequency Error vs Symbol**
  For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol.

<frequency error in Hz>, ...
The command returns data only for parameter TRACE1.

- **EVM vs Subframe**
  For the EVM vs Subframe result display, the command returns a value for each subframe. The unit is either dB or %, depending on the unit you have set.
  <EVM in dB | EVM in %>, ...
  The command returns data only for parameter TRACE1.
- **Spectrum Emission Mask**
  For the Spectrum Emission Mask result display, the command returns one value for each trace point for parameter TRACE1.
  <power in dBm>
  For parameter LIST, it returns the contents of the SEM table.
  <index in result table>, <start frequency band in Hz>, <stop frequency band in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <failure flag>, ...
  The <failure flag> element returns 1 for FAIL and 0 for PASS.
- **Adjacent Channel Leakage Ratio**
  For the ACLR result display, the command returns one value for each trace point for parameter TRACE1.
  <power in dBm>, ...
  For parameter LIST, it returns the contents of the ACLR table.
- **Power Spectrum**
  For the Power Spectrum result display, the command returns the signal power in dBm/Hz as list over the considered frequency span for parameter TRACE1
  <power in dB>
- **Power vs RB RS**
  For the Power vs RB RS result display, the command returns one value for each resource block (RB) of the reference signal.
  <power in dBm>, ...
  The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
  TRACE1: Mean power of the reference signal per RB (averaged over all subframes)
  TRACE2: Minimum power of the reference signal per RB or nothing if a single subframe is selected
  TRACE3: Maximum power of the reference signal per RB or nothing if a single subframe is selected
- **Power vs RB PDSCH**
  For the Power vs RB PDSCH result display, the command returns one value for each resource block (RB) of the PDSCH.
  <power in dBm>, ...
  The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
  TRACE1: Mean power of the reference signal per RB (averaged over all subframes)
  TRACE2: Minimum power of the reference signal per RB or nothing if a single subframe is selected
  TRACE3: Maximum power of the reference signal per RB or nothing if a single subframe is selected
- **Channel Flatness**

For the Channel Flatness result display, the command returns one value for each trace point.
<spectrum flatness in dB>, ...
The number of trace points depends on the LTE bandwidth.
The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
TRACE1: mean power of the channel flatness (averaged over all subframes)
TRACE2: minimum power of the channel flatness or nothing if a single subframe is selected
TRACE3: maximum power of the channel flatness or nothing if a single subframe is selected

- **Channel Group Delay**
  For the Channel Group Delay result display, the command returns one value for each trace point.
  <channel group delay in ns>
  The number of trace points depends on the LTE bandwidth.
  The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
  TRACE1: Mean time of the channel group delay (averaged over all subframes)
  TRACE2: Minimum time of the channel group delay or nothing if a single subframe is selected
  TRACE3: Maximum time of the channel group delay or nothing if a single subframe is selected
- **Channel Flatness Difference**
  For the Channel Flatness Difference result display, the command returns one value for each trace point.
  <channel flatness difference in dB>, ...
  The number of trace points depends on the LTE bandwidth.
  The command returns the following for parameter TRACE1 to TRACE3, depending on the Subframe Configuration
  TRACE1: Mean power of the channel flatness difference (averaged over all subframes)
  TRACE2: Minimum power of the channel flatness difference or nothing if a single subframe is selected
  TRACE3: Maximum power of the channel flatness difference or nothing if a single subframe is selected
- **Constellation Diagram**
  For the Constellation Diagram result display, the command returns an array of interleaved I and Q data until all data is exhausted.
  By default, the command returns all measured data points. You can reduce the amount of data by filtering the results via "Constellation Selection" on page 58.
  Constellation data is returned in the following order.
  – Subframe 0, Symbol 0: first to last carrier of symbol 0
  – Subframe 0, Symbol 1: first to last carrier of symbol 1
  – Subframe 0, (...) to last symbol of subframe 0
  – Subframe 1, Symbol 0: first to last carrier of symbol 0
  – Subframe 1, Symbol 1: first to last carrier of symbol 1
  – Subframe 1, (...) to last symbol of subframe 1

– (...) to last subframe

TRACE1: all constellation data covered by the selection
TRACE2: reference symbols
TRACE3: sounding reference signal

- **CCDF**
  For the Complementary Cumulative Distribution Function result display, the command returns the probability over the power level.
  The command returns the following for parameter TRACE1 to TRACE2
  TRACE1: returns the values of the y-axis: <probability value in %>
  TRACE2: returns the corresponding values of the x-axis: <power steps in dB>
- **Allocation Summary**
  For the Allocation Summary result display, the command returns seven values for each line of the allocation summary table.
  <subframe>, <allocation ID>, <number of RB>, <relative power>, <modulation>, <power in dBm>, <EVM in dB or %>, ...
  This command is not available for Real32 data format and will therefore always return ASCII formatted data.
- **Bitstream**
  For the BitStream result display, the command returns returns six values for each line in the bitstream table.
  <subframe>, <allocation ID>, <codeword>, <modulation>, <number of symbols or bits>, <hexadecimal or binary numbers>, ...
  This command is not available for Real32 data format and will therefore always return ASCII formatted data.

Parameters:

<hexadecimal or binary numbers> — In Hexmode, a comma-separated stream of two-digit hexadecimal numbers and in binary mode a comma-separated stream of binary numbers.

<number of symbols or bits> — In Hexmode, the number of symbols to be transmitted and in binary mode the number of bits to be transmitted.

Parameters for setting and query:

<TraceNumber> — **TRACE1 | TRACE2 | TRACE3**
If you have more than one trace in the result display, this parameter selects the trace whose data you want.

Return values:

<allocation ID> Allocation ID for downlink signals. The range is {-1...-13}
-1= INVALID
-2= ALL
-3= P-SYNC
-4= S-SYNC
-5= PILOTS_ANT1
-6= PILOTS_ANT2
-7= PILOTS_ANT3
-8= PILOTS_ANT4
-9= PCFICH
-10= PHICH
-11= PDCCH
-12= PBCH
-13= PMCH

<codeword> Codeword of the allocation. The range is from {0...2}.
0= '1/1'
1= '1/2'
2= '2/2'

<EVM> EVM is returned either in dB or in %, depending on the unit you have set.

<modulation> Type of modulation. The range is {0...8}.
0= Unrecognized
1= RBPSK (both constellation points are located on the x-axis)
2= QPSK
3= 16QAM
4= 64QAM
5= 8PSK
6= PSK
7= Modulation mixture
8= BPSK

<number of RB> Number of resource blocks.

<subframe> Number of the subframe.

Usage: Query only

TRACe:IQ:FILTer:FLATness <FilterType>

This command turns the wideband filter on and off.

Parameters:

<FilterType> **NORMal**
Uses the normal filter.

WIDE
Turns the wideband filter on.

*RST: NORMal

Example: `TRAC:IQ:FILT:FLAT WIDE`
Turns the wideband filter on.

9.13 TRIGger Subsystem

TRIGger[:SEQuence]:HOLDoff<analyzer> <TrigOffset>

This command defines the trigger offset.

Parameters:
<TrigOffset> <numeric value>
*RST: 0 s
Default unit: s

Example: `TRIG:HOLD 5MS`
Sets the trigger offset to 5 ms.

TRIGger[:SEQuence]:LEVel<analyzer>[:EXTernal] <Level>

This command defines the level of an external trigger.

Parameters:
<TriggerLevel> Range: 0.5 V to 3.5 V
*RST: 1.4 V

Example: `TRIG:LEV 2V`

TRIGger[:SEQuence]:MODE <TrigMode>

This command selects the trigger source.

Parameters:
<TrigMode> EXTernal | IMMediate | POWer

EXTernal
Selects external trigger source.

IMMediate
Selects free run trigger source.

POWer
Selects IF power trigger source.

*RST: IMMediate

Example: `TRIG:MODE EXT`
Selects an external trigger source.

9.14 UNIT Subsystem

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit>

SYMbols
Displays the bit stream using symbols

BITs
Displays the bit stream using bits

*RST: SYMbols

Example: `UNIT:BSTR BIT`
Bit stream gets displayed using Bits.

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit> DB | PCT

DB
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

Example: `UNIT:EVM PCT`
EVM results to be returned in %.

9.15 Status Reporting System (LTE Measurements)

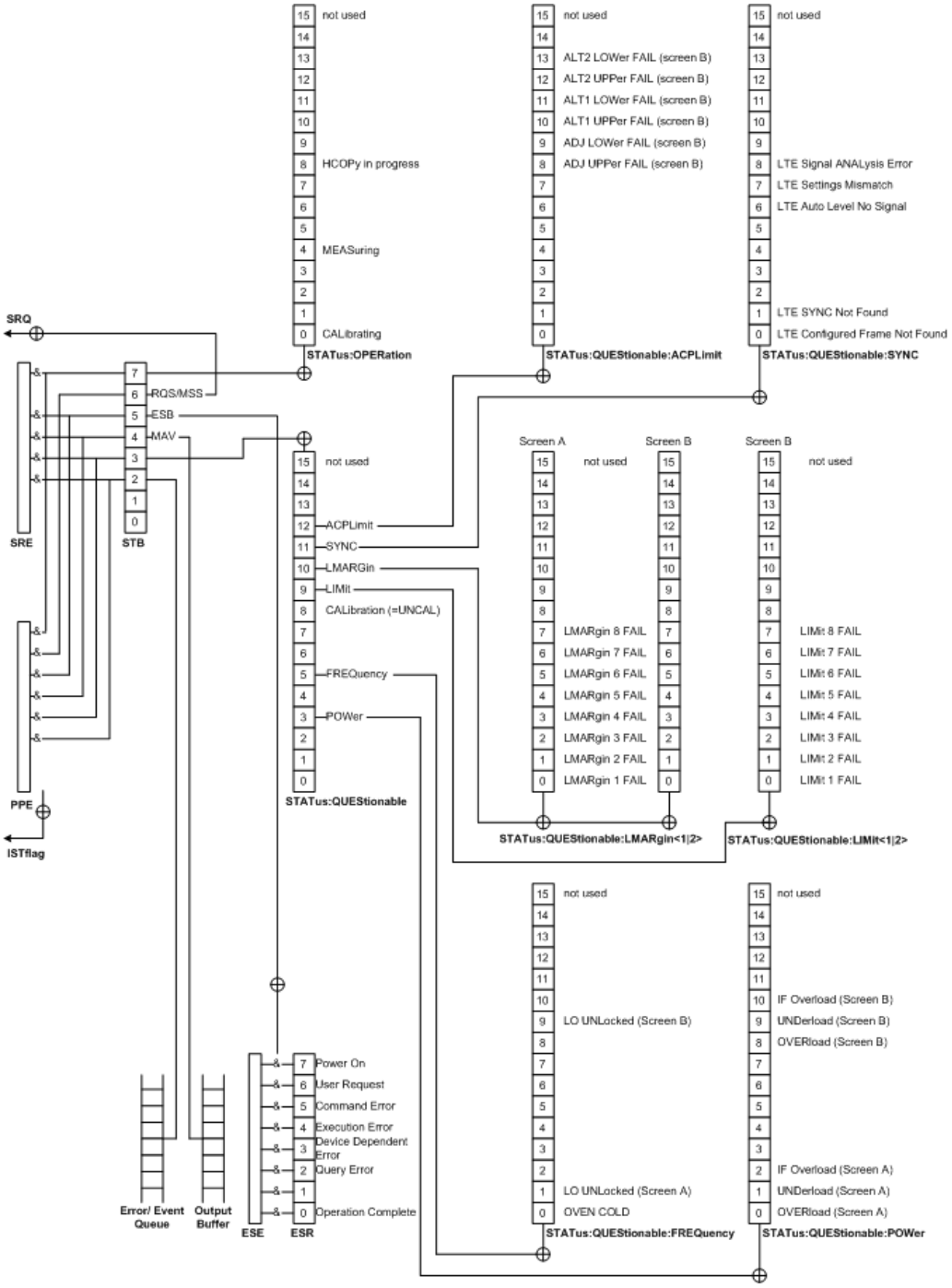
The status reporting system stores information about the current state of the R&S FSQ. This includes, for example, information about errors during operation or information about limit checks. The R&S FSQ stores this information in the status registers and in the error queue. You can query the status register and error queue via IEC bus.

The R&S FSQ structures the information hierarchically, with the Status Byte register (STB) and the Service Request Enable mask register (SRE) being on the highest level. The STB gets its information from the standard Event Status Register (ESR) and the Event Status Enable mask register (ESE). The STB and ESR are both defined by IEEE 488.2. In addition to the ESR, the STB also gets information from the STATus:OPERation and STATus:QUEStionable registers. These are the link to the lower levels of the status

register and are defined by SCPI. They contain information about the state of the R&S FSQ.

In addition to the status registers of the base system, the LTE measurement application provides additional or different registers specific to this firmware option. This chapter decribes the registers specific to the LTE measurement applications (uplink and downlink). For a description of the other registers see the operating manual of the R&S FSQ.

Overview of the status register



9.15.1 STATus:QUEStionable:LIMit Register

The STATus:QUEStionable:LIMit register contains information about the results of a limit check when you are working with limit lines.

The LTE measurement application contains one LIMit register only because limit lines are always displayed in screen B.

The number of LIMit registers depends on the number of measurement windows available in any operating mode.

You can read out the register with `STATus:QUEStionable:LIMit[:EVENt]` or `STATus:QUEStionable:LIMit:CONDition`. For more information see the manual of the base unit.

Table 9-1: Meaning of the bits used in the STATus:QUEStionable:LIMit register

Bit No.	Meaning
0	LIMit 1 FAIL This bit is set if limit line 1 is violated.
1	LIMit 2 FAIL This bit is set if limit line 2 is violated.
2	LIMit 3 FAIL This bit is set if limit line 3 is violated.
3	LIMit 4 FAIL This bit is set if limit line 4 is violated.
4	LIMit 5 FAIL This bit is set if limit line 5 is violated.
5	LIMit 6 FAIL This bit is set if limit line 6 is violated.
6	LIMit 7 FAIL This bit is set if limit line 7 is violated.
7	LIMit 8 FAIL This bit is set if limit line 8 is violated.
8 to 14	Unused
15	This bit is always 0.

9.15.2 STATus:QUEStionable:SYNC Register

The STATus:QUEStionable:SYNC register contains information about the synchronization of the R&S FSQ to the signal.

You can read out the register with `STATus:QUEStionable:SYNC[:EVENt]` or `STATus:QUEStionable:SYNC:CONDition`. For more information see the manual of the base unit.

Table 9-2: Meaning of the bits used in the STATus:QUEStionable:LIMit register

Bit No.	Meaning
0	LTE Configured Frame Not Found This bit is set if the application could not find the configured frame. Only possible with uplink measurements.
1	SYNC Not Found This bit is set if the application could not synchronize to the signal. Only possible with downlink measurements.
2 to 5	Unused
6	LTE Auto Level No Signal
7	LTE Settings Mismatch This bit is set if the configuration is not the same as the signal.
8	LTE Signal Analysis Error
9 to 14	Unused
15	This bit is always 0.

List of Commands

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