R&S®FSV-K100 and -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 FSV-K100 EUTRA / LTE FDD Downlink Measurement Application (1310.9051.02)
- R&S FSV-K104 EUTRA / LTE TDD Downlink Measurement Application (1309.9774.02)

This manual is applicable for the following analyzer models with firmware version 1.55:

- R&S®FSV 3 (1307.9002K03)
- R&S®FSV 7 (1307.9002K07)
- R&S®FSV 13 (1307.9002K13)
- R&S®FSV 30 (1307.9002K30)
- R&S®FSV 40 (1307.9002K40)

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The following abbreviations are used throughout this manual: R&S®FSV-K100 is abbreviated as R&S FSV-K100, R&S®FSV-K104 is abbreviated as R&S FSV-K104 and R&S®FSV is abbreviated as R&S FSV.

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

75 Years of Driving Innovation

ROHDE&SCHWARZ

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Contents

1 Documentation Overview

The user documentation for the R&S FSV is divided as follows:

- Quick Start Guide
- Operating Manuals for base unit and options
- Service Manual
- Online Help
- Release Notes

Quick Start Guide

This manual is delivered with the instrument in printed form and in PDF format on the CD. It provides the information needed to set up and start working with the instrument. Basic operations and basic measurements are described. Also a brief introduction to remote control is given. The manual includes general information (e.g. Safety Instructions) and the following chapters:

Chapters 1-3	Introduction, General information
Chapter 4	Front and Rear Panel
Chapter 5	Preparing for Use
Chapter 6	Firmware Update and Installation of Firmware Options
Chapter 7	Basic Operations
Chapter 8	Basic Measurement Examples
Chapter 9	Brief Introduction to Remote Control
Appendix 1	Printer Interface
Appendix 2	LAN Interface

Operating Manuals

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

The Operating Manual for the base unit provides basic information on operating the R&S FSV in general, and the "Spectrum" mode in particular. Furthermore, the software options that enhance the basic functionality for various measurement modes are described here. The set of measurement examples in the Quick Start Guide is expanded by more advanced measurement examples. In addition to the brief introduction to remote control in the Quick Start Guide, a description of the basic analyzer commands and programming examples is given. Information on maintenance, instrument interfaces and error messages is also provided.

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

The following Operating Manuals are available for the R&S FSV:

- R&S FSV base unit; in addition:
  - R&S FSV-K9 Power Sensor Support
  - R&S FSV-K14 Spectrogram Measurement
- R&S FSV-K7 Analog Demodulation and R&S FSV-K7S FM Stereo Measurements
- R&S FSV-K10 GSM/EDGE Measurement
- R&S FSV-K30 Noise Figure Measurement
- R&S FSV-K40 Phase Noise Measurement
- R&S FSV-K70 Vector Signal Analysis
- R&S FSV-K72 3GPP FDD BTS Analysis
- R&S FSV-K73 3GPP FDD UE Analysis
- R&S FSV-K76/77 3GPP TD-SCDMA BTS/UE Measurement
- R&S FSV-K82/83 CDMA2000 BTS/MS Analysis
- R&S FSV-K84/85 1xEV-DO BTS/MS Analysis
- R&S FSV-K91 WLAN IEEE 802.11a/b/g/j/n
- R&S FSV-K93 WiMAX IEEE 802.16 OFDM/OFDMA Analysis
- R&S FSV-K100/K104 EUTRA / LTE Downlink Measurement Application
- R&S FSV-K101/K105 EUTRA / LTE Uplink Measurement Application

These manuals are available in PDF format on the CD delivered with the instrument. The printed manual can be ordered from Rohde & Schwarz GmbH & Co. KG.

Service Manual

This manual is available in PDF format on the CD delivered with the instrument. It describes how to check compliance with rated specifications, instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the R&S FSV by replacing modules. The manual includes the following chapters:

Chapter 1	Performance Test
Chapter 2	Adjustment
Chapter 3	Repair
Chapter 4	Software Update / Installing Options
Chapter 5	Documents

Online Help

The online help contains context-specific help on operating the R&S FSV and all available options. It describes both manual and remote operation. The online help is installed on the R&S FSV by default, and is also available as an executable .chm file on the CD delivered with the instrument.

Release Notes

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

2 LTE Measurement Application

Overview of the LTE measurement application

This manual contains all information that you need to work with the LTE measurement application like manual operation or remote control operation.

The manual covers all LTE Uplink firmware applications that are available for the R&S FSV:

- R&S FSV-K100 (LTE Downlink FDD)
- R&S FSV-K104 (LTE Downlink TDD)

The LTE measurement applications make use of the I/Q capture functionality of the R&S FSV. The I/Q capture enables EUTRA/LTE TX measurements in accordance with the EUTRA specification.

This part of the documentation covers only functions that are particular to the firmware application. For all other functionality, refer to the description of the base unit.

2.1 Introduction

The R&S FSV-K100/-K104 EUTRA/LTE Downlink Measurement Application uses the I/Q capture functionality of the R&S FSV 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.

2.1.1 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).

2.1.1.1 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.

2.1.1.2 Long-Term Evolution Downlink Transmission Scheme

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.

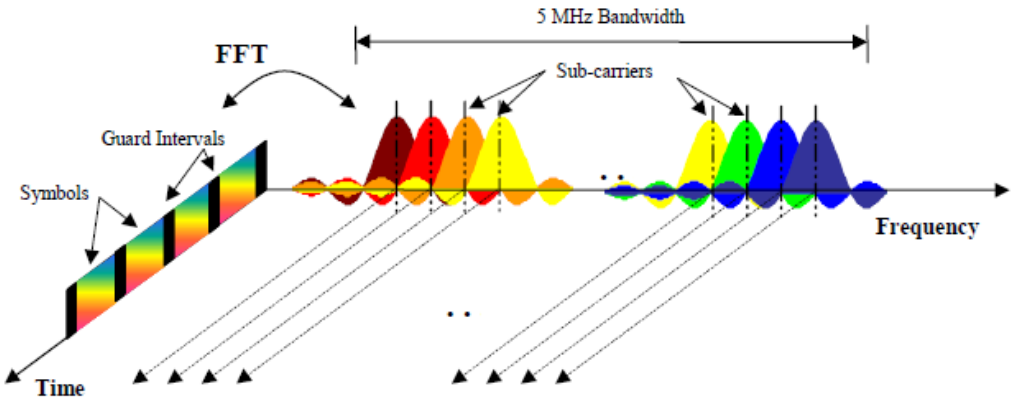

Fig. 2-1: Frequency-Time Representation of an OFDM Signal (3GPP TR 25.892 [2])

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 $mT_u < t \leq (m+1)T_u$.

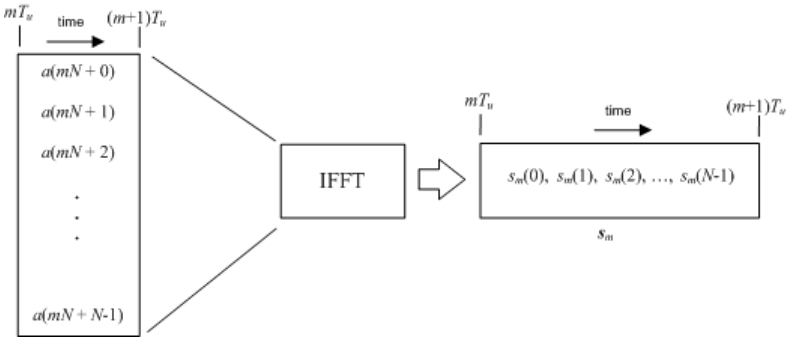

Fig. 2-2: OFDM useful symbol generation using an IFFT (3GPP TR 25.892 [2])

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 sub-carriers 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.

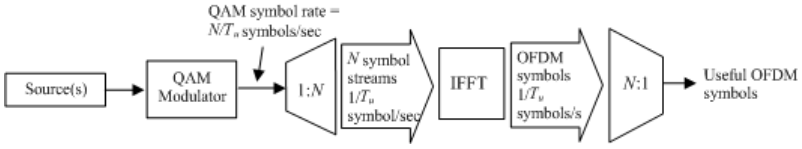

Fig. 2-3: OFDM Signal Generation Chain (3GPP TR 25.892 [2]

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.

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 v8.3.0 [3]. 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).

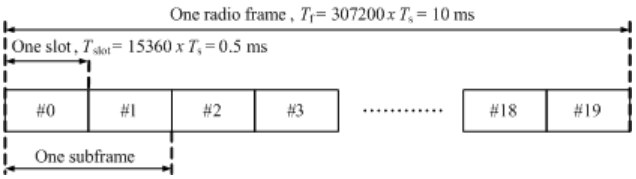

Fig. 2-4: Generic Frame Structure in EUTRA Downlink (3GPP TS 36.211 v8.3.0 [3]

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_{BW}^{DL} 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_{BW}^{DL} 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_{BW}^{DL} 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.

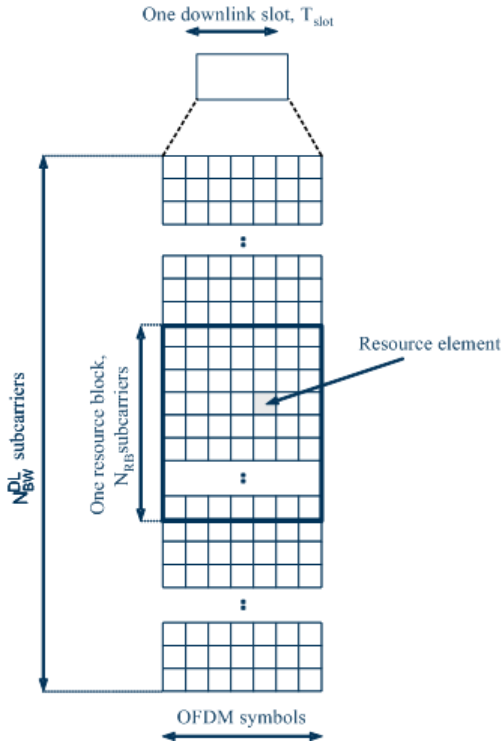

Fig. 2-5: Downlink Resource Grid (3GPP TS 36.211 v8.3.0 [3]

One downlink slot consists of N_{symb}^{DL} OFDM symbols. To each symbol, a cyclic prefix (CP) is appended as guard time, compare figure 2-1. N_{symb}^{DL} depends on the cyclic prefix length. The generic frame structure with normal cyclic prefix length contains N_{symb}^{DL} = 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-E}≈16.7µs contains N_{symb}^{DL} = 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

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^{DL}_{symb} 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.

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.

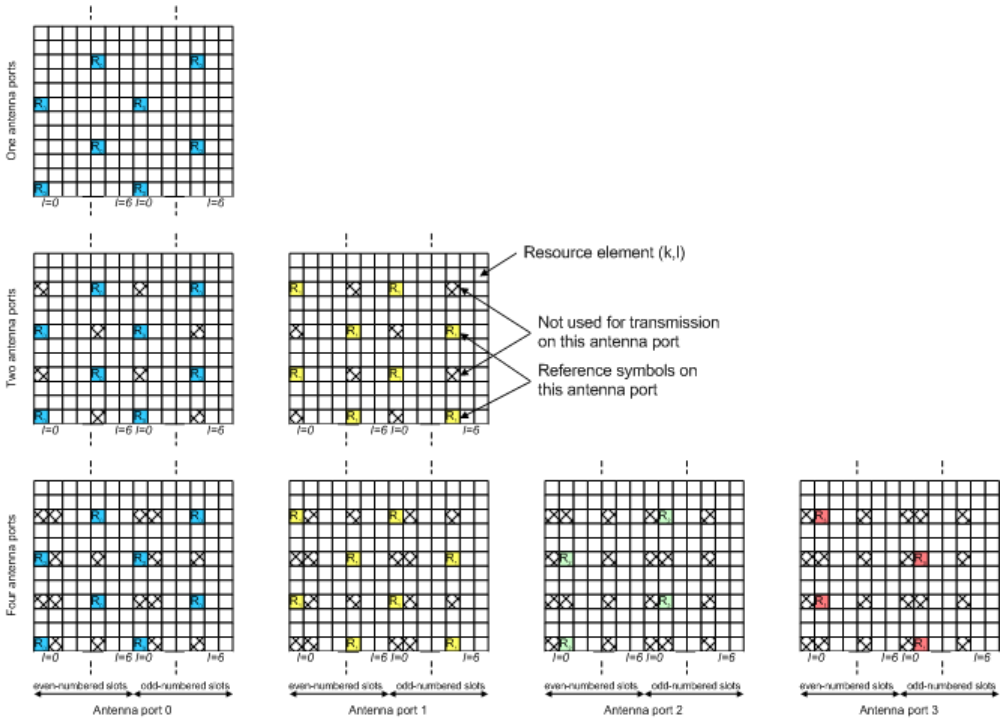

Fig. 2-6: Downlink Reference Signal Structure (Normal Cyclic Prefix)

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 (PSYNC) 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.

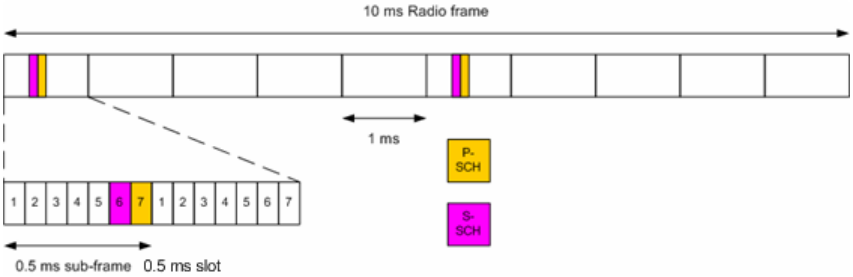

Fig. 2-7: P-SYNC and S-SYNC Structure

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.

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.

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

This section describes working assumptions for EUTRA/LTE test & measurement solutions that cannot yet be derived from 3GPP specifications. These 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:

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

- 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

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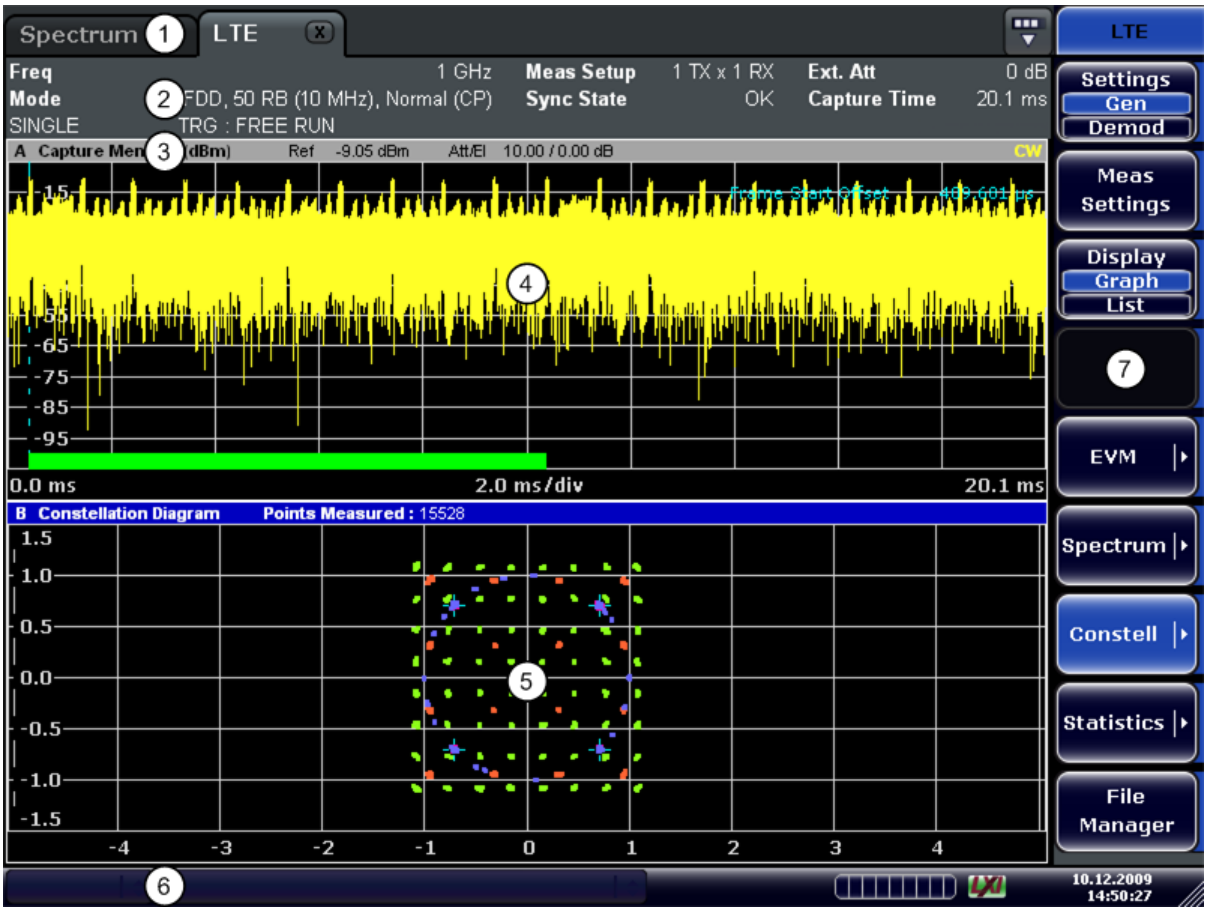
2.2 Screen Layout

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



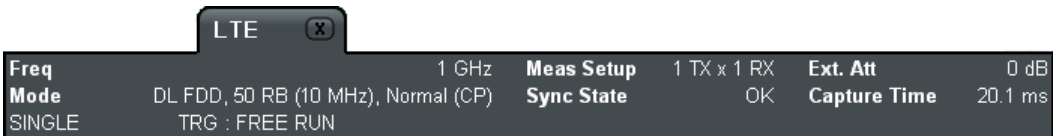
1 = Title Bar: shows the currently active measurement application
2 = Table Header: shows basic measurement information, e.g. the frequency
3 = Result Display Header: shows information about the display trace
4 = Result Display Screen A: shows the measurement results
5 = Result Display Screen B: shows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

Status Bar

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 88
- **Ext. Att**
  External attenuation in dB.
- **Capture Time**
  Capture length in ms.

2.3 Configuring Measurements

Before you can start a measurement, you have to configure the R&S FSV 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.

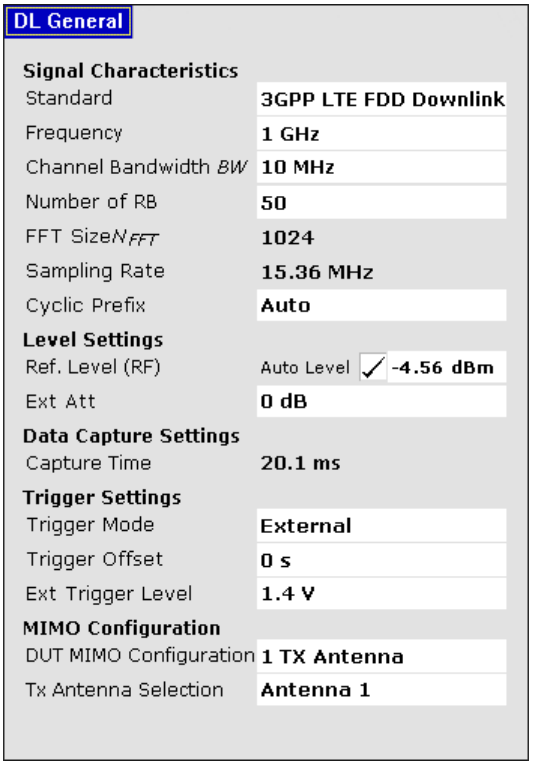
In addition, you can set up general measurement parameters in the "Measurement Settings" dialog box. Special settings for SEM and ACLR measurements are provided by the corresponding dialog boxes.

2.3.1 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 two tabs, one for general settings and one for advanced settings. By default, the "General" tab is the active one. You can switch between the tabs by touching the tab on the touchscreen or with the cursor keys.

2.3.1.1 General

In the DL General tab you can set all basic parameters, like the frequency of the signal or the reference level, that are necessary to perform a measurement.



Signal Characteristics

The signal characteristics define settings related to the physical attributes of the signal you want to analyze.

Standard
Sets the standard, duplexing method and link direction to use for this measurement.

Select either 3GPP LTE FDD Downlink (R&S FSV-K100) or 3GPP LTE TDD Downlink (R&S FSV-K104).

For the uplink, you can select either 3GPP LTE FDD Uplink (R&S FSV-K101) or 3GPP LTE TDD Uplink (R&S FSV-K105).

The header table shows the standard you are currently using.

SCPI command:
CONFigure[:LTE]:LDIRection on page 72
CONFigure[:LTE]:DUPLexing on page 72

Frequency
Specifies the center frequency of the signal to be measured. The maximum frequency depends on the hardware configuration of your R&S FSV.

The header table shows the current center frequency.

SCPI command:
[SENSe]:FREQuency:CENTer on page 85

Channel Bandwidth / Number of RB
Specify the channel bandwidth or, alternatively, the number of resource blocks (RB) of the channel. The software calculates the number of resource blocks from the channel bandwidth you have set according to the standard specification and vice versa.

If you set a bandwidth or number of resource blocks other than those specified in the standard, the R&S FSV labels that parameter as "User".

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100

SCPI command:
CONFigure[:LTE]:DL:BW on page 64
CONFigure[:LTE]:DL:NORB on page 66

FFT Size N_{FFT} / Sampling Rate
The Sampling Rate and FFT Size are read-only parameters that depend on the channel bandwidth and the number of resource blocks.

See chapter 2.1.1.3, "EUTRA / LTE Test & Measurement Assumption made by Rohde & Schwarz", on page 16 for information on the calculation method.

Cyclic Prefix
Sets the type of cyclic prefix for all subframes. The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences.

- **Normal**
  Normal cyclic prefix: a slot contains 7 OFDM symbols.
- **Extended**
  Extended cycic prefix: a slot contains 6 ODFM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- **Auto**
  The application determines the type of cyclic prefix automatically.

SCPI command:
CONFigure[:LTE]:DL:CYCPrefix on page 65

Level Settings

The level settings define settings related to the reference level and RF attenuation.

Ref Level
Sets the reference level of the R&S FSV. If you enable Auto Level, the R&S FSV calculates the reference level itself.

You can either specify the RF reference level or baseband (BB) reference level, depending on the input source. The unit is dBm for a RF input source and V for a baseband input source.

This field is automatically adjusted if you make any changes to the "Ref Level" field in the Input Settings and vice versa.

SCPI command:
`CONFigure:POWer:EXPected:RF<anaid>` on page 73

Auto Level
If enabled, the R&S FSV automatically measures the reference level. If disabled, you can enter the reference level manually.

When Auto Level is set to ON, the R&S FSV EUTRA/LTE measurement application will measure the reference level automatically at the start of each measurement sweep. This ensures that the reference level is always set at the optimal level for obtaining accurate results but will lead to slightly increased measurement times.

Activating Auto Level also automatically adjusts the RF attenuation.

This field is automatically adjusted to the state of the "Auto Level" in the Input Settings and vice versa.

SCPI command:
`[SENSe]:POWer:AUTO<anaid>[:STATe]` on page 86

Ext Att
Specifies the external attenuation or gain applied to the RF signal. A positive value indicates attenuation, a negative value indicates gain.

All displayed power level values will be shifted by this value.

The external attenuation is also shown in the header table.

SCPI command:
`DISPlay[:WINDow<screenid>]:TRACe<tracenum>:Y[:SCALe]:RLEVel:OFFSet` on page 73

Data Capture Settings

The data capture settings define settings related to the capture of the signal data.

Capture Time
Shows the time (and therefore the amount of data) that is captured in a single sweep.

Note that this field is read only.

Trigger Settings

The trigger settings define settings related to the triggering of a sweep.

Trigger Mode
Trigger Mode is the source of the trigger for the measurement sweep.

The possible values for the Trigger Mode are:

- **Free Run**
  The measurement sweep starts immediately.
- **External**
  The measurement sweep starts when the external trigger signal meets or exceeds the specified external trigger level at the input connector EXT TRIGGER/GATE on the rear panel.

SCPI command:
`TRIGger[:SEQuence]:MODE` on page 95

Trigger Offset
Trigger Offset specifies the time offset between the trigger signal and the start of the sweep. A negative value indicates a pre-trigger.

The Trigger Offset parameter is not editable when Trigger Mode is set to Free Run because this indicates that the measurement sweep should trigger immediately and as such a trigger delay or pre-trigger would not be appropriate.

The External Trigger Level parameter is available only when Trigger Mode is set to External.

SCPI command:
`TRIGger[:SEQuence]:HOLDoff` on page 95

Ext Trigger Level
Specifies the trigger level when an external trigger is selected.

The External Trigger Level parameter is available only when Trigger Mode is set to External.

SCPI command:
`TRIGger<n>[:SEQuence]:LEVel[:EXTernal]` on page 95

MIMO Configuration

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

Configuration
Defines the number of transmit antennas. The application supports one-, two- and four-antenna configurations.

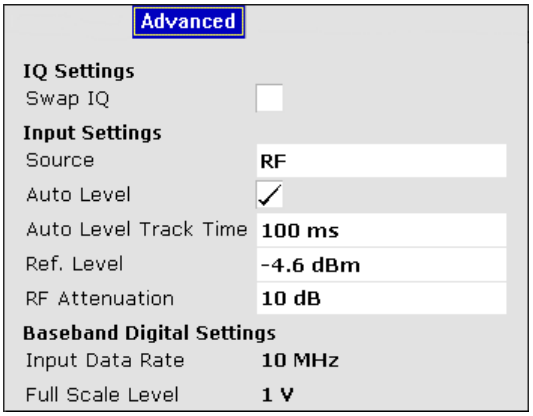
SCPI command:
`CONFigure[:LTE]:DL:MIMO:CONFig` on page 65

Tx Antenna Selection
Select the antenna you want to analyze in a MIMO setup. The number of antennas to choose from depends on the MIMO configuration.

SCPI command:
`CONFigure[:LTE]:DL:MIMO:ASELection` on page 65

2.3.1.2 Advanced

In the Advanced tab you can set more advanced global parameters, like the input source of the signal, that are necessary to perform a measurement.



I/Q Settings

The I/Q settings define settings related to the capture of IQ data.

Swap I/Q
Swaps the I and the Q branch of the signal. You can swap the branches if you use data acquired directly from the hardware.

SCPI command:
`[SENSe]:SWAPiq` on page 87

Input Settings

The input settings define settings related to the input source of the signal.

Source
Selects the input source of the data. By default, this is RF input. Analog and digital baseband input are availbale with options R&S FSV-B71 (Analog Baseband) or R&S FSV-B17 (Digital Baseband).

You can also read the input from a file. Refer to chapter 2.7, "File Management", on page 51 for details on how to import I/Q data from a file.

SCPI command:
`INPut:SELect` on page 82

Auto Level
If enabled, the R&S FSV automatically measures the reference level. If disabled, you can enter the reference level manually.

When Auto Level is set to ON, the R&S FSV EUTRA/LTE measurement application will measure the reference level automatically at the start of each measurement sweep. This ensures that the reference level is always set at the optimal level for obtaining accurate results but will lead to slightly increased measurement times.

Activating Auto Level also automatically adjusts the RF attenuation.

This field is automatically adjusted to the state of the "Auto Level" in the Input Settings and vice versa.

SCPI command:
`[SENSe]:POWer:AUTO<anaid>[:STATe]` on page 86

Ref Level
Sets the reference level of the R&S FSV. If you enable Auto Level, the R&S FSV calculates the reference level itself.

You can either specify the RF reference level or baseband (BB) reference level, depending on the input source. The unit is dBm for a RF input source and V for a baseband input source.

This field is automatically adjusted if you make any changes to the "Ref Level" field in the Input Settings and vice versa.

SCPI command:
`CONFigure:POWer:EXPected:RF<anaid>` on page 73

RF Att
Specifies the mechanical attenuation to be applied to the input RF signal.

The value range is from 0 dB to 75 dB in steps of 5 dB.

The RF Attenuation parameter only takes effect if Auto Level is disabled.

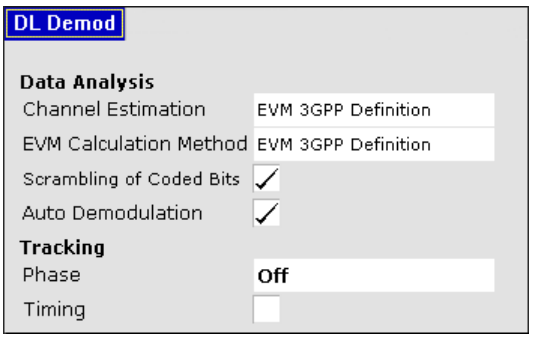
SCPI command:
`INPut<screenid>:ATTenuation<anaid>` on page 81

2.3.2 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 by touching the tab on the touchscreen or with the cursor keys.

2.3.2.1 DL Demod

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



Data Analysis Settings

Channel Estimation

Specifies how channel estimation is performed for the signal.

- **EVM 3GPP Definition**
  Channel estimation method as specified in 3GPP TS 36.141 (averaging in frequency direction and linear interpolation). Only the reference signal is used.
- **Optimal, Pilot only**
  Optimal channel estimation method, only the reference signal is used.
- **Optimal, Pilot and Payload**
  Optimal channel estimation method, both reference signal and payload resource elements are used.

SCPI command:

`[SENSe][:LTE]:DL:DEMod:CESTimation` on page 84

EVM Calculation Method

Specifies the EVM calculation method.

- **EVM 3GPP Definition**
  EVM calculation method as defined in 3GPP TS 36.141. The EVM is evaluated at two trial timing positions and the maximum EVM of these two trials is used.
- **At Optimal Timing Position**
  The EVM is calculated using the optimal timing position.

SCPI command:

`[SENSe][:LTE]:DL:DEMod:EVMCalc` on page 84

Scrambling of Coded Bits

Specifies whether the scrambling for coded bits shall be used or not. This setting applies to all physical channels like PDSCH, PHICH, etc.

Note: The PDSCH n_{RNTI} parameter is set to 0.

SCPI command:

`[SENSe][:LTE]:DL:DEMod:CBSCrambling` on page 83

Auto Demodulation
Specifies whether or not the auto demodulation feature shall be used. If auto demodulation is enabled, the PDSCH subframe configuration is automatically detected by analyzing the received signal.

SCPI command:
`[SENSe][:LTE]:DL:DEMod:AUTO` on page 83

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.

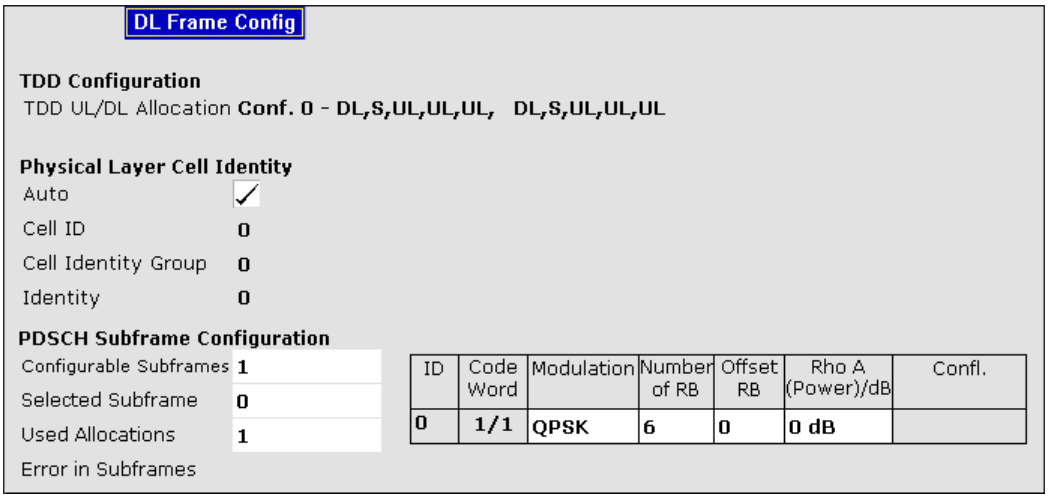
SCPI command:
`[SENSe][:LTE]:DL:TRACking:PHASe` on page 84

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 85

2.3.2.2 DL Frame Config

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



TDD Configuration

TDD UL/DL Allocations

TDD UL/DL Allocations specifies the uplink-downlink allocation configuration.

The details of the current selected configuration is shown as a comma separated list of a complete LTE frame containing the following elements:

- DL (downlink subframe)
  UL (uplink subframe)
  S (special subframe with the three fields DwPTS, GP, UqPTS)

SCPI command:

`CONFigure[:LTE]:DL:TDD:UDConf` on page 71

Physical Layer Cell Identity

There are 504 unique physical-layer cell identities. The physical-layer cell identities are grouped into 168 unique physical-layer cell-identity groups, each group containing three unique identities. A physical-layer cell identity $N_{ID}^{cell} = 3N_{ID}^{(1)} + N_{ID}^{(2)}$ is uniquely defined by a number $N_{ID}^{(1)}$ in the range of 0 to 167, representing the physical-layer cell identity group, and a number $N_{ID}^{(2)}$ in the range of 0 to 2, representing the physical layer identity within the physical-layer cell identity group.

Auto

Automatically detects the physical layer cell ID, cell identity group and identity.

Cell ID

Specifies the physical layer cell ID. If you change either the Cell Identity Group or Identity, the Cell ID will be derived from these values.

Cell Identity Group

Cell Identity Group specifies the physical-layer cell identity group. If you change either the Cell Identity Group or Identity, the Cell ID will be derived from these values.

Identity

Identity specifies the physical-layer identity. If you change either the Cell Identity Group or Identity, the Cell ID will be derived from these values.

PDSCH Subframe Configuration

The PDSCH Subframe Configuration define settings related to the OFDMA resource allocations. If you enable Auto Demodulation, the R&S FSV automatically detects these settings from the signal.

Configurable Subframes

Specifies the number of subframes that can be configured in the Configuration Table. You can set up to 10 subframes.

SCPI command:

`CONFigure[:LTE]:DL:CSUBframes` on page 64

Selected Subframe
Selected Subframe specifies the subframe that is displayed in the Configuration Table. The number of available subframes depends on the configured subframes (see Configurable Subframes).

Used Allocations
The Used Allocations setting specifies the number of allocations used in this subframe. This setting defines the number of rows in the Configuration Table.

SCPI command:
`CONFigure[:LTE]:DL:SUBFrame<subfnum>:ALCount` on page 69

Error in Subframes
Shows if there's an error in one of the subframes and shows the number of the subframe the error occured in.

Note that this is a read only field.

Configuration Table

ID	Code Word	Modulation	Number of RB	Offset RB	Power [dB]	Confl.
0	1/1	QPSK	6	0	0 dB	

The Configuration Table specifies the properties of each allocation used. Each allocation is assigned an ID which counts from 0 to the number of allocations minus one. For each allocation, the following settings are provided:

- **ID**
  Shows the ID of the allocation. This is a read only column.
- **Code Word**
  Shows the code word of the allocation. This is a read only column.
- **Modulation**
  Type of Modulation.
- **Number of RB**
  Sets the size of the allocation in number of resource blocks.
- **Offset RB**
  Sets the start resource block of the allocation.
- **Power [dB]**
  Sets the boosting of the allocation in dB.
- **Conflict**
  Shows details on any errors that occur in the allocation settings. Possible errors are bandwidth errors and allocation conflict errors (overlap of allocations). Bandwidth

errors are shown as "> BW". In case of allocation conflict errors, the IDs of the conflicting allocations are shown.

SCPI command:

Modulation: `CONFigure[:LTE]:DL:SUBFrame<subfnum>:ALLoc<allocnum>[:CW<Cwnum>]:MODulation` on page 71

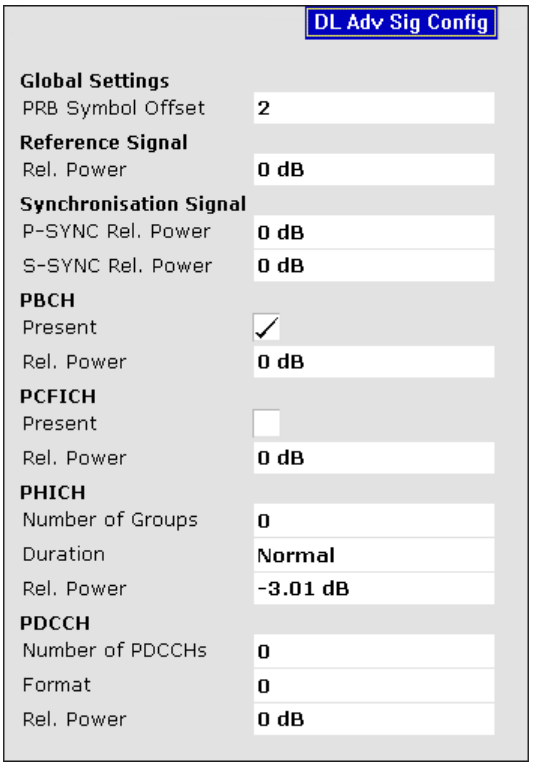
Number of RB: `CONFigure[:LTE]:DL:SUBFrame<subfnum>:ALLoc<allocnum>:RBCount` on page 70

Offset RB: `CONFigure[:LTE]:DL:SUBFrame<subfnum>:ALLoc<allocnum>:RBOFfset` on page 70

Power: `CONFigure[:LTE]:DL:SUBFrame<subfnum>:ALLoc<allocnum>:POWer` on page 70

2.3.2.3 DL Advanced Signal Configuration

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



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.

Reference Signal

Rel Power
Relative power of the reference signal.

SCPI command:
`CONFigure[:LTE]:DL:REFSig:POWer` on page 69

Synchronization Signal

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

SCPI command:
`CONFigure[:LTE]:DL:SYNC:PPOWer` on page 71

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

SCPI command:
`CONFigure[:LTE]:DL:SYNC:SPOWer` on page 71

PBCH

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

SCPI command:
`CONFigure[:LTE]:DL:PBCH:STAT` on page 66

Rel Power
Relative Power of the PBCH.

SCPI command:
`CONFigure[:LTE]:DL:PBCH:POWer` on page 66

PCFICH

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

SCPI command:
`CONFigure[:LTE]:DL:PCFich:STAT` on page 66

Rel Power
Relative Power of the PCFICH.

SCPI command:
`CONFigure[:LTE]:DL:PCFich:POWer` on page 66

PHICH

Number Of Groups
PHICH Number of Groups specifies the number of PHICH groups.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:NOGRoups` on page 68

Duration
PHICH Duration specifies the duration of the PHICH. Normal and Extended duration are supported.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:DURation` on page 68

Rel Power
Relative Power of the PHICH.

SCPI command:
`CONFigure[:LTE]:DL:PHICh:POWer` on page 68

PDCCH

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

SCPI command:
`CONFigure[:LTE]:DL:PDCCh:NOPD` on page 67

PDCCH Format
PDCCH Format specifies the format for the physical downlink control channel.

SCPI command:
`CONFigure[:LTE]:DL:PDCCh:FORMat` on page 67

Rel Power
Relative Power of the PHICH.

SCPI command:
`CONFigure[:LTE]:DL:PDCCh:POWer` on page 67

2.3.3 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 by touching the tab on the touchscreen or with the cursor keys.

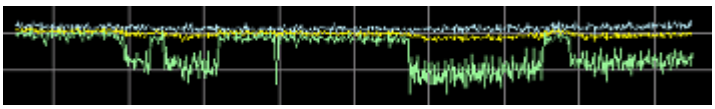
2.3.3.1 Selection

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

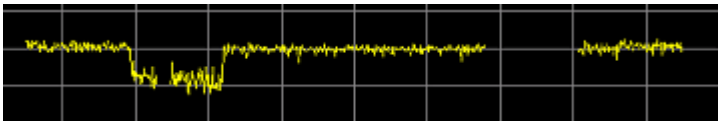
If you select --All---, the R&S FSV shows the minimum / mean / maximum statistic.



with 

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

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



SCPI command:
`[SENSe][:LTE]:SUBFrame:SELect` on page 85

2.3.3.2 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 96

2.3.3.3 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:

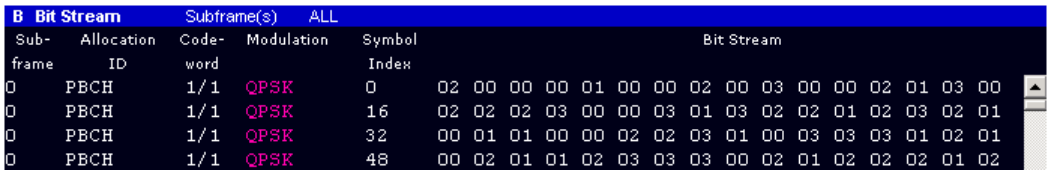


Fig. 2-8: Bit stream display in downlink application if the bit stream format is set to "symbols"

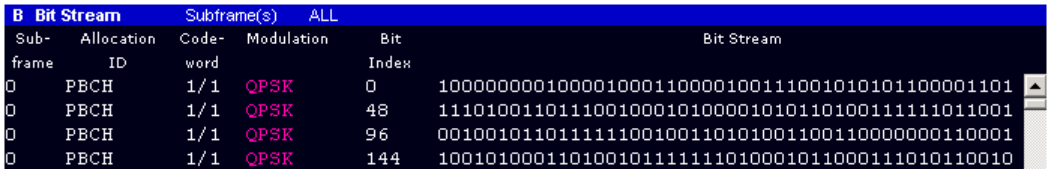


Fig. 2-9: Bit stream display in downlink application if the bit stream format is set to "bits"

SCPI command:
UNIT:BSTR on page 96

2.3.4 ACLR Settings

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

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.

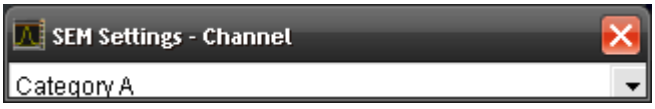
SCPI command:
[SENSe]:POWer:ACHannel:AACHannel on page 86

Noise Correction
Enables noise reduction to be performed on the signal.

SCPI command:
[SENSe]:POWer:NCORrection on page 87

2.3.5 SEM Settings

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



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

SCPI command:
`[SENSe]:POWer:SEM:CATegory` on page 87

2.3.6 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 FSV for details on the softkey functionality.

2.4 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.

2.4.1 Numerical Results

In addition to graphical result displays, the R&S FSV 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 Results	Min		Mean	Limit	Max Limit	Unit
EVM PDSCH QPSK			0.28	17.50		%
EVM PDSCH 16QAM		*	25.60	12.50		%
EVM PDSCH 64QAM		*	8.35	8.00		%
Results for Selection	Subframe(s) ALL		Selection	Antenna 1	Symbols meas.	140
EVM All	0.28		4.46		11.87	%
EVM Phys. Channel	0.28		4.61		15.30	%
EVM Phys. Signal	0.27		0.28		0.29	%
Frequency Error	32.25		32.47		32.65	Hz
Sampling Error	0.02		0.04		0.09	ppm
IQ Offset	-62.06		-61.81		-61.59	dB
IQ Gain Imbalance	-0.01		-0.00		-0.00	dB
IQ Quadrature Error	-0.02		-0.01		0.01	°
OSTP	-30.43		-30.43		-30.43	dBm
Power	-30.51		-30.49		-30.49	dBm
Crest Factor			9.83			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 75
- **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 76
- **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 76

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 and the number of measured symbols.

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.

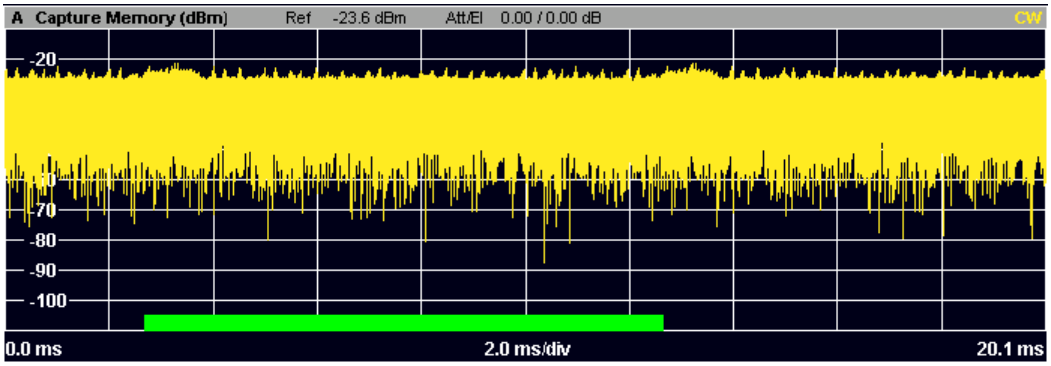
- **EVM All**
  Shows the EVM for all resource elements in the analyzed frame.
  `FETCh:SUMMary:EVM[:ALL]:MINimum` on page 77
- **EVM Phys Channel**
  Shows the EVM for all physical channel resource elements in the analyzed frame.
  `FETCh:SUMMary:EVM:PCHannel:MINimum` on page 76
- **EVM Phys Signal**
  Shows the EVM for all physical signal resource elements in the analyzed frame.
  `FETCh:SUMMary:EVM:PSIGnal:MINimum` on page 76
- **Frequency Error**
  Shows the difference in the measured center frequency and the reference center frequency.
  `FETCh:SUMMary:FERRor:MINimum` on page 78
- **Sampling Error**
  Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
  `FETCh:SUMMary:SERRor:MINimum` on page 79
- **I/Q Offset**
  Shows the power at spectral line 0 normalized to the total transmitted power.
  `FETCh:SUMMary:IQOFfset:MINimum` on page 78
- **I/Q Gain Imbalance**
  Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
  `FETCh:SUMMary:GIMBalance:MINimum` on page 78
- **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:MINimum` on page 79
- **OSTP**
  Shows the OFDM symbol transmit power as defined in 3GPP TS 36.141.
  `FETCh:SUMMary:OSTP:MINimum` on page 79
- **Power**
  Shows the average time domain power of the analyzed signal.
  `FETCh:SUMMary:POWer:MINimum` on page 79
- **Crest Factor**
  Shows the peak-to-average power ratio of captured signal.
  `FETCh:SUMMary:CRESt[:AVERage]` on page 75

2.4.2 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).

In split screen mode, the Capture Memory result display is always visible in the upper screen.



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.

CALCulate<screenid>:FEED 'PVT:CBUF'

2.4.3 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 2.8.1, "Measurements in Detail", on page 52 for details on the mathematical foundations of the EVM measurement.

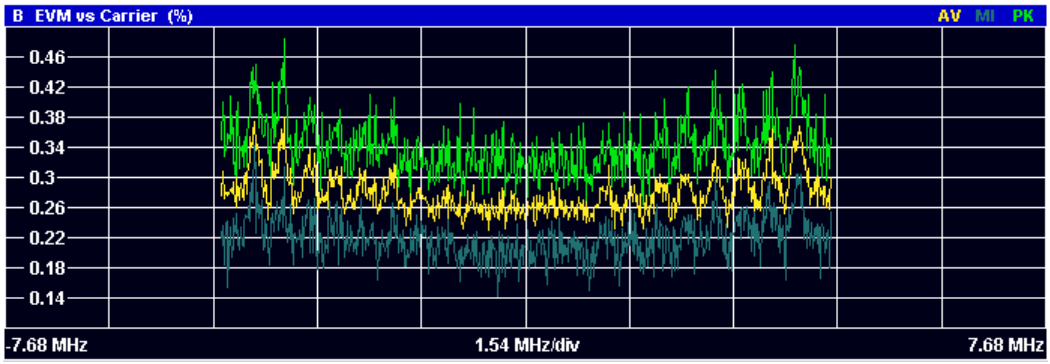
The R&S FSV EUTRA/LTE Measurement Application offers various result displays to determine the EVM of the signal on different levels.

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 shows the minimum and maximum EVM values respectively. You can select to display the EVM for a specific subframe in the Subframe Selection dialog box. In that case, the application shows the EVM of that subframe only.

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.



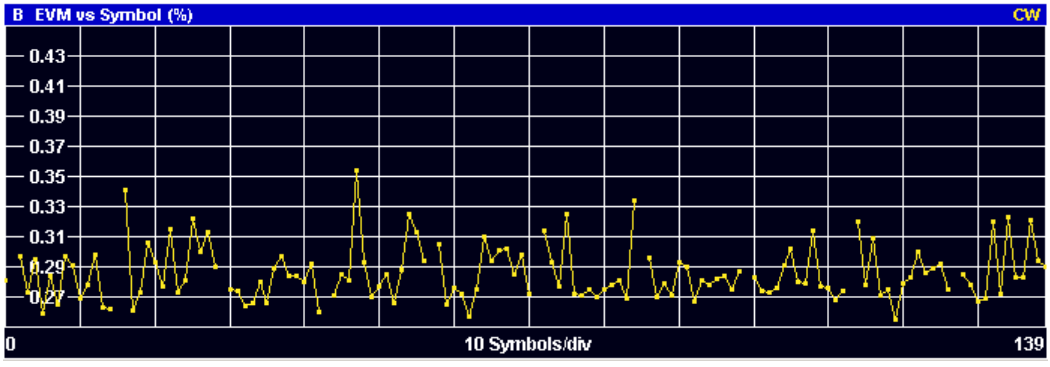
SCPI command:
CALCulate<screenid>:FEED 'EVM:EVCA'

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 FSV 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.



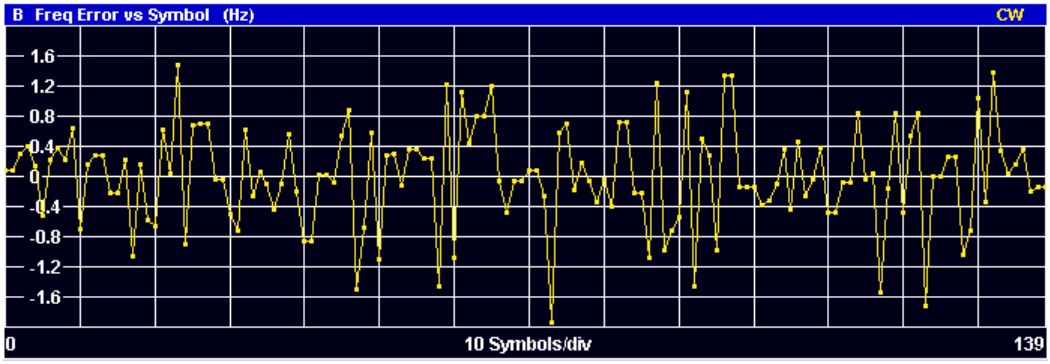
SCPI command:
CALCulate<screenid>:FEED 'EVM:EVSY'

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 FSV could not determine the frequency error for that symbol. On the y-axis, the frequency error is plotted in Hz.



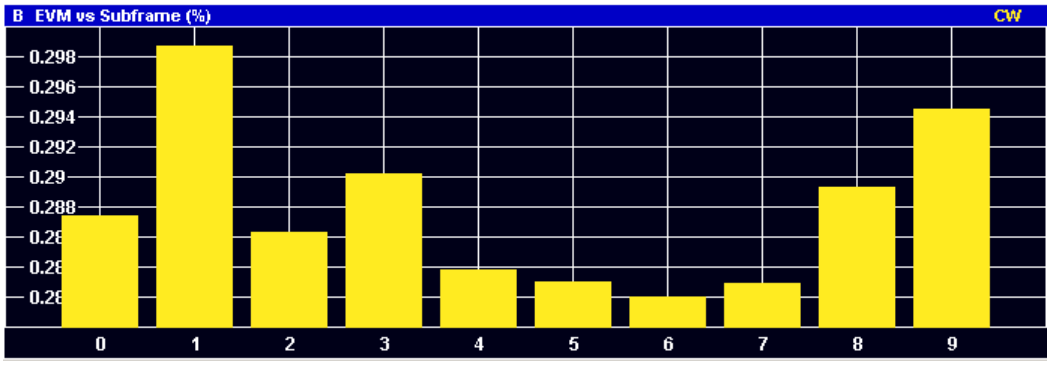
SCPI command:
CALCulate<screenid>:FEED 'EVM:EVVS'

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'

2.4.4 Spectrum Measurements

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

2.4.4.1 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 FSV 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. Therefor 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.

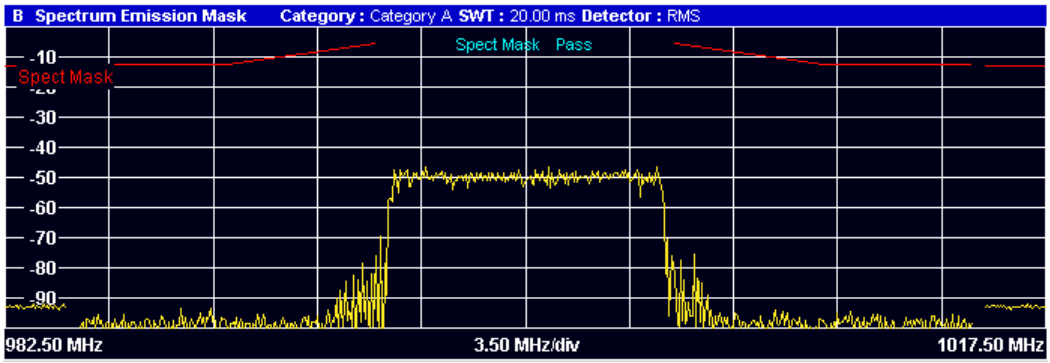
The ACLR and SEM measurements are available if RF input is selected.

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 FSV 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.

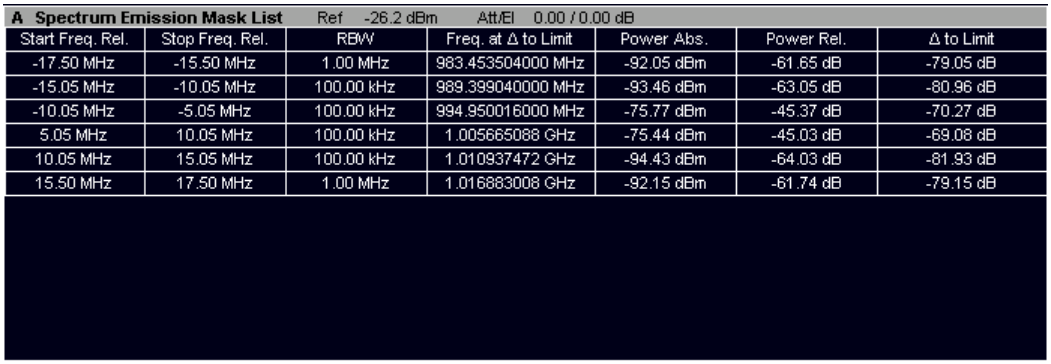


Instead of the Capture Buffer result display, a table above the result display contains the numerical values for the limit check at each check point:

- **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.



A Spectrum Emission Mask List Ref -26.2 dBm Att/El 0.00 / 0.00 dB

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'

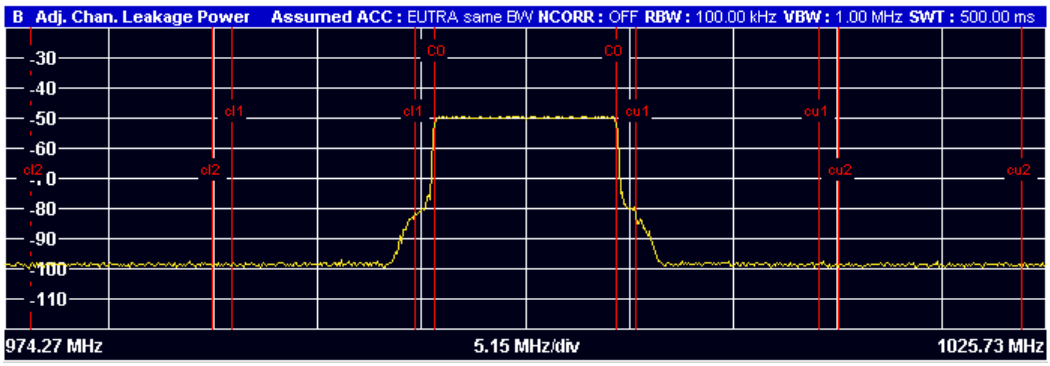
ACLR
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

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.



Instead of the Capture Buffer result display, 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.

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

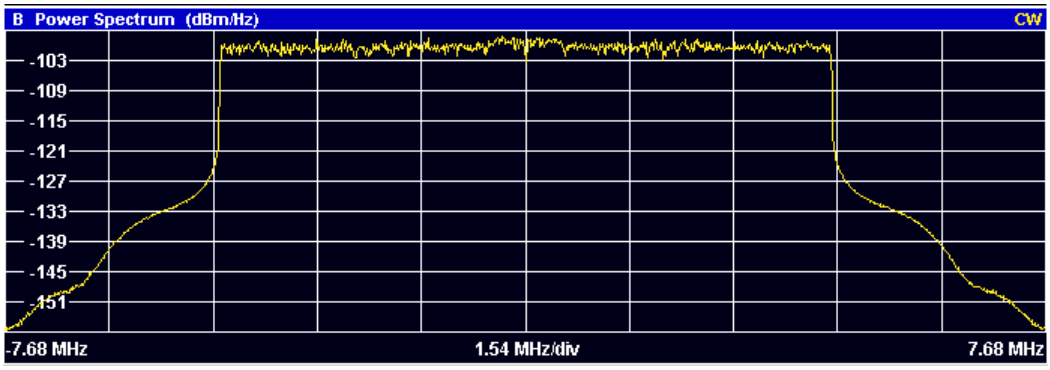
2.4.4.2 I/Q Result Displays

Power (Spec RB_RS RB_PDSCH)
The Power (Spec RB_RS RB_PDSCH) softkey selects one of three result displays. The currently selected result display is highlighted.

Power Spectrum ← Power (Spec RB_RS RB_PDSCH)
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.

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



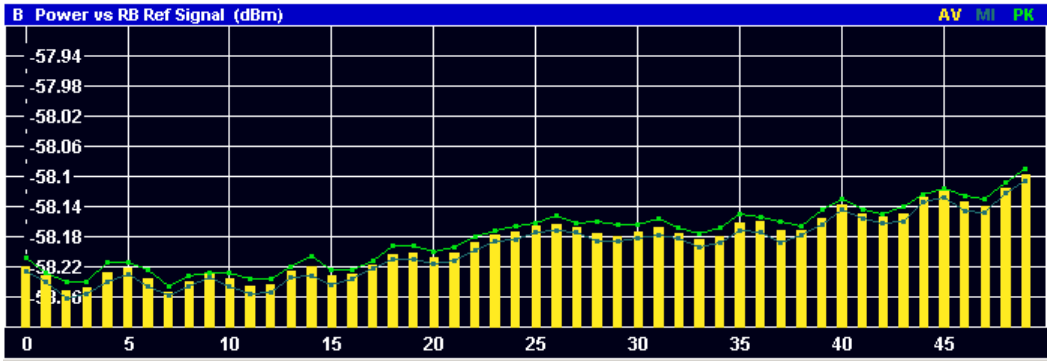
SCPI command:
CALCulate<screenid>:FEED 'SPEC:PSPE'

Power vs Resource Block RS ← Power (Spec RB_RS RB_PDSCH)
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.



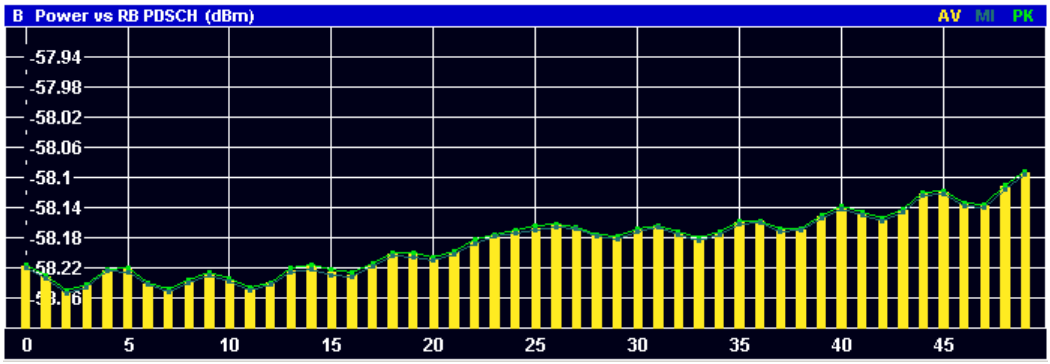
SCPI command:
CALCulate<screenid>:FEED 'SPEC:PVRR'

Power vs Resource Block PDSCH ← Power (Spec RB_RS RB_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.



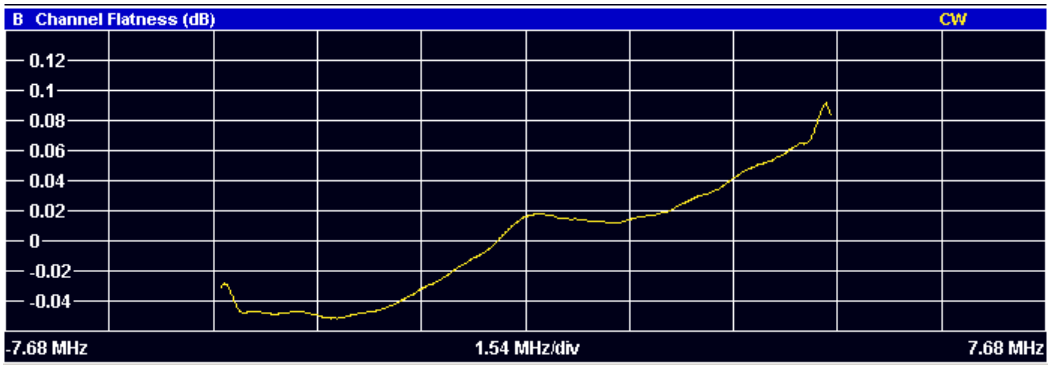
SCPI command:
CALCulate<screenid>:FEED 'SPEC:PVRP'

Flatness (Flat Grdel Diff)
The Flatness (Flat Grdel Diff) softkey selects one of three result displays. The currently selected result display is highlighted.

Channel Flatness ← Flatness (Flat Grdel Diff)
Starts the Channel Flatness result display.

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

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

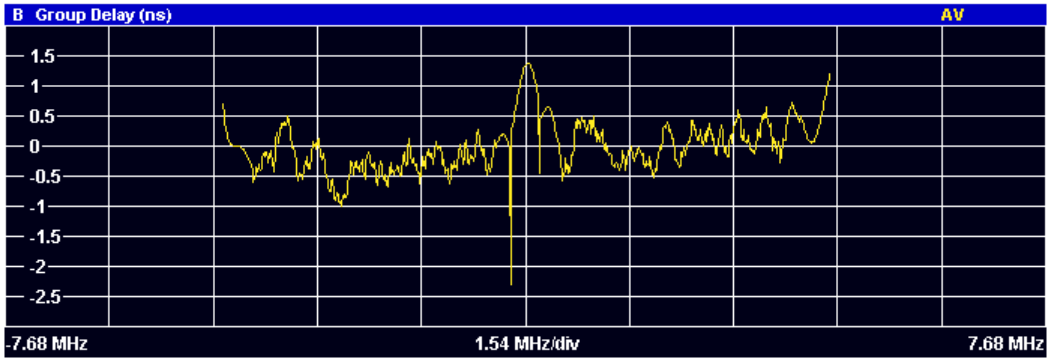


SCPI command:
CALCulate<screenid>:FEED 'SPEC:FLAT'

Channel Group Delay ← Flatness (Flat Grdel Diff)
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

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

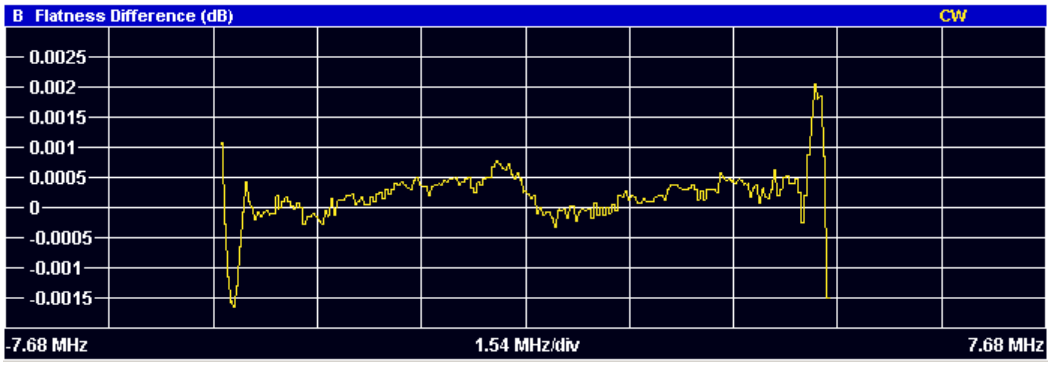


SCPI command:
CALCulate<screenid>:FEED 'SPEC:GDEL'

Channel Flatness Difference ← Flatness (Flat Grdel Diff)
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 x-axis represents the frequency. On the y-axis, the power is plotted in dB.



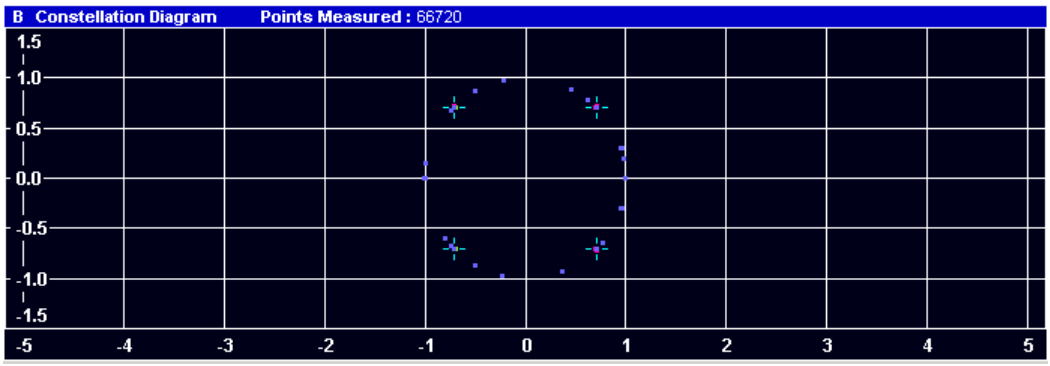
SCPI command:
CALCulate<screenid>:FEED 'SPEC:FDIF'

2.4.5 Constellation Diagrams

Constellation Diagram
Starts the Constellation Diagram result display.

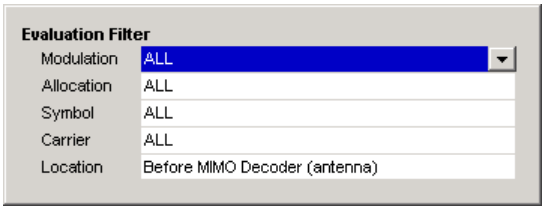
This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal. The result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

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



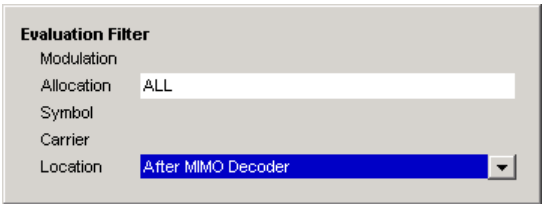
SCPI command:
CALCulate<screenid>:FEED 'CONS:CONS'

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 FSV 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.

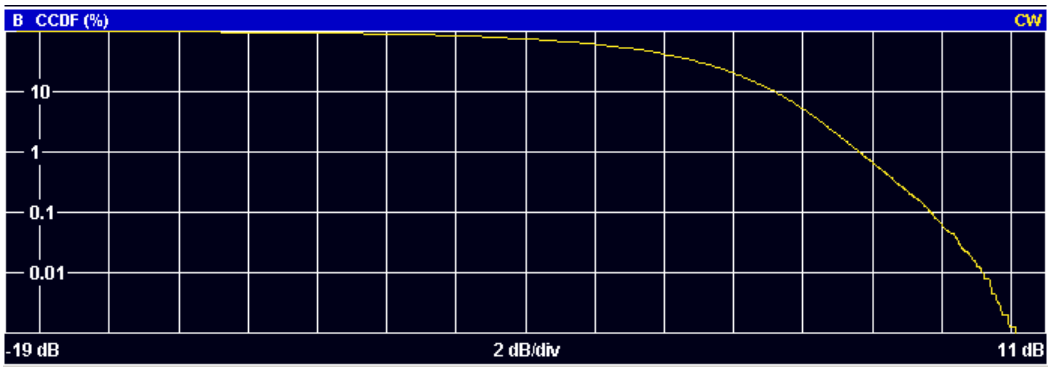


2.4.6 Statistical and Miscellaneous Results

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.

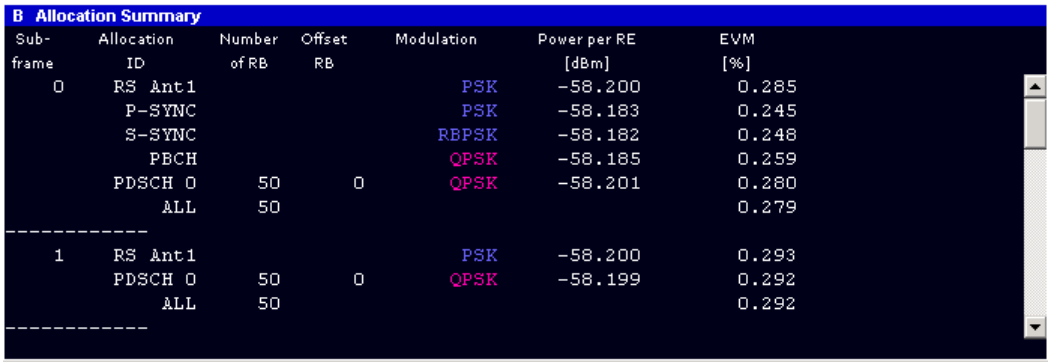
The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.



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:

- **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.

- **Offset RB**
  Shows the resource block offset.
- **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 order 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 order, 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'

2.5 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.

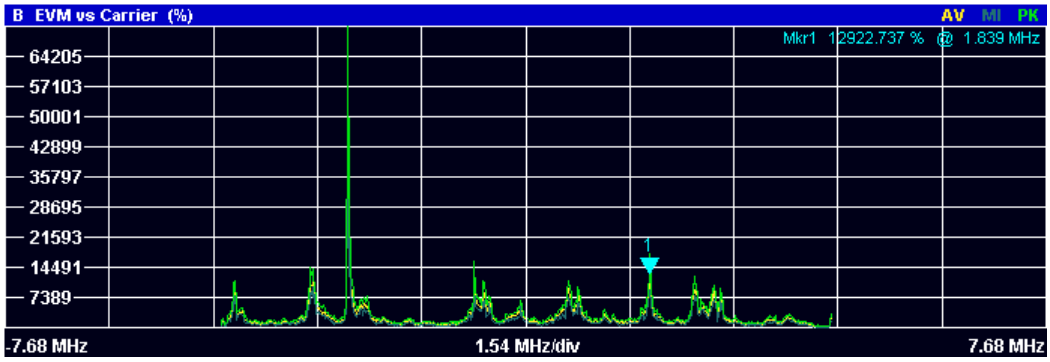


Fig. 2-10: Example: Marker

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 black, the marker is off.

After pressing the "Marker 1" softkey it turns orange 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 blue. 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 61

`CALCulate<n>:MARKer<m>:AOFF` on page 61

`CALCulate<n>:MARKer<m>:TRACe` on page 62

`CALCulate<n>:MARKer<m>:X` on page 62

`CALCulate<n>:MARKer<m>:Y` on page 62

2.6 The Sweep Menu

The sweep menu contains functions that control the way the R&S FSV performs a measurement.

Single Sweep and Continuous Sweep
In continuous sweep mode, the R&S FSV continuously captures data, performs measurements and updates the result display according to the trigger settings.

To activate single sweep mode, press the "Run Single" softkey. In single sweep mode, the R&S FSV captures data, performs the measurement and updates the result display exactly once after the trigger event. After this process, the R&S FSV interrupts the measurement.

You can always switch back to continuous sweep mode with the "Run Cont" softkey.

SCPI command:
`INITiate:CONTinuous` on page 81

Auto Level
The "Auto Level" softkey initiates a process that sets an ideal reference level for the current measurement.

If you start the process while a measurement is running, the R&S FSV aborts the measurement and starts the automatic leveling process. Measurements in continiuous sweep mode are resumed after the auto level is complete.

SCPI command:
`[SENSe]:POWer:AUTO<anaid>[:STATe]` on page 86

Refresh
Updates the current result display in single sweep mode without capturing I/Q data again.

If you have changed any settings after a single sweep and use the Refresh function, the R&S FSV updates the current measurement results with respect to the new settings. It does not capture I/Q data again but uses the data captured last.

SCPI command:
`INITiate:REFResh` on page 81

2.7 File Management

2.7.1 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.

The following restrictions apply to the frame setup content:

- at least one PRB must exist.

- only one frame can be allocated

To load a frame setup, press the "File Manager" softkey in the root menu of the application. In the corresponding submenu, select "Load Demod Setup". A dialog box to select the file opens.

There is a very simple 10 MHz bandwidth setup in the FILE_IO subfolder of the application path.

Loading an I/Q File

The R&S FSV is able to process I/Q data that has been captured with a R&S FSV 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. In the corresponding submenu, select "Load IQ Data". A dialog box to select the file opens.

2.7.2 SAVE/RECALL Key

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

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

2.8 Further Information

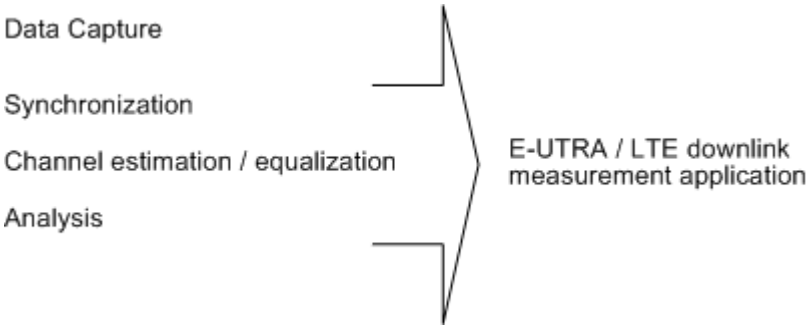
2.8.1 Measurements in Detail

This section provides a detailed explanation of the measurements provided by R&S FSV-K100/-K104 and provides help for using R&S FSV-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

2.8.1.1 Introduction

The following description provides a brief overview of the digital signal processing used in the R&S FSV'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.

2.8.1.2 Signal Processing

Data Capturing

The block diagram in figure 2-11 shows the R&S FSV 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 down-sampling to the target rate. Up to 16 M samples of the now available I/Q data can be stored in the capture buffer.

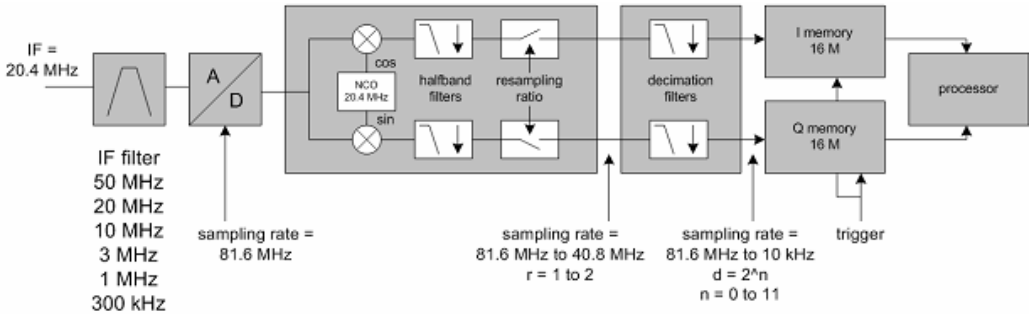


Fig. 2-11: Data Capturing Mechanism of the R&S FSV

The maximum allowable bandwidth of the measurement signal depends on the target sampling rate according to table 2-2.

Table 2-2: Relation of bandwidth and sampling rate

sampling rate	max. bandwidth
10 kHz to 20.4 MHz	0.8 x sampling rate
20.4 MHz to 40.8 MHz	0.68 x sampling rate
40.8 MHz to 81.6 MHz	30 MHz

2.8.1.3 E-UTRA / LTE Downlink Measurement Application

The block diagram in figure 2-12 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.

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 SCH symbol in time and frequency by using the coarse fractional frequency offset compensated capture buffer and the timing estimate coarse $\hat{i}_{coarse}$ to position the window of the FFT. The fine timing block prior to the FFT allows a timing improvement using a level-based search for the beginning and end of the estimated channel impulse response. A coarse estimate of the CIR can be directly obtained from the SCH.

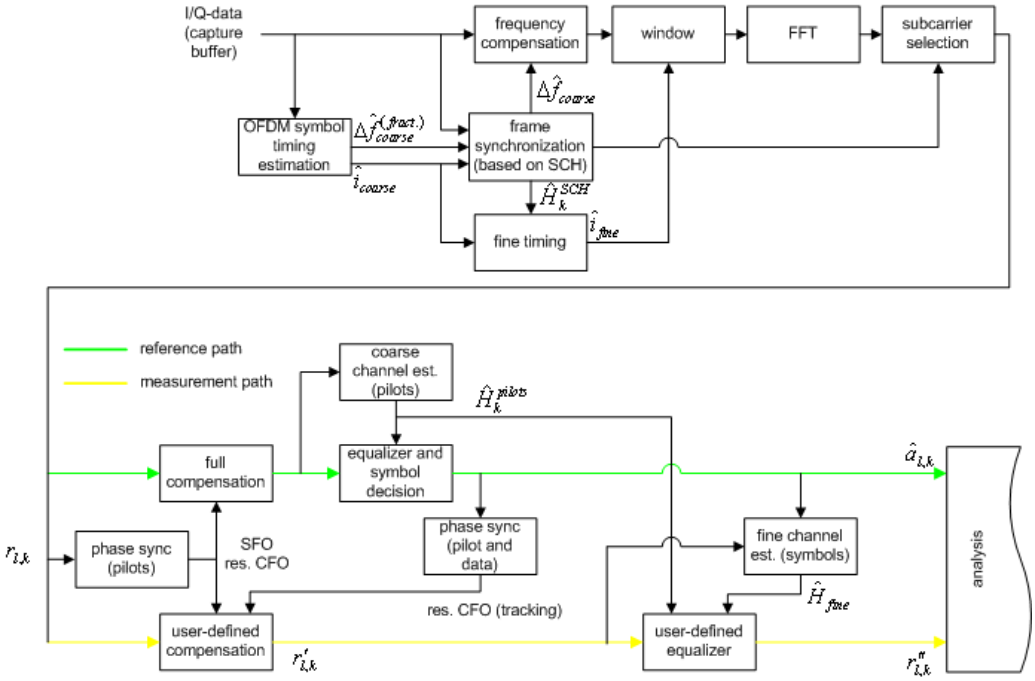


Fig. 2-12: EUTRA/LTE Downlink Measurement Application

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

- the relative sampling frequency offset ζ
- the residual carrier frequency offset Δf_{res}
- 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

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

(2 - 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 common phase error estimation.

Channel Estimation / Equalization

As shown in figure 2-12, there is one coarse and one fine channel estimation block. The pilot-based coarse estimation is tapped behind the full compensation block of the reference path. The coarse estimation block uses available training symbols to determine initial estimates $\hat{H}_{l,k}$ of the channel transfer function at fixed positions in the subcarrier-symbol plane. Based on these nodes, the missing CTF values are obtained by interpolation in both time and frequency direction. The coarse estimation results are used to equalize the samples $r'_{l,k}$ 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.

Analysis

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

EVM

The most important variable is the error vector magnitude

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

(2 - 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 2-2 can be rewritten as

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

(2 - 3)

The average EVM of all data subcarriers is then

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

(2 - 4)

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

I/Q Imbalance

The I/Q imbalance can be written as

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

(2 - 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+Q.

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

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

(2 - 6)

and the

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

(2 - 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

2.8.2 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.

2.8.3 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 FSV stores the information in a number of files that are located in the R&S FSV 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.

2.9 Remote Control

This section describes all the remote control commands available for the R&S FSV 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 FSV. Also refer to the Quick Start Guide and the Operating Manual of the base unit for detailed information on working with remote control commands.

2.9.1 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.

<screenid> = <1...2>

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

1 selecting screen A and

2 selecting screen B.

<num> = <1>

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

<anaid> = <1...4>

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

<subfnum> = <0...9>

This suffix selects the subframe that you want to analyze (see "Configuration Table" on page 28). Depending on your configuration, possible values are <0...9>.

<allocnum> = <0...99>

This suffix selects the allocation that you want to analyze (see "Configuration Table" on page 28). Depending on your configuration, possible values are <0...99>.

2.9.2 CALCulate Subsystem

CALCulate<screenid>:FEED <DispType>

Selects the measurement and result display.

Parameters for setting and query:

<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<screenid>:MARKer<num>:FUNCtion:POWer:RESult[:CURRent]? <ACPResults>

This command queries the current result values of the adjacent channel power measurement. An ACLR (adjacent channel leakgae ratio) measurement must have previously been run for there to be summary data available.

Results are output separated by commas in the following order:

Return values:

<ACPResults> <TX channel power in dBm>, <relative lower adjacent channel power in dB>, <relative upper adjacent channel power in dB>, <relative lower alternate channel 1 power in dB>, <relative upper alternate channel 1 power in dB>, ...

Adjacent channel power values are output in dB. The returned list is variable length depending on the number of channels to be measured, i.e. if the number of channels is 2 then the list will contain 5 results (main channel plus two results each for each adjacent channel specified).

Example: "CALC1:MARK:FUNC:POW:RES"
Returns the current ACP measurement results.

Usage: Query only

CALCulate<n>:MARKer<m>:AOFF

This command switches off all active markers, delta markers, and marker measurement functions in the specified window.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> depends on mode
irrelevant

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

Mode: all

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

This command activates a marker in the specified window. If no indication is made, marker 1 is selected automatically. If activate, the marker is switched to normal mode.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> depends on mode
marker number; For applications that do not have more than 1 marker, the suffix <m> is irrelevant.

Parameters:

<State> ON | OFF

*RST: OFF

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

Mode: all

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

This command assigns the selected marker to the indicated measurement curve in the specified window. The corresponding trace must be active, i.e. its status must not be "BLANK".

If necessary, the corresponding marker is switched on prior to the assignment.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> depends on mode
marker number; For applications that do not have more than 1 marker, the suffix <m> is irrelevant.

Parameters:

<Trace> **1 to 6**
Selects trace 1 through 6.

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

Mode: all

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

This command positions the selected marker to the indicated x-value in the window specified by the suffix <n>.

If marker 2, 3 or 4 is selected and used as delta marker, it is switched to marker mode.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Parameters:

<Position> 0 to MAX (frequency | sweep time | level)

Example: `CALC:MARK2:X 10.7MHz`
Positions marker 2 to frequency 10.7 MHz.

Mode: ALL

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

This command queries the measured value of the selected marker in the window specified by the suffix <n>. The corresponding marker is activated before or switched to marker mode, if necessary.

To obtain a correct query result, a complete sweep with synchronization to the sweep end must be performed after the change of a parameter and before the query of the Y value. This is only possible in single sweep mode.

Suffix:

<n> window; For applications that do not have more than 1 measurement window, the suffix <n> is irrelevant.

<m> marker number

Return values:

<Result> The measured value of the selected marker is returned.
In I/Q Analyzer mode, if the result display configuration "Real/Imag (I/Q)" is selected, this query returns the Real (Q) value of the marker first, then the Imag (I) value.

Example:

```
INIT:CONT OFF
```
Switches to single sweep mode.
```
CALC:MARK2 ON
```
Switches marker 2.
```
INIT;*WAI
```
Starts a sweep and waits for the end.
```
CALC:MARK2:Y?
```
Outputs the measured value of marker 2.
In I/Q Analyzer mode, for "Real/Imag (I/Q)", for example:
```
1.852719887E-011,0
```

Usage: Query only

Mode: ALL

2.9.3 CONFigure Subsystem

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

Configures the bandwidth of the LTE downlink signal.

Parameters:

<Bandwidth> BW1_40 | BW2_50 | 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>

Defines if the constellation diagram shall use data before or after the MIMO decoder.

Parameters:

<ConstLoc> AMD | BMD

AMD
After the MIMO decoder

BMD
Before the MIMO decoder

*RST: AMD

Example: `CONF:DL:CONS:LOC AMD`

Use data from after the MIMO decoder.

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

Sets the number of configurable subframes of the LTE uplink signal.

Parameters:

<NofSubframes> 1...10

*RST: 1

Example: `CONF:DL:CSUB 5`

Sets the number of configurable subframes to 5.

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

Defines the cyclic prefix type for DL.

Parameters:

<PrefixLength> NORM | EXT | AUTO

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>

Changes the antenna settings for MIMO-configurations.

Parameters:

<AntennaID> ANT1 | ANT2 | ANT3 | ANT4 | ALL

ANT1 | ANT2 | ANT3 | ANT4
Select a single antenna to be analyzed

ALL
Select all antennas to be analyzed

*RST: ANT1

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

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

Defines the number of antennas used for DL MIMO.

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:NORB <NofRessBlocks>

Configures the number of resource blocks used in DL

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>

Configures the PHICH relative power for DL.

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>

Activates or deactivates the physical broadcast channel.

Parameters:

<boolean> ON | OFF

*RST: ON

Example: `CONF:DL:PBCH:STAT ON`

Activates the PBCH.

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

Configures the PHICH relative power.

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>

Activates or deactivates PCFICH.

Parameters:
<boolean> ON | OFF

*RST: OFF
Example: CONF:DL:PCF:STAT ON
Activates the PCFICH.

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

Configures the physical downlink control channel format.

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

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

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

Configures the number of physical downlink control channels.

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>

Configures the PDCCH relative power.

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:PDCCh:STAT <boolean>

Activates or deactivates PDCCH mode.

Parameters:
<boolean> ON | OFF

*RST: OFF
Example: CONF:DL:PDCC:STAT ON
Activates the PDCCH.

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

Configure the PHICH duration.

Parameters:

<Duration> NORM | EXT

NORM
Normal

EXT
Extended

*RST: NORM

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

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

Configures 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>

Configures the PHICH relative power.

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>

Configures the cell identity group.

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:REFSig:POWer <Power>

Configures 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 <CellIdentity>

Configures the physical layer cell identity.

Parameters:

<CellIdentity> 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<subfnum>:ALCount <NofAllocations>

Configures the number of allocations used for all DL-subframes. The suffix stands for the corresponding subframe number.

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<subfnum>:ALLoc<allocnum>:POWer <Power>

Configures the power of an allocation in a DL-subframe. The first suffix stands for the corresponding subframe number and the second one stands for the corresponding allocation number.

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<subfnum>:ALLoc<allocnum>:RBCount <NofRBs>

Configures the number of ressource blocks for an allocation in a DL-subframe. The first suffix stands for the corresponding subframe number and the second one stands for the corresponding allocation number.

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<subfnum>:ALLoc<allocnum>:RBOFfset <RBOffset>

Configures the ressource block offset for an allocation in a DL-subframe. The first suffix stands for the corresponding subframe number and the second one stands for the corresponding allocation number.

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<subfnum>:ALLoc<allocnum>[:CW<Cwnum>]:MODulation <ModType>

Configures the modulation type for an allocation in a DL-subframe. In case of MIMO there might be more than one codewords which can be configured seperately. The first suffix stands for the corresponding subframe number and the second one stands for the corresponding allocation number. The third suffix stands for the codeword.

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:PPOWer <Power>

Configures the P-SYNC relative power of the synchronization signal.

Parameters:

<Power> <numeric value>

*RST: 0 dB
Default unit: DB

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

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

Configures the S-SYNC relative power of the synchronization signal.

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:UDConf <AllocConf>

Configures the TDD UL/DL Allocations.

Parameters:

<AllocConf> <numeric value>

*RST: 0

Example: `CONF:DL:TDD:UDC 2`

Selects allocation configuration number 2.

CONFigure[:LTE]:DUPLexing <DuplType>

Configures 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>

Set or get current link direction

Parameters:

<LinkDir> DL | UL

DL
Downlink

UL
Uplink

Example: `CONF:LDIR DL`

EUTRA/LTE option is configured to analyze downlink data.

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

Sets the reference level for baseband-input. The suffix <1..4> specifies to which analyzer the setting applies to.

Parameters:

<RefLev> <numeric value>

Range: -25 to +20 in steps of 5 dBm
*RST: 0 dBm
Default unit: dBm

Example: `CONF:POW:EXP:IQ2 -10`

Sets the baseband-reference level used by analyzer 2 to -10 dBm.

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

Sets the reference level for RF input. The suffix <1..4> specifies to which analyzer the setting applies to.

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.

2.9.4 DISPlay Subsystem

DISPlay[:WINDow<screenid>]:SELect

Selects the active measurement window. WINDow1 corresponds to SCREEN A, WINDow2 to SCREEN B.

Screen A is active after an reset.

Example: `DISP:WIND2:SEL`
Selects SCREEN B.

Usage: Event

DISPlay[:WINDow<screenid>]:TRACe<tracenum>:Y[:SCALe]:RLEVel:OFFSet <ExtAtten>

Specifies the external attenuation or gain applied to the RF signal. A positive value indicates attenuation, a negative value indicates gain.

Parameters:
<ExtAtten> <numeric value>

Default unit: DB

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

2.9.5 FETCh Subsystem

FETCh:CYCPrefix?

Returns the cyclic prefix type detected by the DSP kernel. If no valid value has been detected yet the command will return -1.

Return values:

<CYCPrefix> NORM | EXT

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?

Returns the cell identity group detected by the DSP kernel. If no valid value has been detected yet, the command will return -1.

Return values:
<CidGroup>
Example: `FETC:PLCI:CIDG?`
Returns the current detected CID group.

Usage: Query only

FETCh:PLCI:PLID?

Returns the cell identity detected by the DSP kernel. If no valid value has been detected yet the command will return -1.

Return values:
<CellIdentity>
Example: `FETC:PLCI:PLID?`
Returns the current detected cell identity.

Usage: Query only

FETCh:SUMMary:CRESt[:AVERage]?

Returns the average crest factor from the result summary list.

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 returns the EVM of all QPSK-modulated resource elements of the PDSCH channel as shown in the result summary.

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

Example: `FETC:SUMM:EVM:DSQP?`
Returns the mean EVM.

Usage: Query only

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

This command returns the EVM of all 64QAM-modulated resource elements of the PDSCH channel as shown in the result summary.

Return values:

<AvgEVM> <numeric value>

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

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

Returns the mean value.

Usage: Query only

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

This command returns the EVM of all 16QAM-modulated resource elements of the PDSCH channel as shown in the result summary.

Return values:

<AvgEVM> <numeric value>

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

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

Returns the mean value.

Usage: Query only

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

This command returns the EVM of the physical channel resource elements as shown in the result summary.

Return values:

<EVM> <numeric value>

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

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

This command returns the EVM of all physical signal resource elements as shown in the result summary.

Return values:

<EVM> <numeric value>

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

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

This command returns the EVM for all resource elements as shown in the result summary.

Return values:

<EVM> <numeric value>

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

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:EVM:USQP[:AVERage]? <AvgEVM>

This query returns the EVM for all QPSK-modulated resource elements of the PUSCH in the analyzed frame.

Parameters:

<AvgEVM>

Example: `FETC:SUMM:EVM:USQP?`

Usage: Query only

FETCh:SUMMary:EVM:USSF[:AVERage]? <AvgEVM>

This query returns the the EVM for all 64QAM-modulated resource elements of the PUSCH in the analyzed frame.

Parameters:

<AvgEVM>

Example: `FETC:SUMM:EVM:USSF?`

Usage: Query only

FETCh:SUMMary:EVM:USST[:AVERage]? <AvgEVM>

This query returns the the EVM for all 16QAM-modulated resource elements of the PUSCH in the analyzed frame.

Parameters:
<AvgEVM>
Example: `FETC:SUMM:EVM:USST?`

Usage: Query only

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

This command returns the frequency error as shown in the result summary.

Return values:
<FreqError> <numeric value>

Frequency error in Hz.

Example: `FETC:SUMM:FERR?`
Returns the average frequency error in Hz.

Usage: Query only

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

This command returns the IQ gain imbalance as shown in the result summary.

Return values:
<GainImbalance> <numeric value>

IQ gain imbalance in dB.

Example: `FETC:SUMM:GIMB?`
Returns the current gain imbalance in dB.

Usage: Query only

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

This command returns the IQ offset as shown in the result summary.

Return values:
<IQOffset> <numeric value>

IQ offset in dB.

Example: `FETC:SUMM:IQOF?`
Returns the current IQ-offset in dB

Usage: Query only

FETCh:SUMMary:OSTP[:AVERage]
FETCh:SUMMary:OSTP:MAXimum
FETCh:SUMMary:OSTP:MINimum? <MinOSTP>

This command returns the OSTP as shown in the result summary.

Return values:

<AvgOSTP> <numeric value>

OSTP in dBm.

Example: `FETC:SUMM:OSTP?`
Returns the current average OSTP value.

Usage: Query only

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

This command returns the Frame Power as shown in the result summary.

Return values:

<Power> <numeric value>

Frame power in dBm.

Example: `FETC:SUMM:POW?`
Returns the Current Frame Power in dBm

Usage: Query only

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

This command returns the Quadrature Error as shown in the result summary.

Return values:

<QuadError> <numeric value>

Quadrature error in degrees.

Example: `FETC:SUMM:QUAD?`
Returns the current mean Quadrature Error in degrees.

Usage: Query only

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

This command returns the Sampling Error as shown in the result summary.

Return values:

<SamplingError> <numeric value>

Sampling error in ppm.

Example: FETC:SUMM:SERR?
Returns the current mean Sampling Error in ppm.

Usage: Query only

FETCh:SUMMary:TFRame?

This command returns the Trigger to Frame result for downlink signals and the Trigger to Subframe result for uplink signals as shown in the capture buffer result display.

Return values:

<TrigToFrame> <numeric value>
Trigger to frame in s.
Default unit: s

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

Usage: Query only

2.9.6 FORMat Subsystem

FORMat[:DATA] [<DataFormat>, <DataFormat>]

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

Parameters for setting and query:

<DataFormat> ASCii | REAL
*RST: ASCii

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

Usage: SCPI conform

Mode: DL

2.9.7 INITiate Subsystem

INITiate[:IMMediate]

Starts a new measurement sequence. If a measurement sequence is already in progress the command will have no effect.

Example: `INIT`
Attempts to start a new measurement.

Usage: Event

Mode: DL

INITiate:CONTinuous <boolean>

This command defines the sweep mode.

Parameters:

<boolean> **ON**
Activates continuous sweep mode. In this mode, the R&S FSV continuously captures data, performs measurements and updates the display according to trigger settings.

OFF
Activates single sweep mode. In this mode, the R&S FSV interrupts the measurement after a single sweep.

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 IQ measurement results to reflect the current measurement settings. Note no new IQ data is captured. I.e. the measurement settings apply to the IQ data being currently in the capture buffer. The command applies exclusively to IQ measurements. It requires available IQ data.

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

Usage: Event

Mode: DL

2.9.8 INPut Subsystem

INPut<screenid>:ATTenuation<anaid> <Attenuation>

Configures the RF attenuation used by the analyzer specified via the second suffix. The first suffix can be omitted.

Parameters:

<Attenuation> Numeric value

*RST: 10 dB
Default unit: dB

Mode: RF, DL

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 FSV-B25, but not if R&S FSV-B17 is active.

Parameters:

<State> ON | OFF

*RST: ON

Example:
```
INP1:EATT:AUTO OFF
```

Mode: all

INPut:SELect <InputType>

Selects the input source of the data.

Parameters:

<InputType> RF | AIQ | DIQ | FILe

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 FSV-B71.

DIQ
Selects the digital baseband input as the data source. This source is available only with option R&S FSV-B17.

FILe
Selects a file as the data source.

2.9.9 MMEMory Subsystem

MMEMory:LOAD:DEModsettings <Path>

Restores previously saved demodulation settings. The input file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. Only files with correct link directions can get loaded.

Parameters:
<Path>
Example: `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`
Usage: Setting only
Mode: DL

2.9.10 SENSe Subsystem

[SENSe][:LTE]:DL:DEMod:AUTO <boolean>

Activates or deactivates automatic demodulation.

Parameters:
<boolean> ON | OFF

*RST: ON
Example: `SENS:DL:DEM:AUTO ON`
Activates the auto-demodulation for DL.

[SENSe][:LTE]:DL:DEMod:CBSCrambling <boolean>

Activates or deactivates scrambling of coded bits.

Parameters:
<boolean> ON | OFF

*RST: ON

Example: `SENS:DL:DEM:CBSC ON`
Activate scrambling of coded bits.

[SENSe][:LTE]:DL:DEMod:CESTimation <RefType>

Configures the channel estimation type.

Parameters:

<RefType> TGPP | PIL | PILPAY

TGPP
3GPP EVM definition

PIL
Optimal, pilot only

PILPAY
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>

Sets the EVM calculation method.

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:TRACking:PHASe <TrackType>

Configures the phase tracking type.

Parameters:

<TrackType> OFF | PIL | PILPAY

OFF
Deactivate phase tracking

PIL
Pilot only

PILPAY
Pilot and payload

*RST: OFF

Example: `SENS:DL:TRAC:PHAS PILPAY`
Use pilots and payload for channel estimation.

[SENSe][:LTE]:DL:TRACking:TIME <TrackTime>

Activates or deactivates timing tracking.

Parameters:

<TrackTime> ON | OFF

*RST: OFF

Example: `SENS:DL:TRAC:TIME ON`
Activates timing tracking.

[SENSe][:LTE]:SUBFrame:SELect <SFSelection>

Configures the subframe to be analyzed.

Parameters:

<SFSelection> ALL | <numeric value>

ALL
Select all subframes

0...9
Select a single subframe

*RST: ALL

Example: `SENS:SUBF:SEL ALL`
Select all subframes for analysis.

[SENSe]:FREQuency:CENTer <Frequency>

Configures the current center frequency for RF-mode. Modifiers like MHz or GHz may also be used.

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]:INPut <InputType>

Configures the current signal source.

Parameters:

<InputType> RF | AIQ | DIQ | FILe

RF
Select radio frequency input as signal source.

AIQ
Select analog IQ input (baseband) as signal source.

DIQ
Select digital IQ input as signal source.

Example: `SENS:INP DIQ`
Select digital IQ as signal source.

[SENSe]:POWer:ACHannel:AACHannel <AssumedChan>

Selects the ACLR Assumed Adjacent Channel Carrier.

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<anaid>[:STATe] <State>

This command activates the automatic reference level search process.

Parameters:

<State> ON | OFF | ONCE

OFF
Performs no automatic reference level detection.

ON
Performs an automatic reference level detection after each sweep.

ONCE
Performs an automatic reference level once.

*RST: ON

Example: `SENS:POW:AUTO2 ON`
Activate auto level for analyzer number 2.

[SENSe]:POWer:AUTO<anaid>:TIME <Time>

Configures the auto level track time.

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>

Activates or deactivates Noise Correction for ACLR measurements.

Parameters:

<boolean> ON | OFF

*RST: OFF

Example: `SENS:POW:NCOR ON`
Activates noise correction.

[SENSe]:POWer:SEM:CATegory <Category>

Specifies the SEM category as defined in 3GPP TS 36.101.

Parameters:

<Category> A | B

*RST: A

Example: `SENS:POW:SEM:CAT B`
Selects category B for all SEM measurements.

[SENSe]:SWAPiq <boolean>

Specifies if the IQ data shall be swapped.

Parameters:

<boolean> ON | OFF

*RST: OFF

Example: `SENS:SWAP ON`

Activate IQ-swapping

[SENSe]:SYNC[:STATe]?

Returns the current sync state as comma separated list containing three values.

Return values:

<SyncState> <OFDM symbol timing>, <P-SYNC synchronization>, <S-SYNC synchronization>

The first value stands for the coarse OFDM symbol timing, the second value stands for the P-SYNC synchronization and the third value stands for the S-SYNC synchronization.
A zero represents a failure and a one represents a successful operation.

Example: `SENS:SYNC:STAT?`

Returns "1,1,0" if coarse timing and P-SYNC were successful but S-SYNC failed.

Usage: Query only

2.9.11 TRACe Subsystem

Example for querying the results of the allocation summary result display

This section shows an example of what the R&S FSV will return when the Allocation Summary result display is queried with the TRACe[:DATA] command.

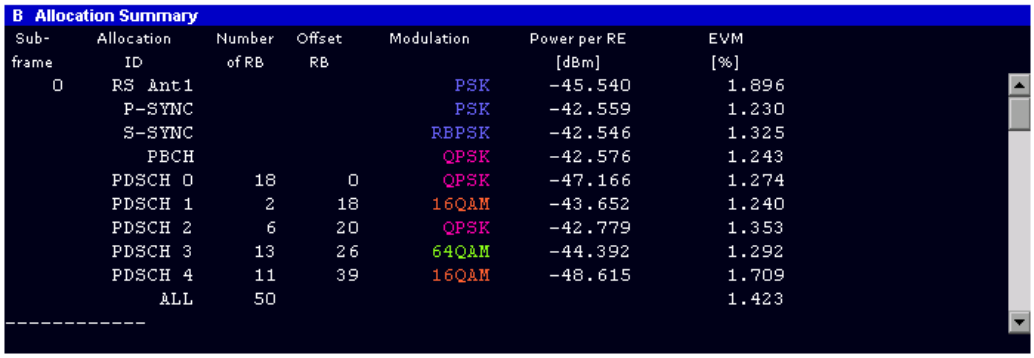


Fig. 2-13: Display of the allocation summary

The TRACe[:DATA] command would return this:

```
<subframe>, <allocation ID>, <number of RB>, <offset RB>,
<modulation>, <power in dBm>, <EVM in dB or %>, ...
```

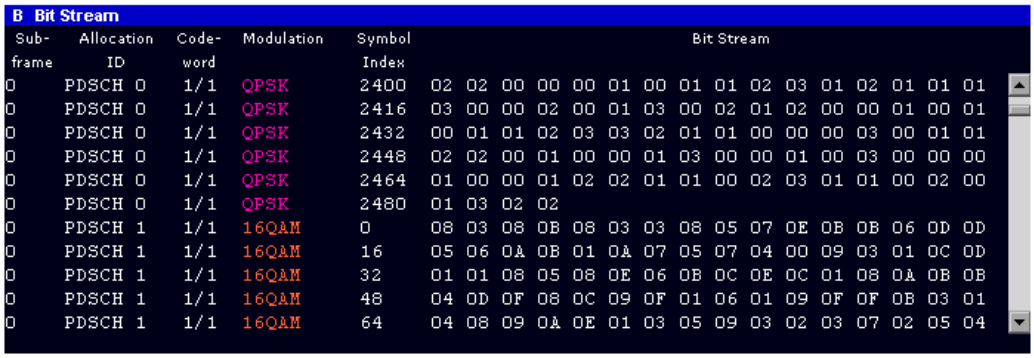
Each line in this example corresponds to one set of values.

```
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,
0,2,11,4,4,-17.1194836675011,8.1122671247158E-06,
0,3,2,15,2,-17.0926996097583,8.03053410436405E-06,
0,4,27,17,4,-17.1130321527746,8.12566085528488E-06,
0,5,6,44,3,-17.105305197162,9.96321958268709E-06,
0,-2,50,,,,8.4165201030828E-06,
1,-5,,,0,-17.0926996097583,8.8521098007277E-06,
1,0,41,0,3,-17.0730933763501,1.00923926993346E-05,
1,1,9,41,2,-17.0926996097583,8.2804383794155E-06,
1,-2,50,,,,9.74191536329272E-06,
2,-5,,,0,-17.0926996097583,8.73975167792196E-06,
2,0,18,0,4,-17.1170893880663,8.48596712899052E-
06,2,1,13,18,2,-17.0926996097583,8.37752480720155E-06,
2,2,6,31,3,-17.1306290208122,9.84026229389201E-
06,2,3,13,37,2,-

<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 FSV 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. 2-14: 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,
00,03,00,01,01,01,02,01,00,03,03,00,01,01,02,02,03,00,01,01,
```

```
02,01,02,02,01,02,01,03,00,03,02,02,00,03,00,00,02,01,03,01,
02,03,00,03,03,00,00,02,00,02,00,02,02,01,01,03,01,02,03,01,
03,02,03,03,00,02,02,02,01,01,02,01,02,02,02,03,03,00,02,01,
01,02,03,03,01,03,02,03,01,02,02,00,01,03,03,00,01,03,03,01,
02,03,02,02,00,02,00,01,03,02,00,01,00,00,02,03,01,03,00,00,
00,03,02,02,02,01,01,02,04,32,0B,18,17,3A,0B,32,33,21,1B,3D,
01,12,39,05,29,28,28,0A,06,0F,2D,18,24,3C,0D,26,18,0B,17,0D,
3E,05,01,08,3D,19,0F,1F,2D,10,36,31,27,38,2F,17,17,2E,2B,2C,
19,07,13,...

<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,04,15,32,2D,3D,11,
3B,1D,04,0D,1E,23,19,00,28,33,17,25,35,2F,35,31,37,25,3A,0F,
08,35,2D,3B,1B,1D,32,27,1E,32,29,04,32,0B,18,17,3A,0B,32,33,
21,1B,3D,01,12,39,05,29,28,28,0A,06,0F,2D,18,24,3C,0D,26,18,...

<continues like this till next datablock starts or end of data reached>
```

TRACe[:DATA].....90

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**
  Not yet implemented, returns nothing
- **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 nine values in the following order:
  <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>, ...
- **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 freqeuncy span.
  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 freqeuncy span.
  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 frequency span.
  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 changing the Constellation selection settings.

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

- **CCDF**
  For the Complementary Cumulative Distribution Function result display, the command returns the probability over the power level. The first value returned represents the number of following values.
  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>, <offset RB>, <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.

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.

<offset RB> Offset resource blocks>

<subframe> Number of the subframe.

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.

Usage: Query only

Mode: DL

2.9.12 TRIGger Subsystem

TRIGger[:SEQuence]:HOLDoff <TrigOffset>

Configures the trigger offset.

Parameters:

<TrigOffset> Numeric value in seconds

*RST: 0 s
Default unit: s

Example: `TRIG:HOLD 5MS`
Sets the trigger offset to 5 ms.

Mode: DL

TRIGger<n>[:SEQuence]:LEVel[:EXTernal] <TriggerLevel>

This command sets the level of the external trigger source in Volt.

Suffix:

<n> irrelevant

Parameters:

<TriggerLevel>

Range: 0.5 V to 3.5 V
*RST: 1.4 V

Example: `TRIG:LEV 2V`

Mode: All

TRIGger[:SEQuence]:MODE <TrigMode>

Configures the trigger mode used.

Parameters:

<TrigMode> EXTernal | IMMediate

EXTernal
Use an external trigger during measurement

IMMediate
Run measurement in "free trigger"-mode

*RST: IMMediate

Example: `TRIG:MODE IMM`
Free trigger will be used for measurements.

Mode: DL

2.9.13 UNIT Subsystem

UNIT:BSTR <Unit>

Specifies if the bit stream gets displayed using bits or using symbols.

Parameters:

<Unit> SYMBols | BITs

SYMBols
Bit stream gets displayed using Symbols

BITs
Bit stream gets displayed using Bits

*RST: SYMbols

Example: `UNIT:BSTR BIT`
Bit stream gets displayed using Bits.

Mode: DL

UNIT:EVM <Unit>

Specifies the units for EVM results.

Parameters:

<Unit> DB | PCT

DB
EVM results returned in dB

PCT
EVM results returned in %

*RST: DB

Example: `UNIT:EVM PCT`
EVM results to be returned in %.

Mode: DL

List of Commands

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