

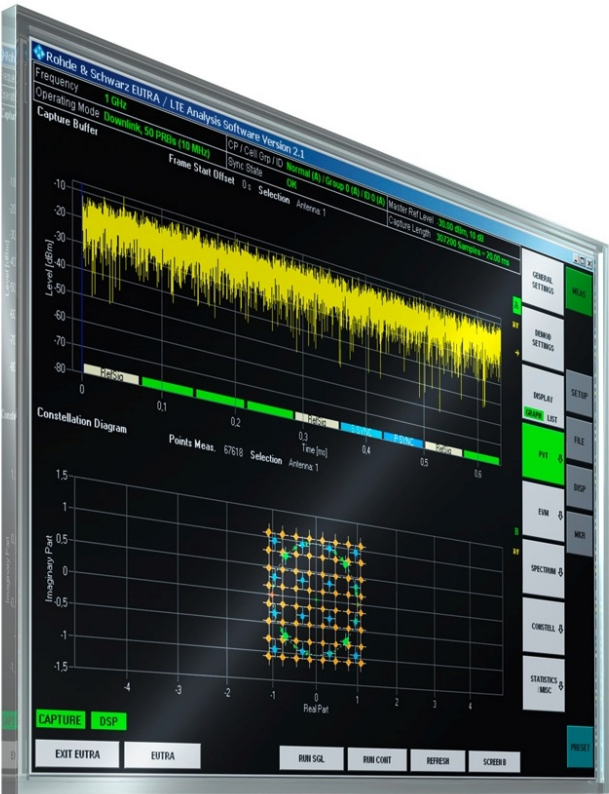
R&S®FS-K100/102/104PC

R&S®FSV-K100/102/104

R&S®FSQ-K100/102/104

EUTRA / LTE Downlink PC Software

User Manual



1308.9029.42 – 13

This manual covers the following products.

- R&S®FSQ-K100 (1308.9006.02)
- R&S®FSQ-K102 (1309.9000.02)
- R&S®FSQ-K104 (1309.9422.02)
- R&S®FSV-K100 (1310.9051.02)
- R&S®FSV-K102 (1310.9151.02)
- R&S®FSV-K104 (1309.9774.02)
- R&S®FS-K100PC (1309.9916.02)
- R&S®FS-K102PC (1309.9939.02)
- R&S®FS-K104PC (1309.9951.02)

The R&S®FS-K10xPC versions are available for the following spectrum and signal analyzers

- R&S®FSG
- R&S®FSQ
- R&S®FSV
- R&S®FSVR
- R&S®FSW

The contents of the manual correspond to version 3.00 or higher.

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

Basic Safety Instructions

Always read through and comply with the following safety instructions!




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

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








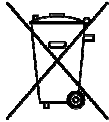

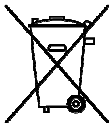

The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and, in some cases, a basic knowledge of English.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

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

Symbols and safety labels

Symbol	Meaning	Symbol	Meaning
	Notice, general danger location Observe product documentation	○	ON/OFF supply voltage
	Caution when handling heavy equipment	⏻	Standby indication
	Danger of electric shock	— — —	Direct current (DC)

Basic Safety Instructions

Symbol	Meaning	Symbol	Meaning
	Warning! Hot surface		Alternating current (AC)
	Protective conductor terminal		Direct/alternating current (DC/AC)
	Ground		Device fully protected by double (reinforced) insulation
	Ground terminal		EU labeling for batteries and accumulators For additional information, see section "Waste disposal/Environmental protection", item 1.
	Be careful when handling electrostatic sensitive devices		EU labeling for separate collection of electrical and electronic devices For additional information, see section "Waste disposal/Environmental protection", item 2.
	Warning! Laser radiation For additional information, see section "Operation", item 7.		

Signal words and their meaning

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



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



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



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

Basic Safety Instructions

Operating states and operating positions

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

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

Electrical safety

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

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

Basic Safety Instructions

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

Operation

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

Basic Safety Instructions

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

Repair and service

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

Basic Safety Instructions

Batteries and rechargeable batteries/cells

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

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

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/Environmental protection

1. Specially marked equipment has a battery or accumulator that must not be disposed of with unsorted municipal waste, but must be collected separately. It may only be disposed of at a suitable collection point or via a Rohde & Schwarz customer service center.

Instrucciones de seguridad elementales

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

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

Instrucciones de seguridad elementales

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

El principio del grupo de empresas Rohde & Schwarz consiste en tener nuestros productos siempre al día con los estándares de seguridad y de ofrecer a nuestros clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas de seguridad vigentes. Nuestro sistema de garantía de calidad controla constantemente que sean cumplidas estas normas. El presente producto ha sido fabricado y examinado según el certificado de conformidad 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.














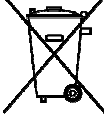
Además queda en la responsabilidad del usuario utilizar el producto en la forma debida. Este producto está destinado exclusivamente al uso en la industria y el laboratorio o, si ha sido expresamente autorizado, para aplicaciones de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa 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.

Instrucciones de seguridad elementales


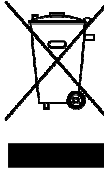

Se parte del uso correcto del producto para los fines definidos si el producto es utilizado conforme a las indicaciones de la correspondiente documentación del producto y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso del producto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

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

Símbolos y definiciones de seguridad

Símbolo	Significado	Símbolo	Significado
	Aviso: punto de peligro general Observar la documentación del producto		Tensión de alimentación de PUESTA EN MARCHA / PARADA
	Atención en el manejo de dispositivos de peso elevado		Indicación de estado de espera (standby)
	Peligro de choque eléctrico		Corriente continua (DC)
	Advertencia: superficie caliente		Corriente alterna (AC)
	Conexión a conductor de protección		Corriente continua / Corriente alterna (DC/AC)
	Conexión a tierra		El aparato está protegido en su totalidad por un aislamiento doble (reforzado)
	Conexión a masa		Distintivo de la UE para baterías y acumuladores Más información en la sección "Eliminación/protección del medio ambiente", punto 1.

Instrucciones de seguridad elementales

Símbolo	Significado	Símbolo	Significado
	Aviso: Cuidado en el manejo de dispositivos sensibles a la electrostática (ESD)		Distintivo de la UE para la eliminación por separado de dispositivos eléctricos y electrónicos Más información en la sección "Eliminación/protección del medio ambiente", punto 2.
	Advertencia: rayo láser Más información en la sección "Funcionamiento", punto 7.		

Palabras de señal y su significado

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



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.

Instrucciones de seguridad elementales

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

Seguridad eléctrica

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

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

Instrucciones de seguridad elementales

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

Instrucciones de seguridad elementales

Funcionamiento

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

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.

Instrucciones de seguridad elementales

2. El ajuste, el cambio de partes, el mantenimiento y la reparación deberán ser efectuadas solamente por electricistas autorizados por Rohde & Schwarz. Si se reponen partes con importancia para los aspectos de seguridad (p. ej. el enchufe, los transformadores o los fusibles), solamente podrán ser sustituidos por partes originales. Después de cada cambio de partes relevantes para la seguridad deberá realizarse un control de seguridad (control a primera vista, control del conductor de protección, medición de resistencia de aislamiento, medición de la corriente de fuga, control de funcionamiento). Con esto queda garantizada la seguridad del producto.

Baterías y acumuladores o celdas

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

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

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.

Instrucciones de seguridad elementales

3. Si se utiliza el producto dentro de un vehículo, recae de manera exclusiva en el conductor la responsabilidad de conducir el vehículo de manera segura y adecuada. El fabricante no asumirá ninguna responsabilidad por accidentes o colisiones. No utilice nunca el producto dentro de un vehículo en movimiento si esto pudiera distraer al conductor. Asegure el producto dentro del vehículo debidamente para evitar, en caso de un accidente, lesiones u otra clase de daños.

Eliminación/protección del medio ambiente

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

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

Customer Support

Technical support – where and when you need it

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

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

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Contents

1	Introduction.....	7
1.1	Requirements for UMTS Long-Term Evolution.....	7
1.2	Long-Term Evolution Downlink Transmission Scheme.....	9
1.2.1	OFDMA.....	9
1.2.2	OFDMA Parameterization.....	10
1.2.3	Downlink Data Transmission.....	12
1.2.4	Downlink Reference Signal Structure and Cell Search.....	12
1.2.5	Downlink Physical Layer Procedures.....	14
1.3	References.....	14
2	Welcome.....	16
2.1	Licensing the Software.....	16
2.2	Installing the Software.....	19
2.3	Connecting the Computer to an Analyzer.....	19
2.3.1	Figuring Out the Address of an R&S FSQ or R&S FSG.....	19
2.3.2	Figuring Out the Address of an R&S FSV or R&S FSVR.....	20
2.3.3	Figuring Out the Address of an R&S FSW.....	21
2.4	Application Overview.....	22
2.5	Configuring the Software.....	24
2.5.1	Configuring the Display.....	24
2.5.2	Configuring the Software.....	25
3	Measurements and Result Displays.....	27
3.1	Numerical Results.....	28
3.2	Measuring the Power Over Time.....	30
3.3	Measuring the Error Vector Magnitude (EVM).....	33
3.4	Measuring the Spectrum.....	37
3.4.1	Frequency Sweep Measurements.....	37
3.4.2	I/Q Measurements.....	40
3.5	Measuring the Symbol Constellation.....	44
3.6	Measuring Statistics.....	46
3.7	Measuring Beamforming.....	51

4	General Settings	53
4.1	Configuring the Measurement	53
4.1.1	Defining General Signal Characteristics	53
4.1.2	Configuring the Input	54
4.1.3	Configuring the Input Level	55
4.1.4	Configuring the Data Capture	57
4.1.5	Configuring Measurement Results	58
4.1.6	Configuring On/Off Power Measurements	60
4.2	Configuring MIMO Measurement Setups	61
4.3	Triggering Measurements	63
4.4	Spectrum Settings	64
4.4.1	Configuring SEM and ACLR Measurements	64
4.5	Advanced Settings	65
4.5.1	Controlling I/Q Data	65
4.5.2	Configuring the Baseband Input	66
4.5.3	Using Advanced Input Settings	67
4.5.4	Configuring the Digital I/Q Input	67
4.5.5	Configuring Home Base Station Tests	68
4.5.6	Global Settings	68
5	Demod Settings	70
5.1	Configuring Downlink Signal Demodulation	70
5.1.1	Selecting the Demodulation Method	70
5.1.2	Configuring Multicarrier Base Stations	71
5.1.3	Configuring Parameter Estimation	71
5.1.4	Compensating Signal Errors	72
5.1.5	Configuring EVM Measurements	73
5.1.6	Processing Demodulated Data	74
5.1.7	Configuring MIMO Setups	75
5.2	Defining Downlink Signal Characteristics	75
5.2.1	Defining the Physical Signal Characteristics	75
5.2.2	Configuring the Physical Layer Cell Identity	78
5.2.3	Configuring MIMO Setups	79
5.2.4	Configuring PDSCH Subframes	80

5.3	Defining Advanced Signal Characteristics.....	84
5.3.1	Configuring the Synchronization Signal.....	84
5.3.2	Configuring the Reference Signal.....	85
5.3.3	Configuring Positioning Reference Signals.....	85
5.3.4	Configuring Channel State Information Reference Signal.....	87
5.3.5	Defining the PDSCH Resource Block Symbol Offset.....	88
5.3.6	Configuring the Control Channels.....	89
5.3.7	Configuring the Shared Channel.....	92
6	Analyzing Measurement Results.....	93
7	Data Management.....	96
7.1	Importing and Exporting I/Q Data.....	96
7.2	Managing Frame Data.....	97
7.3	Customizing Reference Symbols.....	98
7.4	Importing and Exporting Limits.....	100
8	Measurement Basics.....	102
8.1	Symbols and Variables.....	102
8.2	Overview.....	103
8.3	The LTE Downlink Analysis Measurement Application.....	103
8.3.1	Synchronization.....	103
8.3.2	Channel Estimation and Equalization.....	105
8.3.3	Analysis.....	105
8.4	MIMO Measurement Guide.....	106
8.4.1	Setting Up MIMO Measurements.....	107
8.5	Performing Time Alignment Measurements.....	110
8.6	Performing Transmit On/Off Power Measurements.....	112
9	Remote Commands.....	114
9.1	Overview of Remote Command Suffixes.....	114
9.2	Introduction.....	114
9.2.1	Long and Short Form.....	115
9.2.2	Numeric Suffixes.....	115
9.2.3	Optional Keywords.....	116
9.2.4	(Vertical Stroke).....	116

9.2.5	SCPI Parameters.....	116
9.3	Remote Commands to Select a Result Display.....	118
9.4	Remote Commands to Perform Measurements.....	120
9.5	Remote Commands to Read Numeric Results.....	122
9.6	Remote Commands to Read Trace Data.....	128
9.6.1	Using the TRACe[:DATA] Command.....	128
9.6.2	Reading Out Limit Check Results.....	140
9.7	Remote Commands to Configure General Settings.....	148
9.7.1	Remote Commands for General Settings.....	148
9.7.2	Configuring MIMO Measurement Setups.....	154
9.7.3	Using a Trigger.....	155
9.7.4	Configuring Spectrum Measurements.....	156
9.7.5	Remote Commands for Advanced Settings.....	158
9.8	Remote Command to Configure the Demodulation.....	161
9.8.1	Remote Commands for PDSCH Demodulation Settings.....	161
9.8.2	Remote Commands for DL Signal Characteristics.....	165
9.8.3	Remote Commands for DL Advanced Signal Characteristics.....	173
9.9	Configuring the Software.....	181
9.10	Managing Files.....	182
	List of Commands.....	184
	Index.....	189

1 Introduction

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 WCDMA-based 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.

In the context of the LTE study item, 3GPP work first focused on the definition of 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).

- [Requirements for UMTS Long-Term Evolution](#).....7
- [Long-Term Evolution Downlink Transmission Scheme](#).....9
- [References](#).....14

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 hand-over 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. Cost-effective 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.

1.2 Long-Term Evolution Downlink Transmission Scheme

1.2.1 OFDMA

The downlink transmission scheme for EUTRA FDD and TDD modes is based on conventional OFDM.

In an OFDM system, the available spectrum is divided into multiple carriers, called sub-carriers, 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 1-1 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.

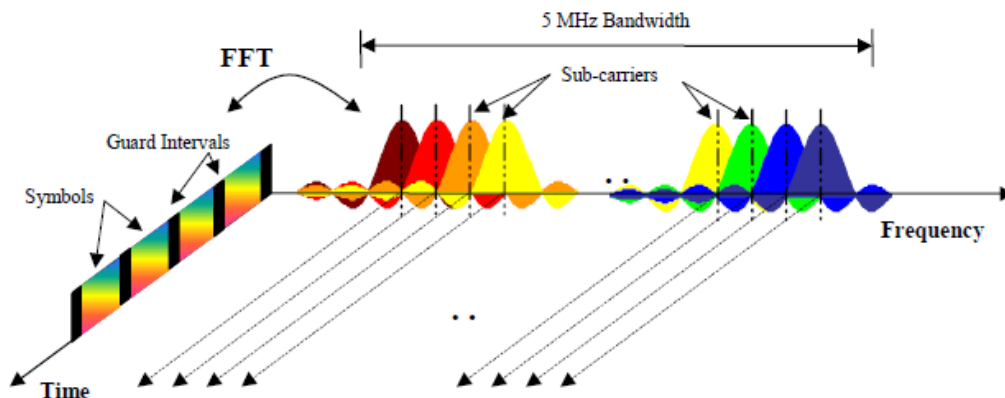


Fig. 1-1: Frequency-Time Representation of an OFDM Signal

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

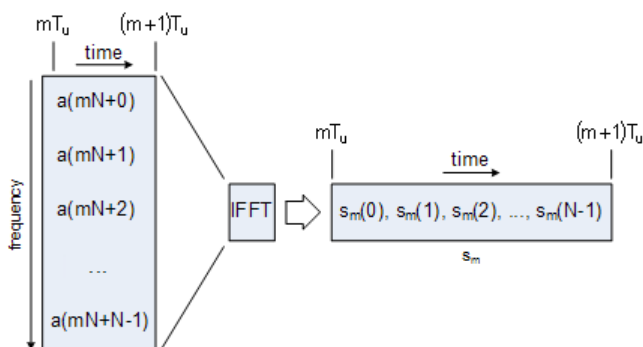


Fig. 1-2: OFDM useful symbol generation using an IFFT

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

figure 1-3 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 1-3 is the process of cyclic prefix insertion.

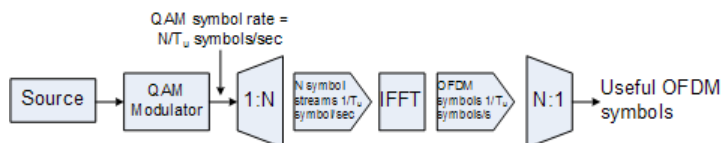


Fig. 1-3: OFDM Signal Generation Chain

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

1.2.2 OFDMA Parameterization

A generic frame structure is defined for both EUTRA FDD and TDD modes. Additionally, an alternative frame structure is defined for the TDD mode only. The EUTRA frame structures are defined in 3GPP TS 36.211. For the generic frame structure, the 10 ms radio frame is divided into 20 equally sized slots of 0.5 ms. A subframe consists of two consecutive slots, so one radio frame contains 10 subframes. This is illustrated in figure 1-4 (T_s expresses the basic time unit corresponding to 30.72 MHz).

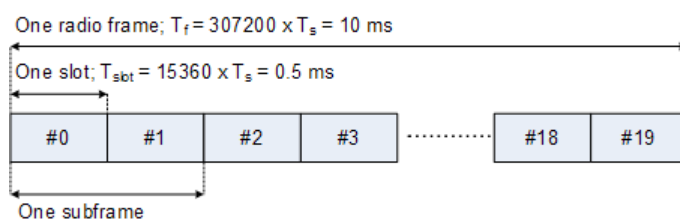


Fig. 1-4: Generic Frame Structure in EUTRA Downlink

figure 1-5 shows the structure of the downlink resource grid for the duration of one downlink slot. The available downlink bandwidth consists of $N_{\text{BW}}^{\text{DL}}$ subcarriers with a spacing of $\Delta f = 15 \text{ kHz}$. In the case of multi-cell MBMS transmission, a subcarrier spacing of $\Delta f = 7.5 \text{ kHz}$ is also possible. $N_{\text{BW}}^{\text{DL}}$ 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 $N_{\text{BW}}^{\text{DL}}$ 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.

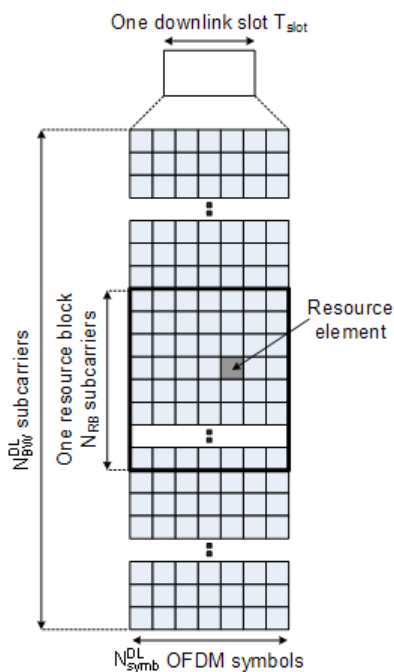


Fig. 1-5: Downlink Resource Grid

One downlink slot consists of $N_{\text{symb}}^{\text{DL}}$ OFDM symbols. To each symbol, a cyclic prefix (CP) is appended as guard time, compare figure 1-1. $N_{\text{symb}}^{\text{DL}}$ depends on the cyclic prefix length. The generic frame structure with normal cyclic prefix length contains $N_{\text{symb}}^{\text{DL}} = 7$ symbols. This translates into a cyclic prefix length of $T_{\text{CP}} \approx 5.2 \mu\text{s}$ for the first symbol and $T_{\text{CP}} \approx 4.7 \mu\text{s}$ 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 $T_{\text{CP-E}} \approx 16.7 \mu\text{s}$ contains $N_{\text{symb}}^{\text{DL}} = 6$ OFDM symbols (subcarrier spacing 15 kHz). The generic frame structure with extended cyclic prefix

of $T_{CP-E} \approx 33.3 \mu\text{s}$ contains $N_{\text{sym}b}^{DL} = 3$ symbols (subcarrier spacing 7.5 kHz). [table 1-1](#) gives an overview of the different parameters for the generic frame structure.

Table 1-1: Parameters for Downlink Generic Frame Structure

Configuration	Number of Symbols $N_{\text{sym}b}^{DL}$	Cyclic Prefix Length in Samples	Cyclic Prefix Length in μs
Normal cyclic prefix $\Delta f=15$ 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 $\Delta f=15$ kHz	6	512	16.7 μs
Extended cyclic prefix $\Delta f=7.5$ kHz	3	1024	33.3 μs

1.2.3 Downlink Data Transmission

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

1.2.4 Downlink Reference Signal Structure and Cell Search

The downlink reference signal structure is important for cell search, channel estimation and neighbor cell monitoring. [figure 1-6](#) 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 1-6](#) represent the sequences transmitted from up to four transmit antennas.

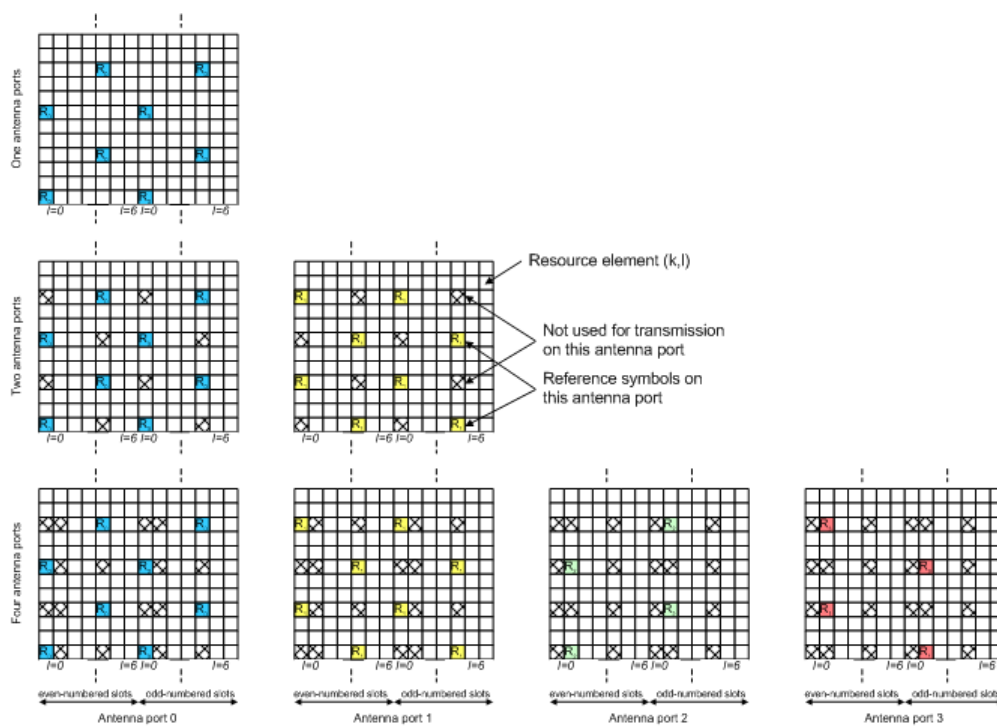


Fig. 1-6: Downlink Reference Signal Structure (Normal Cyclic Prefix)

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

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

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

Besides the reference symbols, synchronization signals are therefore needed during cell search. EUTRA uses a hierarchical cell search scheme similar to WCDMA. This means that the synchronization acquisition and the cell group identifier are obtained from different synchronization signals. Thus, a primary synchronization signal (P-SYNC) and a secondary synchronization signal (S-SYNC) are assigned a predefined structure. They are transmitted on the 72 center subcarriers (around the DC subcarrier) within the same predefined slots (twice per 10 ms) on different resource elements, see [figure 1-7](#).

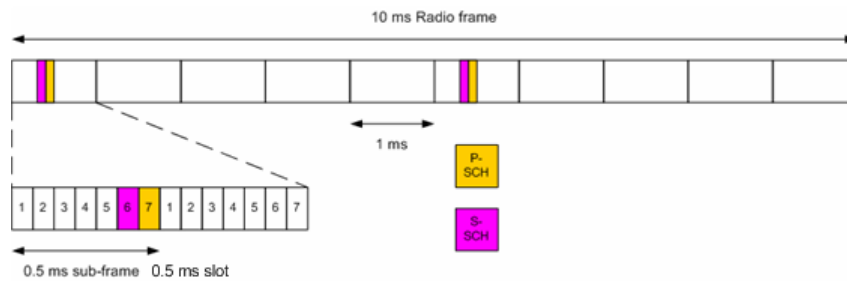


Fig. 1-7: P-SYNC and S-SYNC Structure

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.

1.2.5 Downlink Physical Layer Procedures

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

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

1.3 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 Welcome

The EUTRA/LTE software application makes use of the I/Q capture functionality of the following spectrum and signal analyzers to enable EUTRA/LTE TX measurements conforming to the EUTRA specification.

- R&S FSQ
- R&S FSG
- R&S FSV
- R&S FSVR
- R&S FSW

This manual contains all information necessary to configure, perform and analyze such measurements.

- [Licensing the Software](#).....16
- [Installing the Software](#).....19
- [Connecting the Computer to an Analyzer](#).....19
- [Application Overview](#).....22
- [Configuring the Software](#).....24

2.1 Licensing the Software

The EUTRA/LTE Software enables to

- capture and analyze I/Q data from an R&S®FSW, R&S®FSV, R&S®FSVR, R&S®FSQ or R&S®FSG
- read and analyze I/Q data from a file

You can purchase two different license types for the software.

- R&S®FS-K10xPC
This license enables software operation with and without an R&S signal analyzer. It is e.g. possible to read data from file without a connection to an analyzer. A smartcard reader (dongle) is required for this license type.
- R&S®FSV/FSQ-K10x
This license requires a connection to an R&S®FSV, R&S®FSVR, R&S®FSQ or R&S®FSG. The license must be installed on the analyzer.

Using the smartcard reader (dongle)

To enable the LTE software via smartcard (dongle), you have to load the LTE license(s) on an existing smartcard or order a new smartcard (FSPC).

You can use the smart card together with the USB smart card reader (for SIM format) supplied with the software or insert the smart card (Full format) in a reader already connected to your PC or built in your PC.

Note that support for problems with the smart card licensing can only be guaranteed if the supplied USB smart card reader (for SIM format) is used.

1. With the delivery of the FSPC you got a smart card and a smart card reader.



2. Remove the smart card.



3. Insert the smart card into the reader.
If the OMNIKEY label faces upward, the smart card has to be inserted with the chip facedown and the angled corner facing away from the reader.



4. After pushing the smart card completely inside the USB smart card reader, you can use it together with the software.



When you insert the USB Smartcard reader into the PC, the drivers will be loaded. If your PC does not already have drivers installed for this reader, the hardware will not be detected and the software will not work.

In this case, install the required driver manually. On the CD, it is in the folder `\Install\USB SmartCard Reader Driver Files`, named according to the processor architecture (OMNIKEY3x21_x86... or OMNIKEY3x21_x64). Detailed information on the file content and the download location for updated drivers can be found in the `ReadMe.txt` file in the same folder.



You may have problems locking a computer while the card is inserted, because MS Windows tries to get log-in information from the card immediately after you have locked the computer.

Solve this issue by changing a registry entry.

Either execute the registry file DisableCAD.reg in the same folder the USM Smartcard reader installation files are located. Or manually change the entry.

- Open the Windows Start Menu and select the "Run" item.
- Enter "regedit" in the dialog to open the system registry.
- Navigate to
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\policies\system.
- Set the value of DisableCAD to 0.

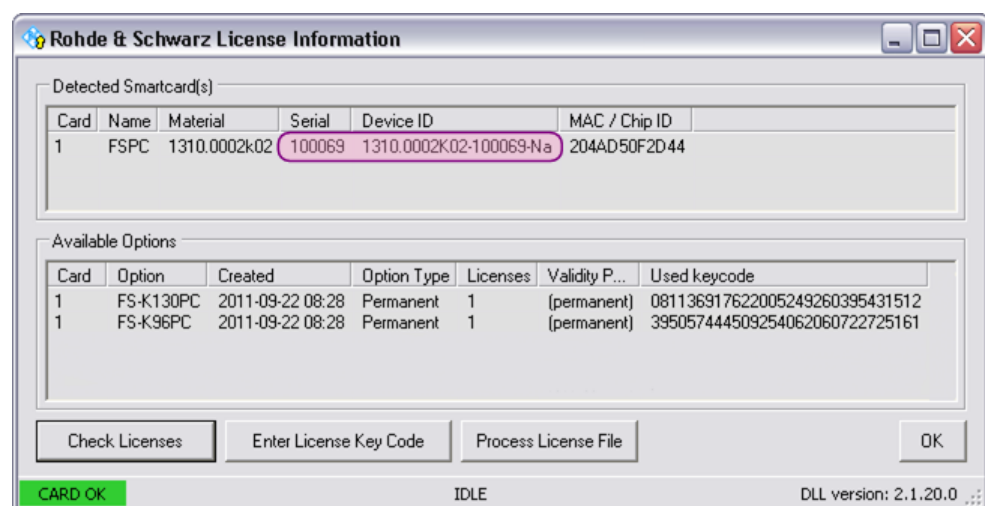
Note that security policies may prevent you from editing the value. Contact your IT administrator if you have problems with editing the value or installing the drivers.

Managing licenses

In case of registered licenses, the license key code is based on the serial number of the R&S FSPC smartcard. Thus, you need to know the serial number when you order a new license.

1. Start the software.
2. Press the SETUP key.
3. Press the "Dongle License Info" softkey.

The software opens the "Rohde & Schwarz License Information" dialog box.



4. Connect the smartcard / dongle to the computer.
5. Press the "Check Licenses" button.

The software shows all current licenses.

The serial number which is necessary to know if you need a license is shown in the "Serial" column.

The "Device ID" also contains the serial number.

6. To enter a new license code, press the "Enter License Key Code" button.

2.2 Installing the Software

For information on the installation procedure see the release notes of the software.

2.3 Connecting the Computer to an Analyzer

In order to be able to communicate with an analyzer (R&S FSQ, R&S FSG, R&S FSV, R&S FSVR or R&S FSW), you have to connect it to a computer. You can use the IEEE bus (GPIB) or a local area network (LAN).

Requirements

To be able to capture I/Q data, you need one of the signal analyzers mentioned above.

If you are using an R&S FSQ, you must

- use firmware 3.65 or higher to be able to establish a connection via TCP/IP or
- install the RSIB passport driver on the computer.
The driver is available for download at <http://www.rohde-schwarz.com/appnote/1EF47>

To establish a connection, you also have to determine the network address of the analyzer and set it up in the LTE software.

For more information on including the analyzer configuration in the software see "[MIMO Analyzer Configuration](#)" on page 61.

2.3.1 Figuring Out the Address of an R&S FSQ or R&S FSG

Follow these steps to figure out GPIB or IP address of an R&S FSQ or R&S FSG.

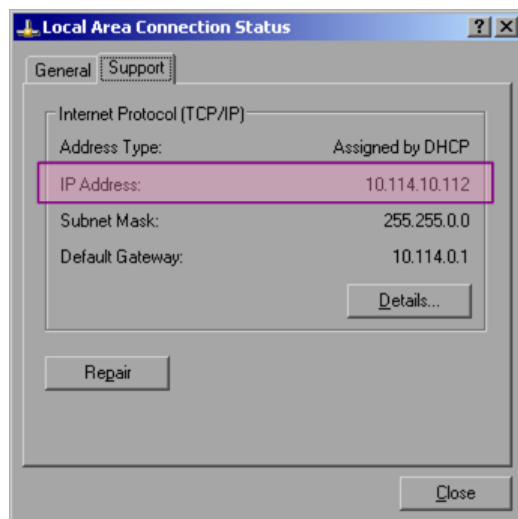
Figuring Out the GPIB address

1. Press the SETUP key.
2. Press the "General Setup" softkey.
3. Press the "GPIB" softkey.

The R&S FSQ / FSG opens a dialog box that shows its current GPIB address.

Figuring Out the IP address

1. Press the SETUP key.
2. Press the "General Setup" softkey.
3. Press the "Configure Network" softkey.
4. Press the "Configure Network" softkey.
The MS Windows "Network Connections" dialog box opens.
5. Select the "Local Area Connection" item.
The "Local Area Connection Status" dialog box opens.
6. Select the "Support" tab.
The "Support" tab shows the current TCP/IP information of the R&S FSQ.

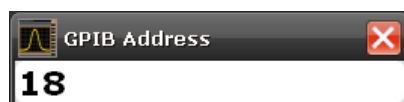


2.3.2 Figuring Out the Address of an R&S FSV or R&S FSVR

Follow these steps to figure out the GPIB or IP address of an R&S FSV or R&S FSVR.

Figuring Out the GPIB address

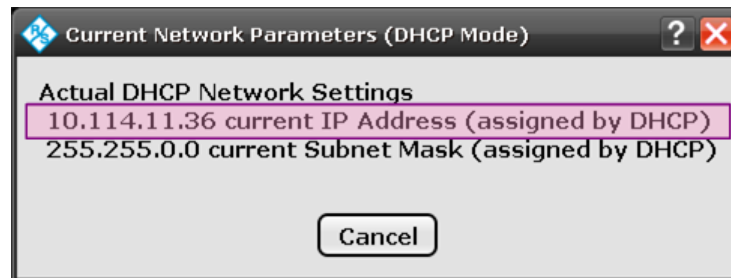
1. Press the SETUP key.
2. Press the "General Setup" softkey.
3. Press the "GPIB" softkey.
4. Press the "GPIB Address" softkey.
The R&S FSV(R) opens a dialog box that shows its current GPIB address.



Figuring Out the IP address

1. Press the SETUP key.
2. Press the "General Setup" softkey.
3. Press the "Network Address" softkey.
4. Press the "IP Address" softkey.

The R&S FSV(R) opens a dialog box that contains information about the LAN connection.



2.3.3 Figuring Out the Address of an R&S FSW

Follow these steps to figure out the GPIB or IP address of an R&S FSW.

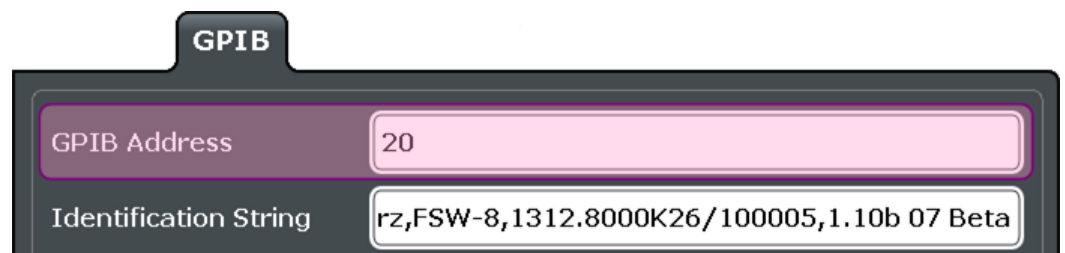
Figuring Out the GPIB address

1. Press the SETUP key.
2. Press the "Network + Remote" softkey.

The R&S FSW opens the "Network & Remote" dialog box.

3. Select the "GPIB" tab.

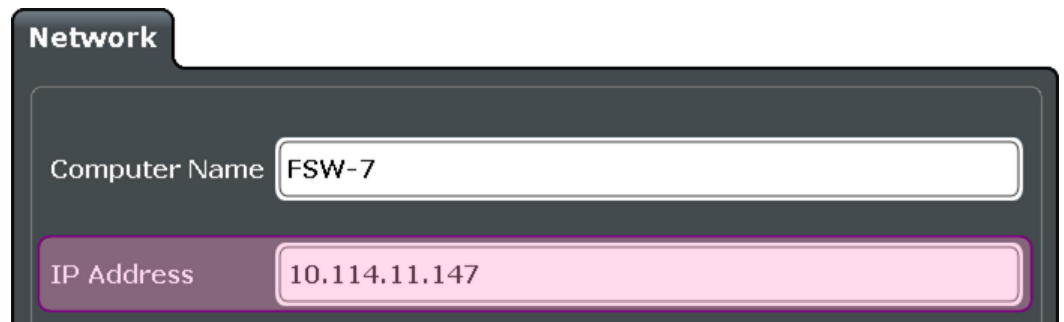
The R&S FSW shows information about the GPIB connection, including the GPIB address.



Figuring Out the IP address

1. Press the SETUP key.
2. Press the "Network + Remote" softkey.

The R&S FSW opens the "Network & Remote" dialog box and shows its current IP address in the corresponding field.



2.4 Application Overview

Starting the application

To start the software, use either the shortcut on the computer desktop or the entry in the Microsoft Windows Start menu.



If you run the software on an analyzer, access the software via the "Mode" menu.

- ▶ Press the MODE key and select "EUTRA/LTE".

Presetting the software

When you first start the software, all settings are in their default state. After you have changed any parameter, you can restore the default state with the PRESET key.

Note that using the preset function also presets an analyzer if one is connected and you capture the data from the hardware.

[CONFigure:PRESet](#) on page 182

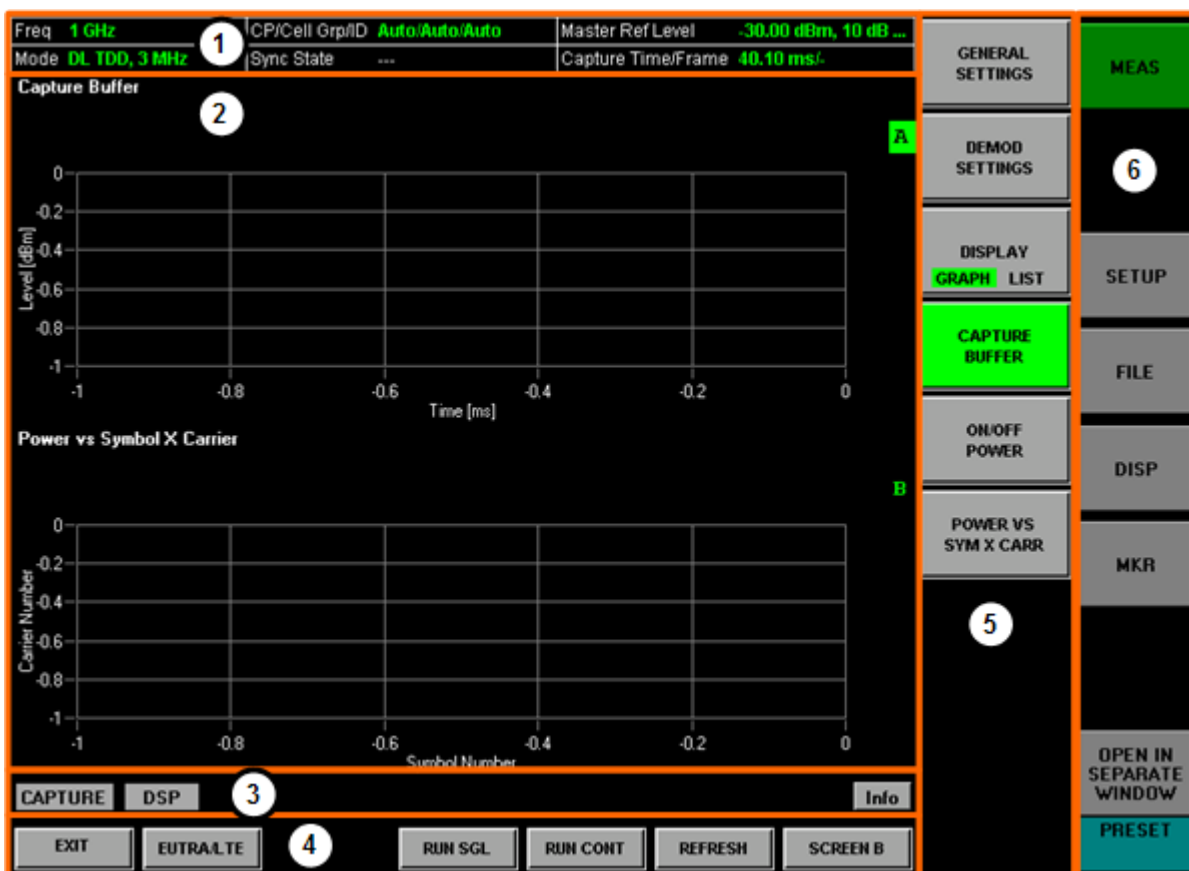
Using the preset if the software has been installed on an R&S FSQ, R&S FSG, R&S FSV, R&S FSVR or R&S FSW presets the software and the analyzer and exits the LTE software.

SCPI command:

```
*RST
```

Elements and layout of the user interface

The user interface of the LTE measurement application is made up of several elements.



- 1 = Header table. The header table shows basic information like measurement frequency or sync state.
- 2 = Diagram area. The diagram area contains the measurement results. You can display it in full screen or split screen mode. The result display is separated in a header that shows the title etc. and the diagram area that show the actual results.
- 3 = Status bar. The status bar contains information about the current status of the measurement and the software.
- 4 = Hotkeys. Hotkeys contain functionality to control the measurement process.
- 5 = Softkeys. Softkeys contain functionality to configure and select measurement functions.
- 6 = Hardkeys. Hardkeys open new softkey menus.

The 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 displays shows information on hardware and measurement settings.

Freq	--- (File)	CP/Cell Grp/ID	Auto/Auto/Auto	Master Ref Level	(0 dB)
Mode	DL TDD, 3 MHz	Sync State	---	Capture Time/Frame	40.10 ms/-

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.
- **CP/Cell Grp/ID**
Shows the cell identity information.
- **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 120
- **Master Ref Level**
Shows the reference level of the master analyzer.
- **Capture Time/Frame**
Shows the capture length in ms.

2.5 Configuring the Software

This chapter contains information about general software functionality.

2.5.1 Configuring the Display

The "Display" menu contains functionality to improve the display and documentation of results.

- ▶ Press the DISP key.

The application features four screens (or result displays). Each of the screens may contain a different result display. The number of visible screens depends on the screen layout.

Full screen mode

In full screen mode, the application shows the contents a single screen.

- ▶ Press the "Full Screen" softkey.

If you have configured more than one result displays, these are still working in the background.

Split screen mode

In split screen mode, the application shows the contents of two screens, either screen A and screen B or screen C and screen D.

- ▶ Press the "Split Screen" softkey.

If you have configured more than two result displays, these are still working in the background.

2x2 split screen mode

In 2x2 split screen mode, the application shows the contents of four screens.

- ▶ Press the "2x2 Split Screen" softkey.



Limitations

For the Spectrum Emission Mask, ACLR and On/Off Power measurements, a maximum of two screens is possible.

By default, the software shows the results in all four screens. The screens are labeled A to D to the right of the measurement diagrams. The label of the currently active screen is highlighted green (A). The currently active screen is the one settings are applied to.

Switch between the screens with the "Screen A", "Screen B", "Screen C" and "Screen D" hotkeys.

The background color of the software by default is black. Apply another color via the "Color Selection" softkey and the corresponding dialog box.

For documentation purposes the software provides a hardcopy function that lets you save the current results in one of the following formats.

- bmp
- gif
- jpeg
- png
- tiff

Use the "Hardcopy to Clipboard" function to take a screenshot.

`DISPlay[:WINDow<n>]:SElect` on page 182

2.5.2 Configuring the Software

The "Setup" menu contains various general software functions.

- ▶ Press the SETUP key to access the "Setup" menu.

Configure Analyzer Connection

Opens the "General Settings" dialog box.

For more information see ["MIMO Analyzer Configuration"](#) on page 61.

Data Source (Instr File)

Selects the general input source (an instrument or a file).

For more information see ["Selecting the Input Source"](#) on page 54.

Dongle License Info

Opens the "Rohde & Schwarz License Information" dialog box.

The dialog box contains functionality to add new (registered) licenses. For more information see [chapter 2.1, "Licensing the Software"](#), on page 16.

"Check Licenses"	Looks for all smartcards connected to the computer and returns their characteristics like the serial number of the smartcard or its device ID. Note that the smartcard has to be connected to figure out its properties.
"Enter License Key Code"	Opens an input field to manually enter a new license key code. A key code consists of 30 digits.
"Process License File"	Opens a dialog box to select a file (xml format) that contains a license. Opening that file automatically adds a new license.

Show Logging

Opens a dialog box that contains a log of all messages that the software has shown in the status bar.

Use the message log for debugging purposes in case any errors occur. You can refresh and clear the contents of the log or copy the contents of the system log to the clipboard.

"Refresh"	Updates the contents of the log.
"Clear All"	Deletes all entries in the log.
"Copy to Clipboard"	Copies the contents of the log to the clipboard.

System Info

Opens a dialog box that contains information about the system like driver versions or the utility software. You can use this information in case an analyzer does not work properly.

3 Measurements and Result Displays

The LTE measurement application features several measurements to examine and analyze different aspects of an LTE signal.

The source of the data that is processed is either a live signal or a previously recorded signal whose characteristics have been saved to a file. For more information see "[Selecting the Input Source](#)" on page 54.

In both cases, you can perform a continuous or a single measurement.

Continuous measurements capture and analyze the signal continuously and stop only after you turn it off manually.

- ▶ Press the "Run Cont" softkey to start and stop continuous measurements.

Single measurements capture and analyze the signal over a particular time span or number of frames. The measurement stops after the time has passed or the frames have been captured.

- ▶ Press the "Run Sgl" softkey to start a single measurement.

You can also repeat a measurement based on the data that has already been captured, e.g. if you want to apply different demodulation settings to the same signal.

- ▶ Press the "Refresh" softkey to measure the signal again.

This chapter provides information on all types of measurements that the LTE measurement application supports.

Note that all measurements are based on the I/Q data that is captured except the Spectrum Emission Mask and the Adjacent Channel Leakage Ratio. Those are based on a frequency sweep the analyzer performs for the measurement.

SCPI command:

`INITiate[:IMMediate]` on page 120

`INITiate:REFresh` on page 120

• Numerical Results	28
• Measuring the Power Over Time	30
• Measuring the Error Vector Magnitude (EVM)	33
• Measuring the Spectrum	37
• Measuring the Symbol Constellation	44
• Measuring Statistics	46
• Measuring Beamforming	51

3.1 Numerical Results

Result Summary

The Result Summary shows all relevant measurement results in numerical form, combined in one table.

► Press the "Display (List Graph)" softkey so that the "List" element turns green to view the Result Summary.

SCPI command:

`DISPlay[:WINDow<n>]:TABLE` on page 119

Contents of the result summary

Result Summary		Selection Antenna: 1				
Frame Results 10/10	Min	Mean	Mean Limit	Max	Max Limit	Unit
EVM PDSCH QPSK	1,12	1,12		1,12	18,50	%
EVM PDSCH 16QAM	1,18	1,18		1,18	13,50	%
EVM PDSCH 64QAM	1,07	1,07		1,07	9,00	%
Time Alignment Error Δ 2.1						ns
Time Alignment Error Δ 3.1						ns
Time Alignment Error Δ 4.1						ns
Results for Selection	Subframes ALL			Frame 10/10		
EVM All	3,94	5,77		7,74		%
EVM Phys. Channel	4,08	6,03		8,12		%
EVM Phys. Signal	1,00	1,16		1,63		%
Frequency Error	-5247,15	-5242,29		-5233,36		Hz
Sampling Error	0,91	1,02		1,12		ppm
IQ Offset	-30,92	-29,83		-28,28		dB
IQ Gain Imbalance	0,16	0,17		0,21		dB
IQ Quadrature Error	-0,23	-0,01		0,08		°
RSTP	-45,55	-45,54		-45,54		dBm
OSTP	-22,72	-20,41		-19,34		dBm
Power	-21,96	-20,26		-19,31		dBm
Crest Factor		11,69				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 indicates limit check results where available. The font of 'Pass' results is green and that of 'Fail' results is red.

By default, the software checks the limits defined by the standard. You can also import customized limits. In that case the software evaluates those limits instead of the predefined ones. For more information see [chapter 7.4, "Importing and Exporting Limits"](#), on page 100.

- **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 124
- **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 124

- **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 124

By default, all EVM results are in %. To view the EVM results in dB, change the [EVM Unit](#).

The second part of the table shows results that refer to a specific selection of the frame.

The header row of the table contains information about the selection you have made (like the subframe).

- **EVM All**

Shows the EVM for all resource elements in the analyzed frame.

[FETCh:SUMMary:EVM\[:ALL\]\[:AVERage\]?](#) on page 123

- **EVM Phys Channel**

Shows the EVM for all physical channel resource elements in the analyzed frame.

[FETCh:SUMMary:EVM:PCHannel\[:AVERage\]?](#) on page 125

- **EVM Phys Signal**

Shows the EVM for all physical signal resource elements in the analyzed frame.

[FETCh:SUMMary:EVM:PSIGNAL\[:AVERage\]?](#) on page 125

- **Frequency Error**

Shows the difference in the measured center frequency and the reference center frequency.

[FETCh:SUMMary:FERRor\[:AVERage\]?](#) on page 125

- **Sampling Error**

Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.

[FETCh:SUMMary:SERRor\[:AVERage\]?](#) on page 127

- **I/Q Offset**

Shows the power at spectral line 0 normalized to the total transmitted power.

[FETCh:SUMMary:IQOFFset\[:AVERage\]?](#) on page 126

- **I/Q Gain Imbalance**

Shows the logarithm of the gain ratio of the Q-channel to the I-channel.

[FETCh:SUMMary:GIMBalance\[:AVERage\]?](#) on page 126

- **I/Q Quadrature Error**

Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.

[FETCh:SUMMary:QUADerror\[:AVERage\]?](#) on page 127

- **RSTP**

Shows the reference signal transmit power as defined in 3GPP TS 36.141.

It is an average power and accumulates the powers of the reference symbols within a subframe divided by the number of reference symbols within a subframe.

[FETCh:SUMMary:RSTP\[:AVERage\]?](#) on page 127

- **OSTP**

Shows the OFDM symbol transmit power as defined in 3GPP TS 36.141.

It accumulates all subcarrier powers of the 4th OFDM symbol. The 4th (out of 14 OFDM symbols within a subframe (in case of frame type 1, normal CP length)) contains exclusively PDSCH.

[FETCh:SUMMArY:OSTP\[:AVERAge\]? on page 126](#)

- **Power**
Shows the average time domain power of the analyzed signal.
[FETCh:SUMMArY:POWer\[:AVERAge\]? on page 127](#)
- **Crest Factor**
Shows the peak-to-average power ratio of captured signal.
[FETCh:SUMMArY:CRESt\[:AVERAge\]? on page 123](#)

3.2 Measuring the Power Over Time

This chapter contains information on all measurements that show the power of a signal over time.

[Capture Buffer](#).....30
[On / Off Power](#).....31
[Power vs Symbol x Carrier](#).....32

Capture Buffer

The capture buffer 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).

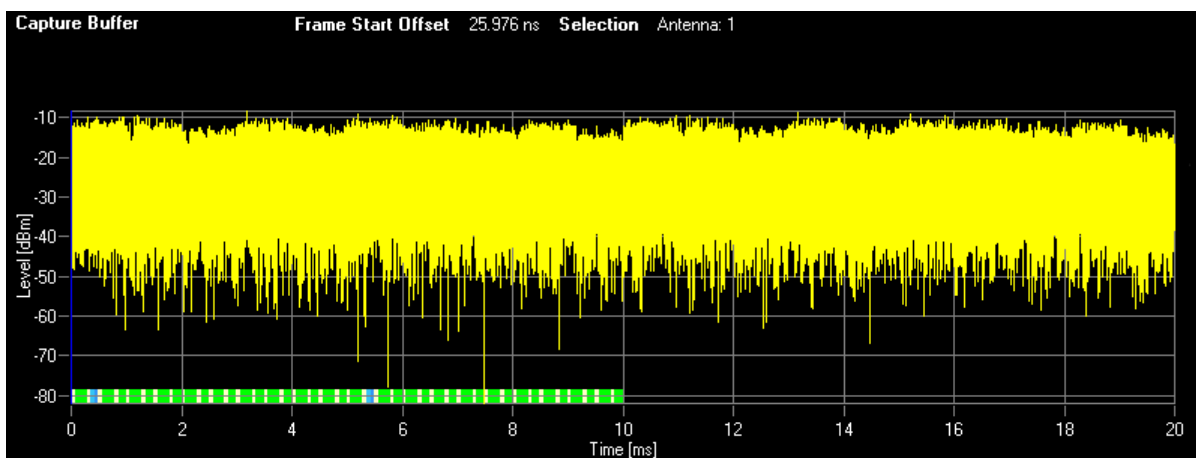




Fig. 3-1: Capture buffer without zoom

The bar at the bottom of the diagram represents the frame that is currently analyzed. Different colors indicate the OFDM symbol type.

- Indicates the data stream.
- Indicates the reference signal and data.
-

-  Indicates the P-SYNC and data.
-  Indicates the S-SYNC and data.

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

When you zoom into the diagram, you will see that the bar may be interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.

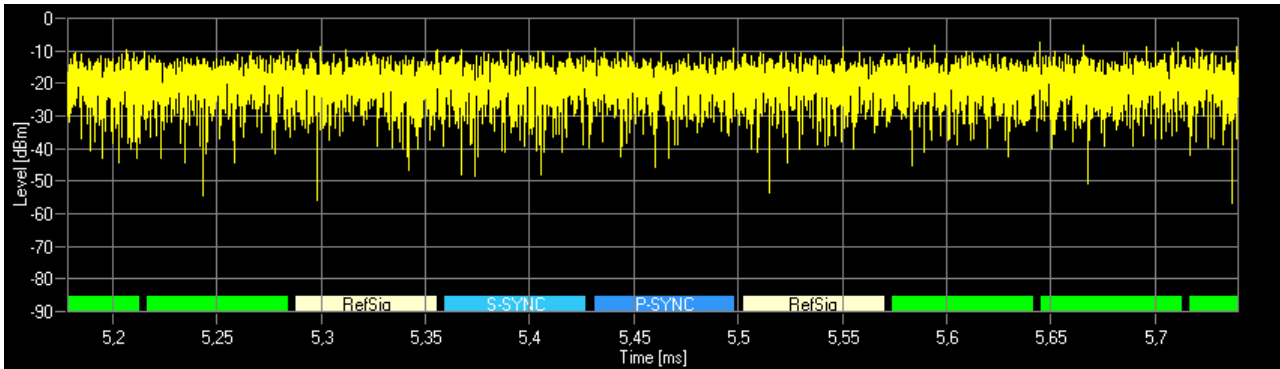


Fig. 3-2: Capture buffer after a zoom has been applied

SCPI command:

```
CALCulate<n>:FEED 'PVT:CBUF'
TRACe:DATA?
```

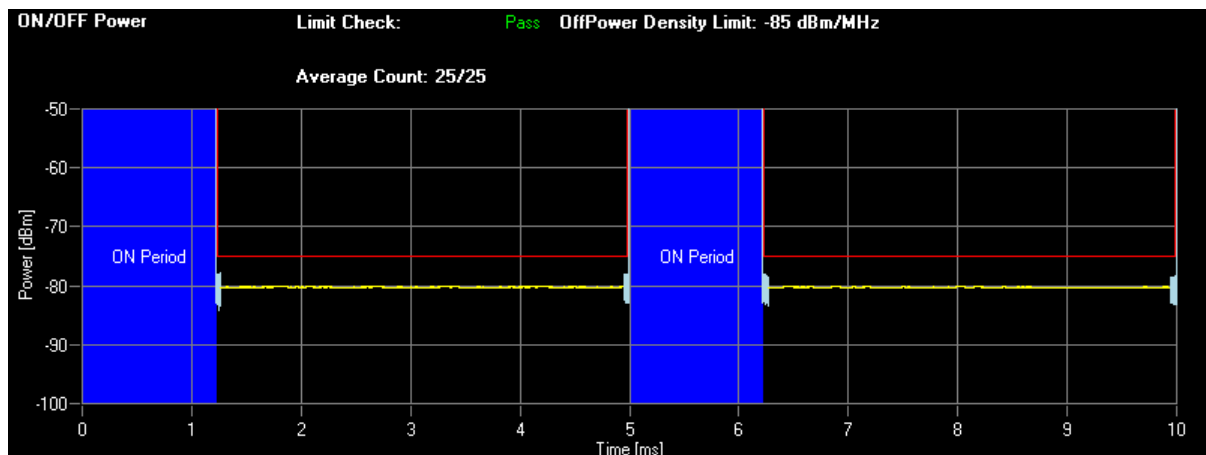
On / Off Power

The ON/OFF power measurement use different signal data than I/Q measurements and as such it is not possible to run an I/Q measurement and then view the results in the ON/OFF power measurement and vice-versa.

The ON/OFF Power measurement is only available if Duplexing is set to TDD and the input source is set to RF.

For more information see [chapter 8.6, "Performing Transmit On/Off Power Measurements"](#), on page 112.

ON/OFF Power						
Start OFF Period Limit	Stop OFF Period Limit	Time at Δ to Limit	OFF Power Abs [dBm]	OFF Power Δ to Limit	Falling Trans. Period	Rising Trans. Period
1,267 ms	4,948 ms	3,304460 ms	-80,11	5,11 dB	1,95 us	2,67 us
6,267 ms	9,948 ms	6,897558 ms	-80,14	5,14 dB	2,18 us	2,54 us



The upper part of the display shows the results of the measurement in numerical form.

In a TDD LTE frame there are periods where no DL subframe signal is transmitted. Each of these periods consist of an ON-to-OFF transient, an OFF period and an OFF-to-ON transient. For each period, one line in the ON/OFF Power results table are shown.

The Start and Stop OFF Period Limit gives the time period over which the OFF power is checked for limit fails. This is the length of the yellow trace.

For the OFF power trace maximum value (i.e. the value which has the lowest distance to the limit line in dB) the time in seconds relative to the frame start, the absolute OFF power value in dBm and the distance to the limit line in dB is given.

The length of the falling and rising transient is given in the last two columns of the table.

If any of the OFF power or transient results fail the limit check, the result will be printed in red color. The overall limit check result given in the header of the graph will pass if all of the limit checks of all periods are passed.

In the lower part of the screen an overview of the EUTRA/LTE frame is shown. Because of the overload during the ON period, only blue rectangles are sketched. The red line displays the limit to fulfill, the blue trace shows the transient period and the yellow trace shows the transmitter OFF power incorporating the filtering prescribed in 3GPP TS 36.141.

SCPI command:

Selection:

[CALCulate<n>:FEED 'PVT:OOP'](#)

Limit check:

[CALCulate<n>:LIMit<k>:OOPower:OFFPower?](#) on page 142

[CALCulate<n>:LIMit<k>:OOPower:TRANSient?](#) on page 143

[\[SENSe\] \[:LTE\]:OOPower:ATIMing](#) on page 121

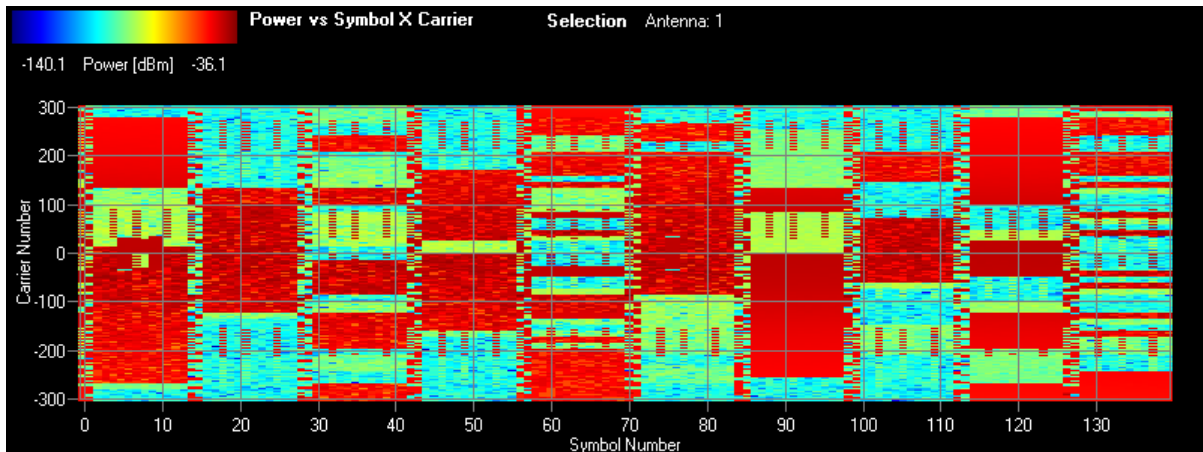
[TRACe:DATA?](#)

Power vs Symbol x Carrier

The Power vs Symbol x Carrier shows the power for each carrier in each symbol.

The horizontal axis represents the symbols. The vertical axis represents the carriers.

Different colors in the diagram area represent the power. The color map for the power levels is provided above the diagram area.



SCPI command:
not yet supported

3.3 Measuring the Error Vector Magnitude (EVM)

This chapter contains information on all measurements that show the error vector magnitude (EVM) of a signal.

The EVM is one of the most important indicators for the quality of a signal. For more information on EVM calculation methods refer to [chapter 8, "Measurement Basics"](#), on page 102.

EVM vs Carrier	33
EVM vs Symbol	34
EVM vs Sym x Carr	35
EVM vs RB	35
EVM vs Subframe	35
Frequency Error vs Symbol	36

EVM vs Carrier

Starts the EVM vs Carrier result display.

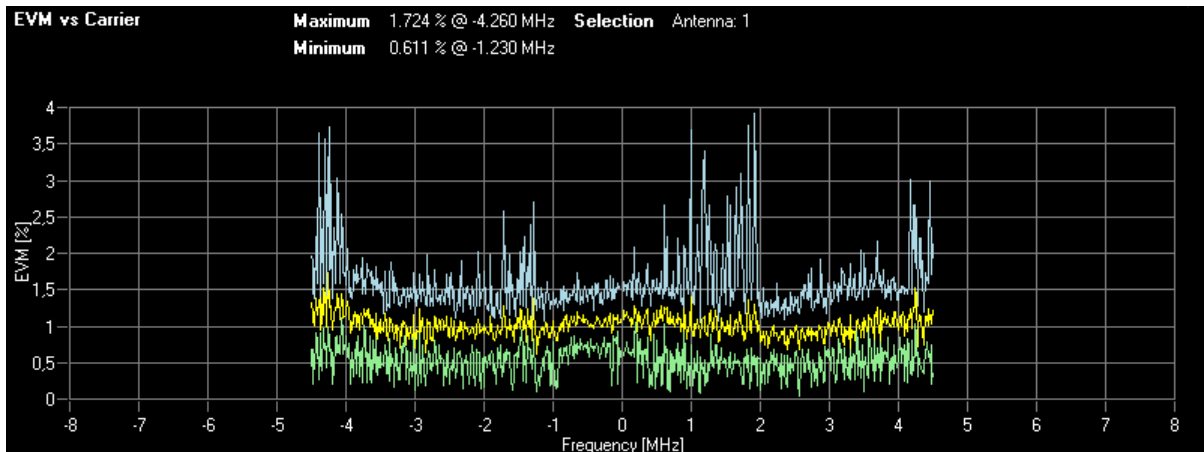
This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

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

For more information see ["Subframe Selection"](#) on page 59

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 the [EVM Unit](#).

Measuring the Error Vector Magnitude (EVM)



SCPI command:

```
CALCulate<n>:FEED 'EVM:EVCA'
TRACe:DATA?
```

EVM vs Symbol

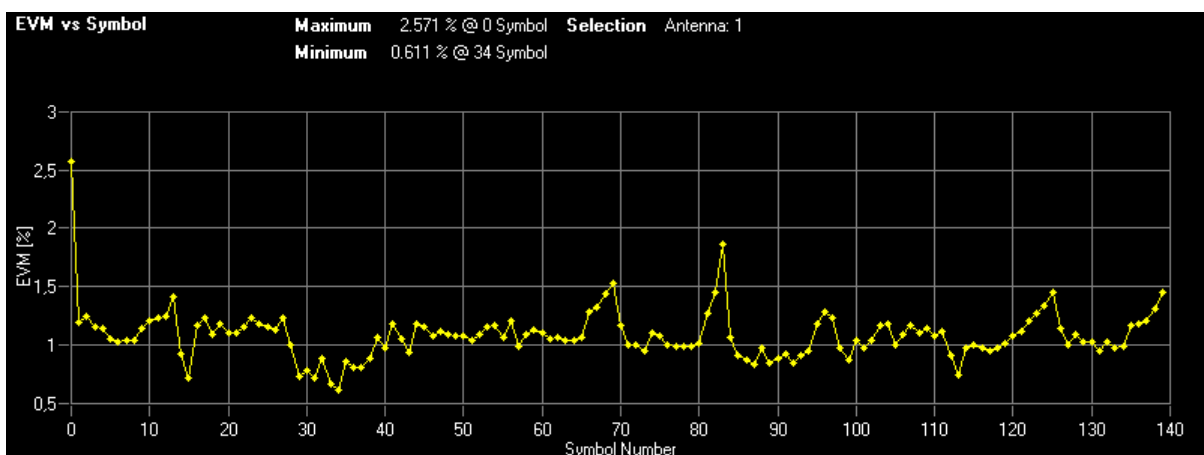
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) on symbol level for all OFDM symbols in all subframes. 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 analyzer could not determine the EVM for that symbol. In case of TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

On the y-axis, the EVM is plotted either in % or in dB, depending on the [EVM Unit](#)



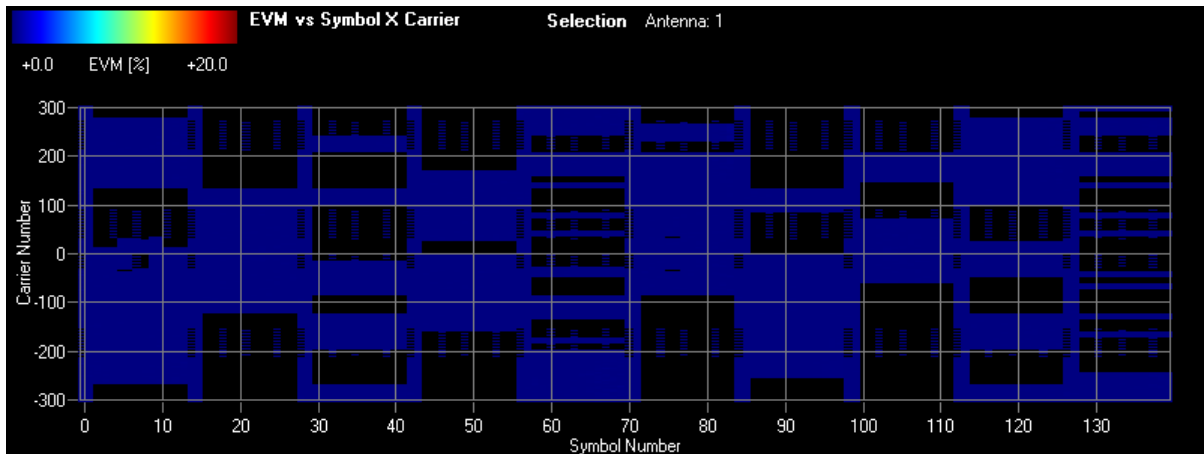
SCPI command:

```
CALCulate<n>:FEED 'EVM:EVSY'
TRACe:DATA?
```

EVM vs Sym x Carr

The EVM vs Symbol x Carrier shows the EVM for each carrier in each symbol.

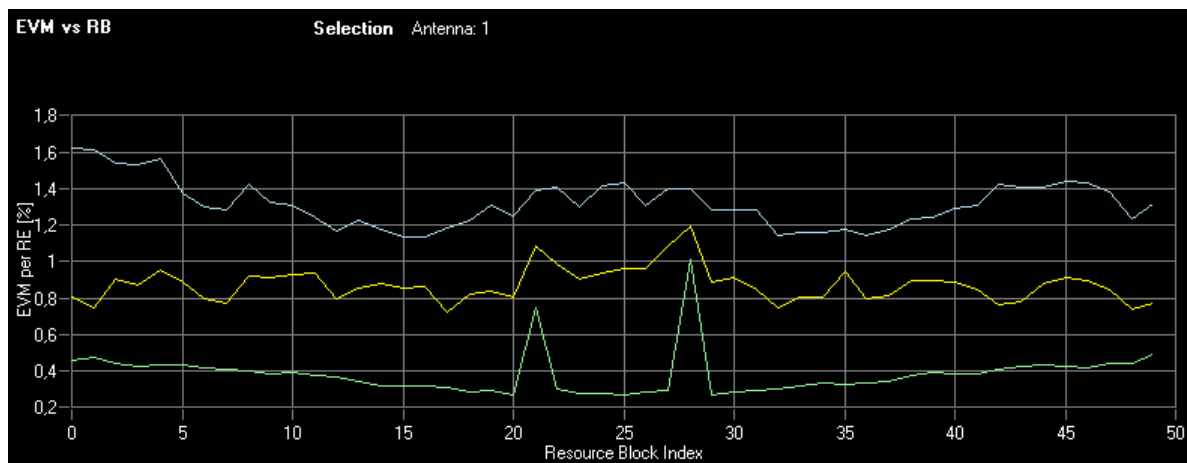
The horizontal axis represents the symbols. The vertical axis represents the carriers. Different colors in the diagram area represent the EVM. The color map for the power levels is provided above the diagram area.



SCPI command:
not supported yet

EVM vs RB

The EVM vs RB shows the EVM of the PDSCH for each resource block it occupies.



SCPI command:
[CALCulate<n>:FEED 'EVM:EVRP'](#)
[TRACe:DATA?](#)

EVM vs Subframe

Starts the EVM vs Subframe result display.

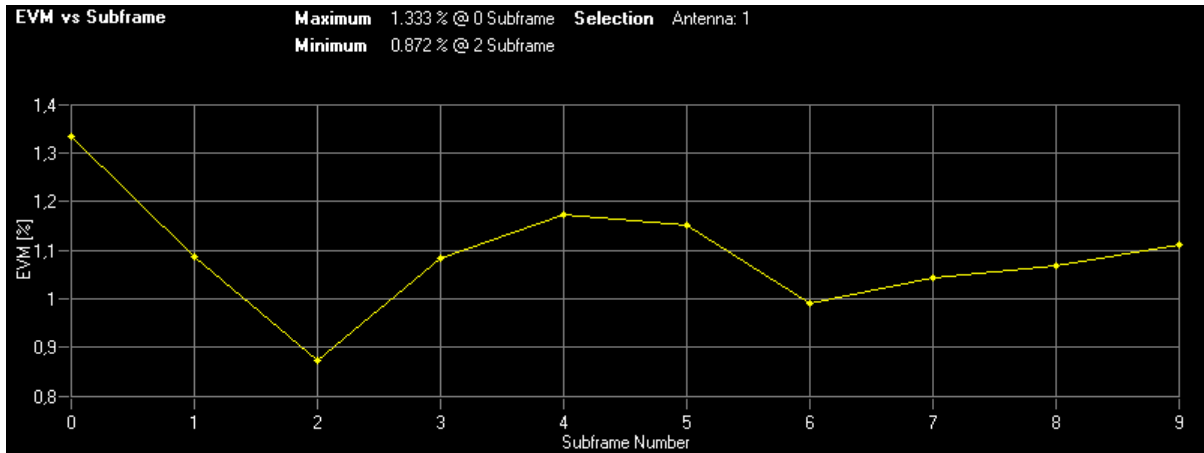
This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

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.

Measuring the Error Vector Magnitude (EVM)

On the y-axis, the EVM is plotted either in % or in dB, depending on the [EVM Unit](#).



SCPI command:

```
CALCulate<n>:FEED 'EVM:EVSU'
TRACe:DATA?
```

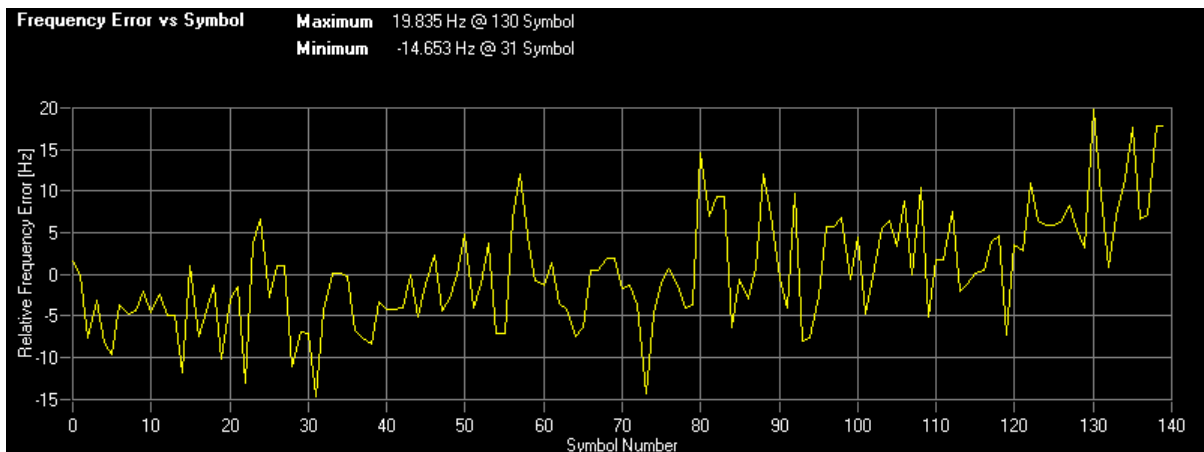
Frequency Error vs Symbol

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. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. On the y-axis, the frequency error is plotted in Hz.



SCPI command:

```
CALCulate<n>:FEED 'EVM:FEVS'
TRACe:DATA?
```

3.4 Measuring the Spectrum

This chapter contains information on all measurements that show the power of a signal in the frequency domain.

In addition to the I/Q measurements, spectrum measurements also include two frequency sweep measurements, the Spectrum Emission Mask and the Adjacent Channel Leakage Ratio.

3.4.1 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available for the EUTRA/LTE measurement application. They do not use the I/Q data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to run an I/Q measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurements uses 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.

Frequency sweep measurements are available if RF input is selected.

Spectrum Mask.....	37
ACLR.....	39

Spectrum Mask

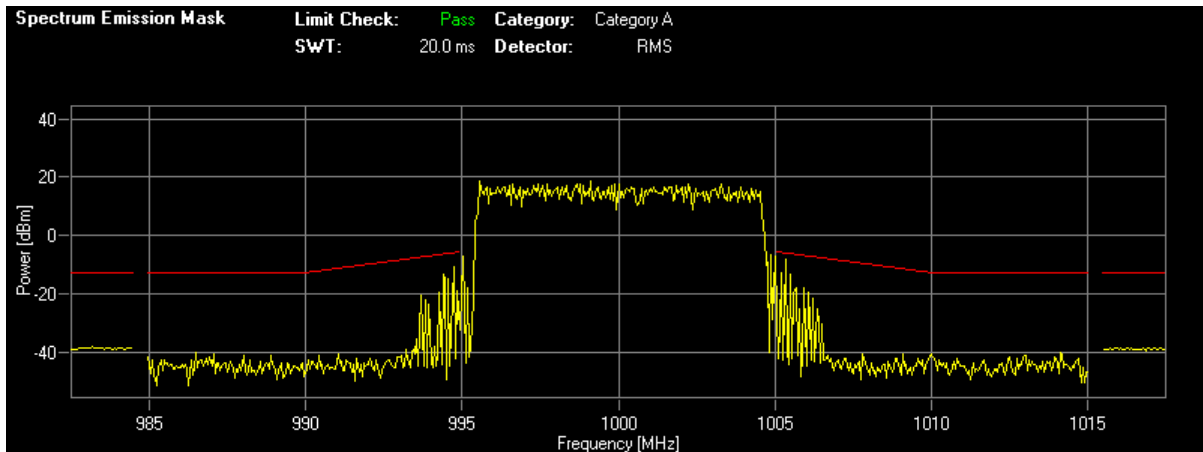
Starts the Spectrum Emission Mask (SEM) result display.

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 analyzer 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.

The result display also contains some numerical results for the SEM measurement, for example the total signal power or the limit check result.



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 measured power of the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Power Rel**
Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The application evaluates this value for each 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.

Spectrum Emission Mask List						
Start Freq. Rel.	Stop Freq. Rel.	RBW	Freq. at Δ to Limit	Pwr Abs [dBm]	Pwr Rel [dB]	Δ to Limit [dB]
-17,50 MHz	-15,50 MHz	1,00 MHz	0,983173100 GHz	-38,26	-72,55	-25,26
-15,05 MHz	-10,05 MHz	0,10 MHz	0,986482400 GHz	-40,14	-74,44	-27,64
-10,05 MHz	-5,05 MHz	0,10 MHz	0,994727600 GHz	-10,81	-45,10	-5,00
5,05 MHz	10,05 MHz	0,10 MHz	1,005329000 GHz	-8,12	-42,41	-2,23
10,05 MHz	15,05 MHz	0,10 MHz	1,014135000 GHz	-40,14	-74,43	-27,64
15,50 MHz	17,50 MHz	1,00 MHz	1,016266000 GHz	-38,40	-72,70	-25,40

SCPI command:
CALCulate<n>:FEED 'SPEC:SEM'
TRACe:DATA?

ACLR

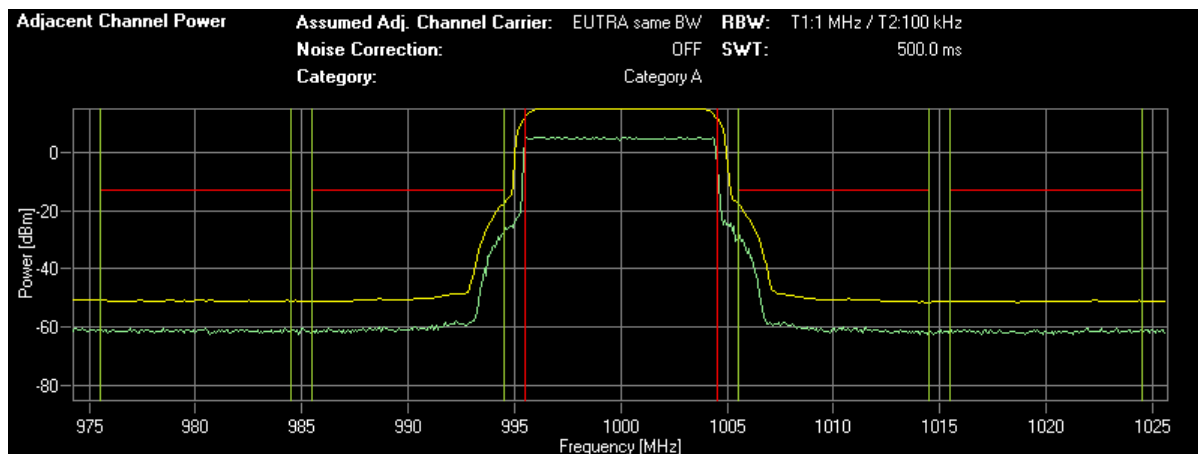
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

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. You can change the assumed adjacent channel carrier type and the "Noise Correction" on page 65.

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



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

- **Channel**
Shows the channel type (TX, Adjacent or Alternate Channel).
- **Bandwidth**
Shows the bandwidth of the channel.
- **Spacing**
Shows the channel spacing.
- **Channel Power**
Shows the absolute power of the corresponding channel.
- **Δ to Limit [dB]**
Shows the distance to the limit line.
- **Frequency at Δ to Limit [GHz]**
Shows the frequency where the discrepancy to the limit line occurs.
- **Overall Limit Check**
Shows the overall limit check results.
PASS indicates a positive result, FAIL a negative result.

Channel	Bandwidth	Spacing (Offset)	Channel Power	Δ to Limit [dB]	Frequency at Δ to Limit [GHz]	Overall Limit Check
TX	9,015 MHz		23,99 dBm			
Lower Adj	9,015 MHz	-10 MHz	-46,39 dB	-5,13	+0,994413952	PASS
Upper Adj	9,015 MHz	10 MHz	-46,72 dB	-4,53	+1,005494720	PASS
Lower Alt	9,015 MHz	-20 MHz	-66,01 dB	-37,69	+0,980143296	PASS
Upper Alt	9,015 MHz	20 MHz	-66,23 dB	-37,84	+1,022283776	PASS

SCPI command:

Selection:

[CALCulate<n>:FEED 'SPEC:ACP'](#)

Limit check:

[CALCulate<n>:LIMit<k>:ACPpower:ACHannel:RESult?](#) on page 140

[CALCulate<n>:LIMit<k>:ACPpower:ALternate:RESult?](#) on page 141

Reading results:

[CALCulate<n>:MARKer<m>:FUNCTION:POWER:RESult\[:CURRENT\]?](#)

on page 142

[TRACe:DATA?](#)

3.4.2 I/Q Measurements

Power Spectrum	40
Power vs Resource Block PDSCH	41
Power vs Resource Block RS	42
Channel Flatness	42
Channel Flatness Difference	43
Channel Group Delay	43

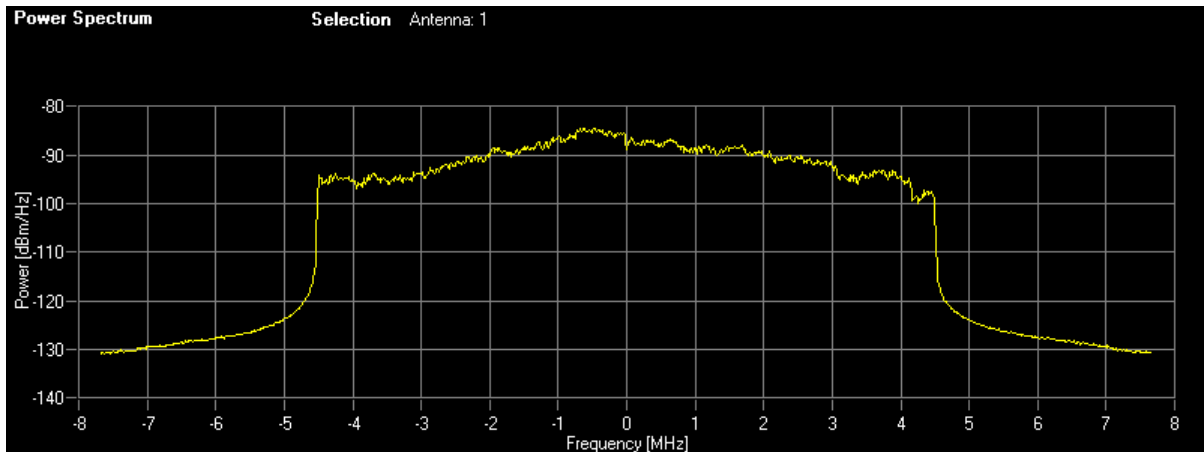
Power Spectrum

Starts the Power Spectrum result display.

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

For more information see "[Channel Bandwidth / Number of Resource Blocks](#)" on page 75.

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



SCPI command:

```
CALCulate<screenid>:FEED 'SPEC:PSPE'
TRACe:DATA?
```

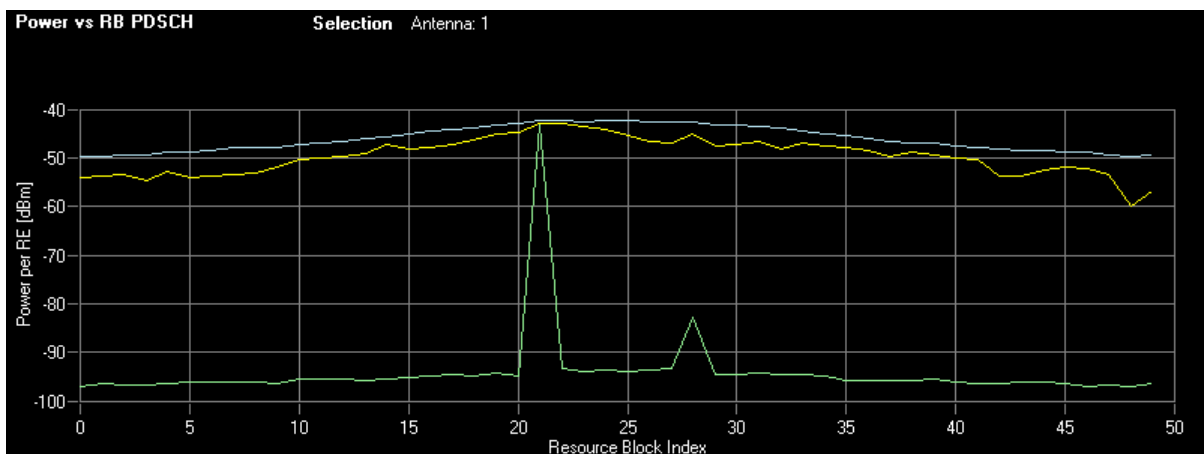
Power vs Resource Block PDSCH

Starts the Power vs Resource Block PDSCH result display.

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

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

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



SCPI command:

```
CALCulate<n>:FEED 'SPEC:PVRP'
TRACe:DATA?
```

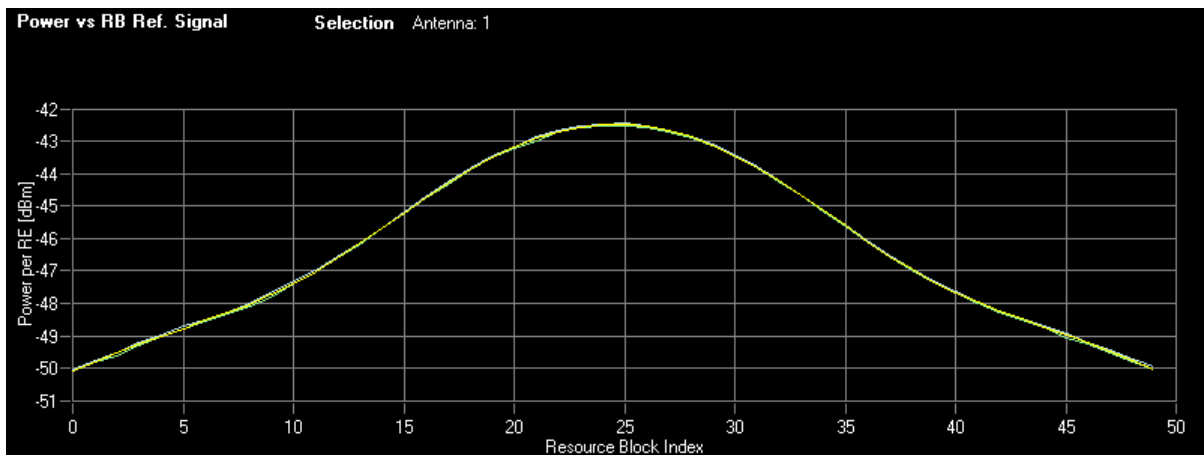

Power vs Resource Block RS

Starts the Power vs Resource Block RS result display.

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

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

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



SCPI command:

```
CALCulate<n>:FEED 'SPEC:PVR'
TRACe:DATA?
```

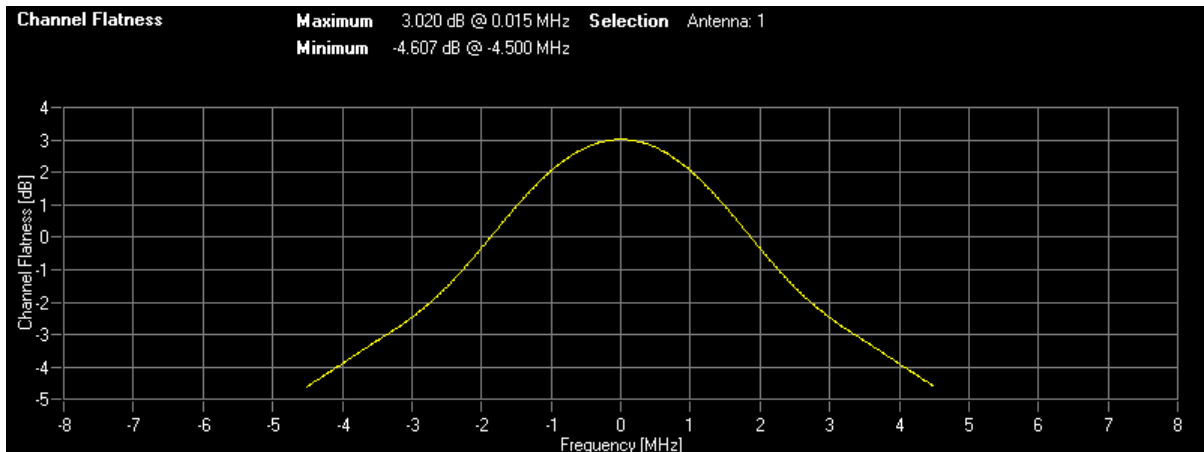
Channel Flatness

Starts the Channel Flatness result display.

This result display shows the relative power offset caused by the transmit channel.

The currently selected subframe depends on your [selection](#).

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



SCPI command:

`CALCulate<n>:FEED 'SPEC:FLAT'`
`TRACe:DATA?`

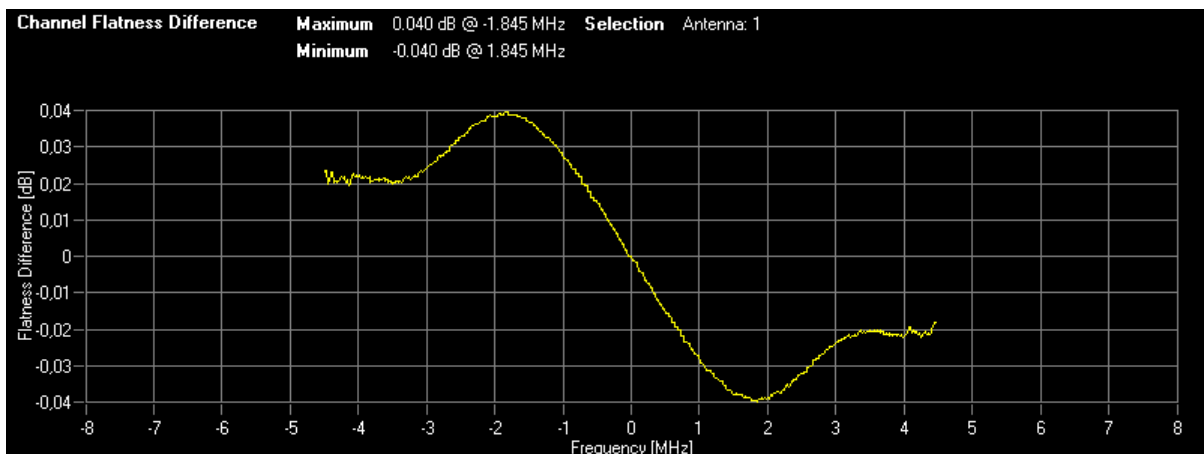
Channel Flatness Difference

Starts the Channel Flatness Difference result display.

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

The currently selected subframe depends on your [selection](#).

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



SCPI command:

`CALCulate<n>:FEED 'SPEC:FDIF'`
`TRACe:DATA?`

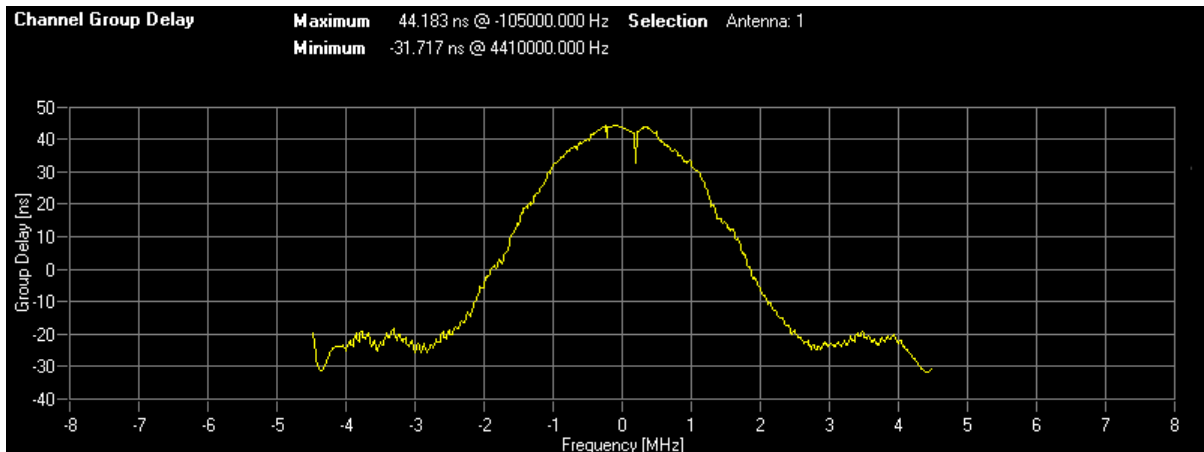
Channel Group Delay

Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The currently selected subframe depends on your [selection](#).

The x-axis represents the frequency. On the y-axis, the group delay is plotted in ns.



SCPI command:

`CALCulate<n>:FEED 'SPEC:GDEL'`
`TRACe:DATA?`

3.5 Measuring the Symbol Constellation

This chapter contains information on all measurements that show the constellation of a signal.

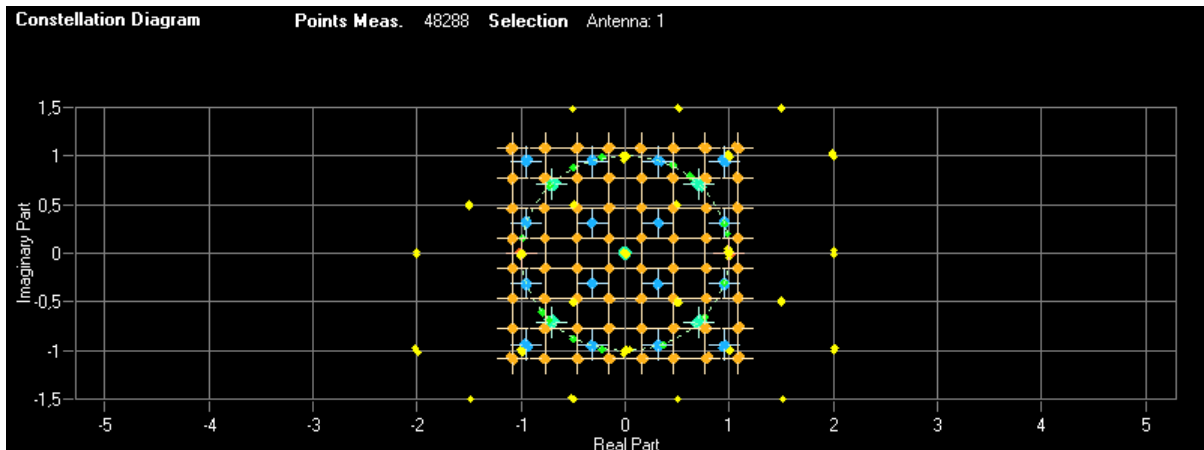
Constellation Diagram	44
Constellation Selection	45

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.



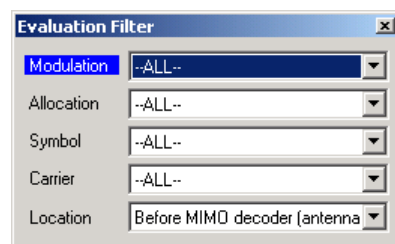
SCPI command:

```
CALCulate<n>:FEED 'CONS:CONS'
TRACe:DATA?
```

Constellation Selection

Filters 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.

Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.



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 analyzer 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.

SCPI command:

Location:

[CONFigure\[:LTE\]:DL:CONS:LOCation](#) on page 121

3.6 Measuring Statistics

This chapter contains information on all measurements that show the statistics of a signal.

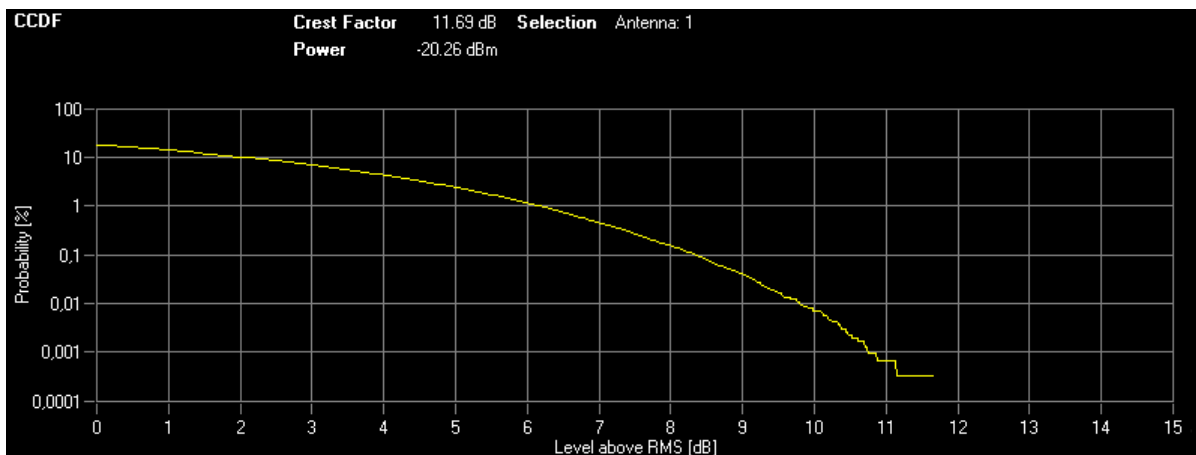
CCDF	46
Signal Flow	46
Allocation Summary	47
Bit Stream	48
Allocation ID vs Symbol x Carrier	49
Channel Decoder Results	49

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<n>:FEED 'STAT:CCDF'](#)
[TRACe:DATA?](#)

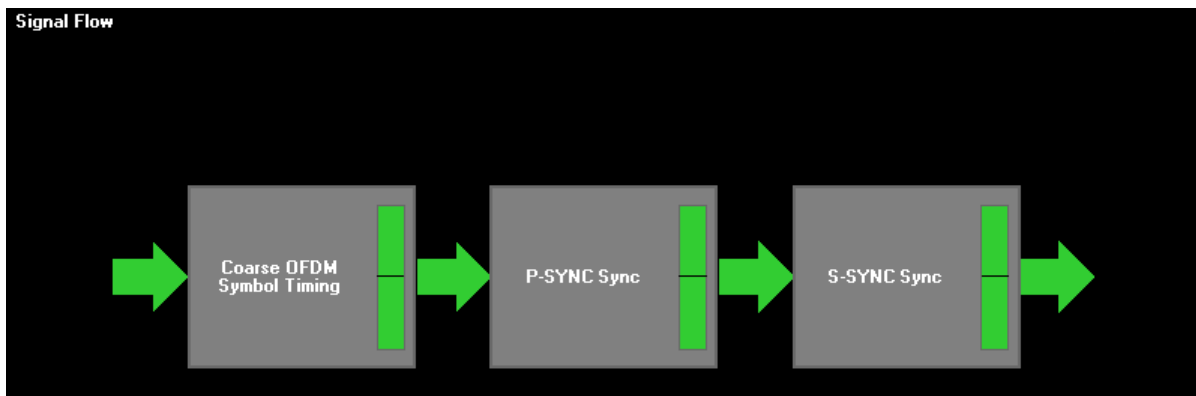
Signal Flow

Starts the Signal Flow result display.

This result display shows the synchronization status of the current measurement. It also shows the location of the synchronization error in the signal processing.

For each synchronization block, a bar is shown giving information about the reliability of the synchronization result. If the level in the bar falls below the threshold indicated by the horizontal line, the synchronization is marked as failed and the color of the bar changes from green to red. When the synchronization of the block fails, the complete block changes its color to red and all succeeding arrows change their color to red, too.

For more information see [chapter 8, "Measurement Basics"](#), on page 102.



SCPI command:
`CALCulate<n>:FEED 'STAT:SFLO'`

Allocation Summary

Starts the Allocation Summary result display.

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

Sub-frame	Alloc. ID	Number of RB	Rel. Power/dB	Modulation	Power per RE/dBm	EVM/%
0	RS Ant1		0,000	QPSK	-45,546	1,733
	P-SYNC		-0,007	CAZAC	-42,558	1,254
	S-SYNC		0,005	RBPSK	-42,546	1,251
	PBCH		-0,003	QPSK	-42,579	1,185
	PCFICH		0,000	QPSK	-45,619	2,079
	PHICH		0,000	MIXTURE	-43,984	2,877
	PDCCH		0,001	QPSK	-47,750	1,784
	PDSCH 0	23	-0,001	64QAM	-45,321	1,092
	PDSCH 1	12	0,003	QPSK	-47,871	1,280
	ALL	35				1.333

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 following information:

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

- **Subframe**
Shows the subframe number.
- **Allocation ID**

- Shows the type / ID of the allocation.
- **Number of RB**
Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Rel. Power/dB**
Shows the relative power of the allocation.
- **Modulation**
Shows the modulation type.
- **Power per RE [dBm]**
Shows the power of each resource element in dBm.
- **EVM**
Shows the EVM of the allocation. The unit depends on your [selection](#).

Note: PDSCH allocation with beamforming. The allocation summary shows two entries for a PDSCH allocation that uses "Beamforming (UE spec. RS)" as the precoding method. The second entry shows the measurement results of the UE specific reference signal.

SCPI command:

```
CALCulate<n>:FEED 'STAT:ASUM'
TRACe:DATA?
```

Bit Stream

Starts the Bit Stream result display.

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

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

Symbols or bits that are not transmitted are represented by a "-".

If a symbol could not be decoded because the number of layers exceeds the number of receive antennas, the application shows a "#" sign.

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

The table contains the following information:

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

Channel the bits belong to.

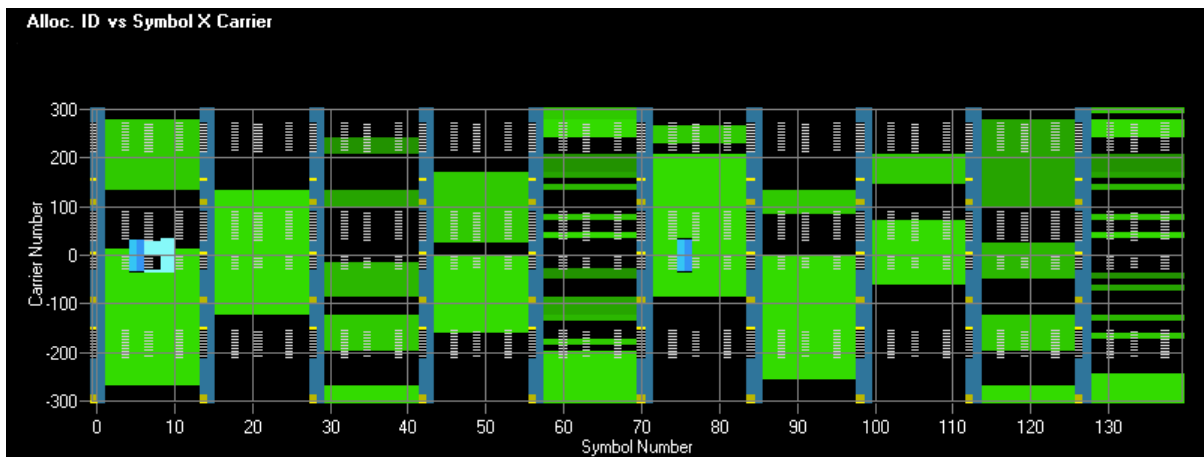
- **Codeword**
Code word of the allocation.
- **Modulation**
Modulation type of the channels.
- **Bit Stream**
The actual bit stream.

SCPI command:

`CALCulate<n>:FEED 'STAT:BSTR'
TRACe:DATA?`

Allocation ID vs Symbol x Carrier

The Allocation ID vs. Symbol X Carrier display shows the allocation ID of each carrier in each symbol of the received signal.



SCPI command:

not supported yet

Channel Decoder Results

The channel decoder result display shows the protocol information in the PBCH, the PCFICH and the PHICH. It also shows information about the DCIs in the PDCCH and the decoded bitstream for each PDCCH. The results are specific to a subframe.

Note that a complete set of results for the control channel is available only if certain configurations have been made for each channel (see below). In addition, results are only available if the corresponding channel has been enabled in the "Advanced Signal Characteristics".

Example:

The results for the PBCH are shown only if **PBCH Present** is enabled.

Channel Decoder Results

Sub-frame	Allocation ID	Data										
0	PBCH	1 Tx Ant., Bandwidth 10 MHz PHICH normal duration, PHICH resource 1/6										
	PCFICH	2 symbols for PDCCH										
	PHICH	<table border="1"> <thead> <tr> <th>ACK(1)/NACK(0)</th> <th>Rel. Power/dB</th> </tr> </thead> <tbody> <tr> <td>0--- 00--</td> <td>-3,01 - - -3,01 -24,01 - -</td> </tr> <tr> <td>00-0 0-0-</td> <td>-3,01 -22,01 - -28,01 -3,01 - -21,01 -</td> </tr> <tr> <td>0--0 0---</td> <td>-3,01 - - -25,01 -3,01 - - -</td> </tr> <tr> <td>0--- 01--</td> <td>-3,01 - - -3,01 -23,01 - -</td> </tr> </tbody> </table>	ACK(1)/NACK(0)	Rel. Power/dB	0--- 00--	-3,01 - - -3,01 -24,01 - -	00-0 0-0-	-3,01 -22,01 - -28,01 -3,01 - -21,01 -	0--0 0---	-3,01 - - -25,01 -3,01 - - -	0--- 01--	-3,01 - - -3,01 -23,01 - -
ACK(1)/NACK(0)	Rel. Power/dB											
0--- 00--	-3,01 - - -3,01 -24,01 - -											
00-0 0-0-	-3,01 -22,01 - -28,01 -3,01 - -21,01 -											
0--0 0---	-3,01 - - -25,01 -3,01 - - -											
0--- 01--	-3,01 - - -3,01 -23,01 - -											
1	PCFICH	2 symbols for PDCCH										

The information depends on the channel.

- PBCH**
 The PBCH decoder results are shown if either PHICH Duration or PHICH N_g is set to Auto (PBCH) or the Decode all control channels is enabled.
 If the CRC is invalid, the message "CRC check failed" is shown. In all other cases, the following PBCH information is provided.
 - MIMO configuration of the DUT i.e. either 1, 2 or 4 transmit antennas.
 - Transmission bandwidth
 - PHICH duration (normal or extended)
 - PHICH resource which is the same as the PHICH N_g parameter (1/6, 1/2, 1 or 2)
 - System frame number
- PCFICH**
 The PCFICH contains the information about the number of OFDM symbols at the beginning of a subframe used for PDCCH.
- PHICH**
 The PHICH carries the hybrid-ARQ ACK/NACK. Multiple PHICHs mapped to the same set of resource elements constitute a PHICH group, where PHICHs within the same PHICH group are separated through different orthogonal sequences.
 Each line in the table corresponds to one PHICH group. On the left side, the ACK/NACK pattern for the group is shown where for each PHICH the following state indicators are used:
 - 0: acknowledgement
 - 1: not acknowledged
 - -: not transmitted
 On the right side, the relative powers for each PHICH in the PHICH group is shown. If a PHICH is not transmitted, a "-" is substituted.
- PDCCH**
 The PDCCH decoder results are shown if PDSCH Subframe Configuration Detection is set to PDCCH Protocol or the Decode all control channels is enabled.
 The following DCI formats are supported: 0, 1, 1A, 1B, 1C, 2, 2A, 3, 3A. The decoding of the PDCCH uses the length of the DCIs to distinguish between the different formats. Since the formats 0, 3 and 3A have the same length, the decoder cannot distinguish these formats.
 Note that a DCI that consist of only zero bits cannot be decoded.

For each PDCCH, the RNTI, the detected DCI format and the bit stream data is given. Additionally, the PDCCH format used to transport the DCI and the correspondice CCE offset is given to identify the position of the current DCI in the PDCCH bit stream.

SCPI command:

```
CALCulate<screenid>:FEED 'STAT:CDR'
TRACe:DATA?
```

3.7 Measuring Beamforming

This chapter contains information on all measurements that show the quality of the beamforming.

- [UE Specific RS Weights \(Magnitude\)](#).....51
- [UE Specific RS Weights \(Phase\)](#).....52
- [Beamforming Selection](#).....52

UE Specific RS Weights (Magnitude)

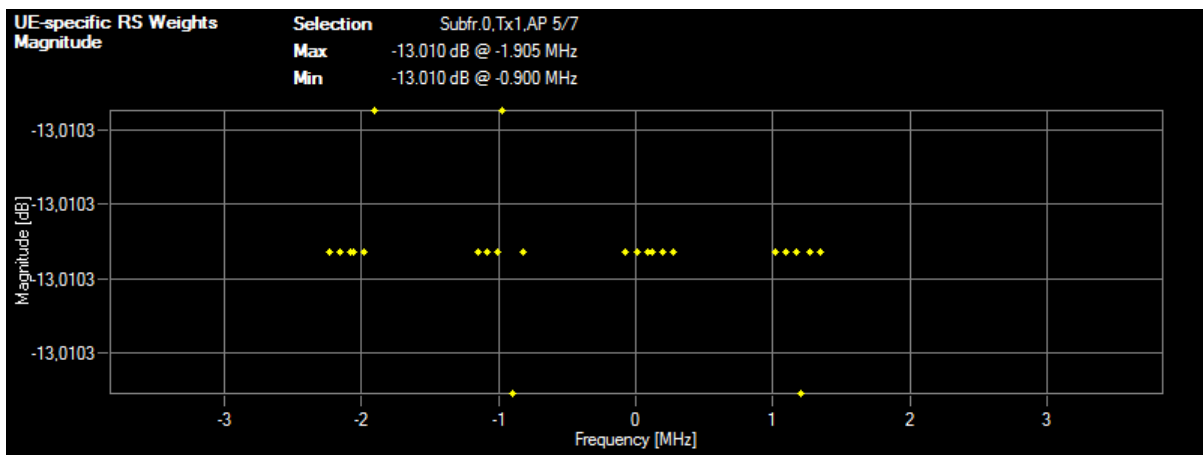
Starts the UE-Specific RS Weights Magnitude result display.

This measurement shows the magnitude of the measured weights of the reference signal (RS) carriers specific to the user equipment (UE). This measurement can be used to calculate the relative magnitude difference between different antenna ports. You can select the antenna port to be measured via the [Beamforming Selection](#) softkey.

Note that you can only make an antenna port selection if the UE-specific RS weights magnitude measurement is selected.

The measurement is evaluated over the currently selected subframe. The currently selected subframe depends on your selection. Note that this measurement is not available if the subframe selection is set to all.

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



SCPI command:

```
CALCulate<screenid>:FEED 'BEAM:URWM'
TRACe:DATA?
```

UE Specific RS Weights (Phase)

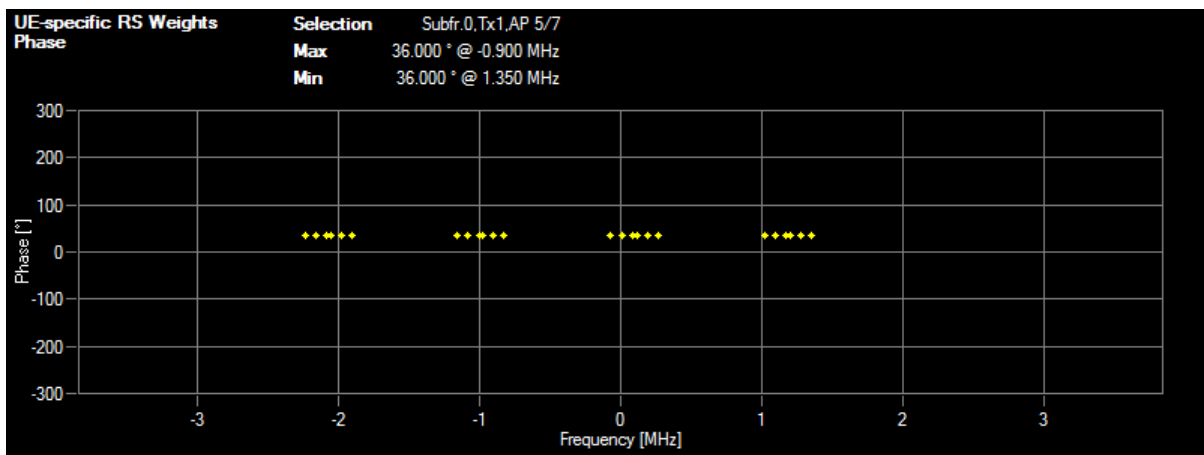
Starts the UE-specific RS Weights Phase result display.

This measurement shows the phase of the measured weights of the reference signal (RS) carriers specific to the user equipment (UE). This measurement can be used to calculate the relative phase difference between different antenna ports. You can select the antenna port to be measured via the [Beamforming Selection](#) softkey.

Note that you can only make an antenna port selection if the UE-specific RS weights phase measurement is selected.

The measurement is evaluated over the currently selected subframe. The currently selected subframe depends on your selection. Note that this measurement is not available if the subframe selection is set to all.

The x-axis represents the frequency. On the y-axis, the weights phase is plotted in degree.



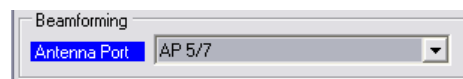
SCPI command:

[CALCulate<screenid>:FEED 'BEAM:URWP'](#)
[TRACe:DATA?](#)

Beamforming Selection

Filters the displayed results by the antenna port.

The availability of antenna ports depends on the number of transmission antennas and the number of beamforming layers you are testing.



SCPI command:

[CONFigure\[:LTE\]:DL:BF:AP](#) on page 121

4 General Settings

The following chapter contains all settings that are available in the "General Settings" dialog box.

4.1 Configuring the Measurement

The general settings contain various settings that configure the general measurement setup.

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

4.1.1 Defining General Signal Characteristics

The general signal characteristics contain settings to describe the general physical attributes of the signal.

The signal characteristics are part of the "General Settings" tab of the "General Settings" dialog box.

Signal Characteristics	
Standard	3GPP LTE
Duplexing	TDD
Link Direction	Downlink
Frequency	1 GHz

Selecting the LTE Mode

The LTE mode is a combination of the "Standard" (always 3GPP LTE), the "Duplexing" mode and the "Link Direction".

The choices you have depend on the configuration of the analyzer.

- option FSx-K100(PC) enables testing of 3GPP LTE FDD signals on the downlink
- option FSx-K101(PC) enables testing of 3GPP LTE FDD signals on the uplink
- option FSx-K102(PC) enables testing of 3GPP LTE MIMO signals on the downlink
- option FSx-K104(PC) enables testing of 3GPP LTE TDD signals on the downlink
- option FSx-K105(PC) enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are **duplexing** methods.

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

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

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

The software shows the currently selected LTE mode (including the bandwidth) in the header table.

Freq 1 GHz	CP/Cell ID E
Mode UL TDD, 10 MHz	Sync State -

SCPI command:

[CONFigure\[:LTE\]:LDIRection](#) on page 149

[CONFigure\[:LTE\]:DUPLexing](#) on page 149

Defining the Signal Frequency

For measurements with an RF input source, you have to match the **center frequency** of the analyzer to the frequency of the signal.

The software shows the current center frequency in the header table.

Freq 1 GHz	CP/Cell ID E
Mode UL TDD, 10 MHz	Sync State -

The available frequency range depends on the hardware configuration of the analyzer you are using.

The frequency setting is available for the RF input source.

SCPI command:

Center frequency:

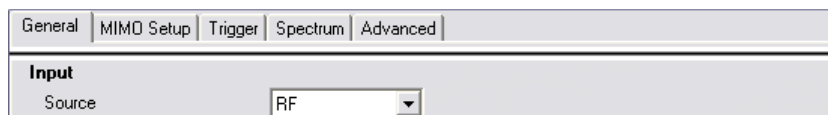
[\[SENSe\]:FREquency:CENTer](#) on page 149

4.1.2 Configuring the Input

The input settings control the basic configuration of the input.

The input source selection is part of the "General Settings" tab of the "General Settings" dialog box.

For more information on advanced input configuration see [chapter 4.5, "Advanced Settings"](#), on page 65.



Selecting the Input Source

The input source selects the source of the data you'd like to analyze. You can either analyze a live signal or a signal that has been recorded previously and whose characteristics have been saved to a file.

You can select the input source from the "Source" dropdown menu.

- RF
Captures and analyzes the data from the RF input of the spectrum analyzer in use.
- Baseband (BB)
Captures and analyzes the data from the baseband input of the spectrum analyzer in use.
Note that you have to use an analyzer that supports analog baseband input if you select that input source.
- Digital I/Q

Captures and analyzes the data from the digital baseband input of the spectrum analyzer in use.

Note that you have to use an analyzer that supports digital baseband input if you select that input source.

- **File**
Analyzes data that has been recorded already and has been saved to a file. If selected, the software asks you to select a file from a dialog box after you have initiated a measurement. If the file contents are not valid or the file could not be found, the software shows an error message.
A connection to an analyzer or a dongle is required to successfully load a file.
For more information see [chapter 7.1, "Importing and Exporting I/Q Data"](#), on page 96.

SCPI command:

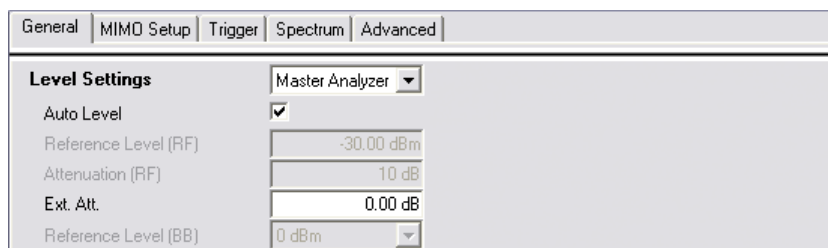
[SENSe:INPut](#) on page 150

4.1.3 Configuring the Input Level

The level settings contain settings that control the input level of any analyzer in the measurement setup.

You can control the input level for any of the four possible analyzers in the measurement setup separately by selecting one of the analyzers from the dropdown menu next to the "Level Settings" label.

The level settings are part of the "General Settings" tab of the "General Settings" dialog box.



Defining a Reference Level

The reference level is the power level the analyzer expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power in case of signals with a high crest factor like LTE.

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

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

You can either specify the **RF Reference Level** (in dBm) or **Baseband Reference Level** (in V), depending on the [input source](#).

You can also use **automatic detection** of the reference level with the "Auto Level" function.

If active, the application measures and sets the reference level to its ideal value before each sweep. This process slightly increases the measurement time. You can define the measurement time of that measurement with the **Auto Level Track Time**.

Automatic level detection also optimizes RF attenuation.

Automatic level detection is available for an RF input source.

The software shows the current reference level of the master analyzer (including RF and external attenuation) in the header table.

Master Ref Level	-20.00 dBm, 15 dB (10 dB)
Capture Time/Frame	20.10 ms/-

SCPI command:

Manual (RF):

`CONFigure:POWer:EXPeCted:RF<analyzer>` on page 150

Manual (BB):

`CONFigure:POWer:EXPeCted:IQ<analyzer>` on page 151

Automatic:

`[SENSe]:POWer:AUTO<analyzer>[:STATe]` on page 150

Auto Level Track Time:

`[SENSe]:POWer:AUTO<analyzer>:TIME` on page 160

Attenuating the Signal

Attenuation of the signal may become necessary if you have to reduce the power of the signal that you have applied. Power reduction is necessary, for example, to prevent an overload of the input mixer.

You can attenuate the signal at the RF input of one of the analyzers in the measurement setup (mechanical or **RF attenuation**) or attenuate the signal externally (**external attenuation**).

If you attenuate or amplify the signal either way, the software adjusts the numeric and graphical results accordingly. In case of graphical power result displays, it moves the trace(s) vertically by the specified value.

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

The range of the RF attenuation depends on the hardware you are using in the measurement setup. For details refer to its data sheet. If the attenuation you have set is not supported by the hardware, the software corrects the attenuation and shows a corresponding message.

The software shows the RF and external attenuation level in the header table next to the reference level.

Master Ref Level	-20.00 dBm, 15 dB (10 dB)
Capture Time/Frame	20.10 ms/-

SCPI command:

RF attenuation:

[INPut<n>:ATTenuation<analyzer>](#) on page 151

External attenuation:

[DISPlay\[:WINDow<n>\]:TRACe<t>:Y\[:SCALE\]:RLEVEL:OFFSet](#) on page 151

4.1.4 Configuring the Data Capture

The data capture settings contain settings that control the amount of data and the way that the application records the LTE signal.

The data capture settings are part of the "General Settings" tab of the "General Settings" dialog box.

General	MIMO Setup	Trigger	Spectrum	Advanced
Data Capture Settings				
Capture Time		40.10 ms		
Overall Frame Count	<input checked="" type="checkbox"/>			
Num. of Frames to Analyze		1		
Auto Acc. to Standard	<input checked="" type="checkbox"/>			

Capture Time

Defines the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the application captures during one sweep.

By default, the application captures 20.1 ms of data to make sure that at least one complete LTE frame is captured in one sweep.

The software shows the current capture time (including the frame number) in the header table.

Master Ref Level	-20.00 dBm, 15 dB (10 dB)
Capture Time/Frame	20.10 ms/-

SCPI command:

[\[SENSe\]:SWEep:TIME](#) on page 151

Overall Frame Count

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

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

If the overall frame count is inactive, the analyzer analyzes all complete LTE frames currently in the capture buffer.

SCPI command:

[\[SENSe\]\[:LTE\]:FRAME:COUNT:STATE](#) on page 152

Number of Frames to Analyze

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

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

The parameter is read only if

- the overall frame count is inactive,
- the data is captured [according to the standard](#).

SCPI command:

[\[SENSe\] \[:LTE\] :FRAMe:COUNT](#) on page 152

Auto According to Standard

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

If active, the analyzer evaluates the number of frames as defined for EVM tests in the LTE standard.

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

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

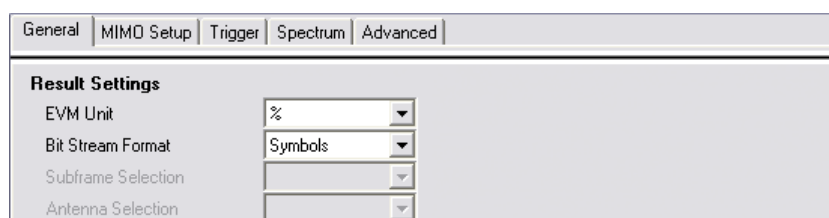
SCPI command:

[\[SENSe\] \[:LTE\] :FRAMe:COUNT:AUTO](#) on page 152

4.1.5 Configuring Measurement Results

The measurement result settings contain settings that define certain aspects of the results that are displayed.

The result settings are part of the "General Settings" tab of the "General Settings" dialog box.

**EVM Unit**

Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

SCPI command:

[UNIT:EVM](#) on page 153

Bit Stream Format

Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

Examples:

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

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

B Bit Stream		Subframe(s)	ALL	Bit Stream																
Sub-frame	Allocation ID	Code-word	Modulation	Bit Index																
0	PBCH	1/1	QPSK	0	1000000000100001000110000100111001010101100001101															
0	PBCH	1/1	QPSK	48	111010011011100100010100001010110100111111011001															
0	PBCH	1/1	QPSK	96	001001011011111100100110101001100110000000110001															
0	PBCH	1/1	QPSK	144	100101000110100101111111010001011000111010110010															

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

SCPI command:

[UNIT:BSTR](#) on page 153

Subframe Selection

Selects a particular subframe whose results the software displays.

You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, Channel Flatness, Channel Group Delay, Channel Flatness Difference, Constellation Diagram, Allocation Summary 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.

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

Example: Subframe selection

If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.



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

If you select a specific subframe, the application shows one trace. This trace contains the results for that subframe only.



SCPI command:

[\[SENSe\] \[:LTE\]:SUBFrame:SElect](#) on page 153

Antenna Selection

Selects the antenna you want to display the results for.

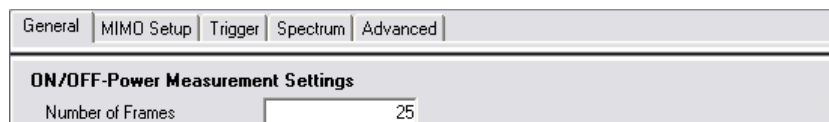
SCPI command:

[\[SENSe\] \[:LTE\]:ANTenna:SElect](#) on page 153

4.1.6 Configuring On/Off Power Measurements

The On/Off Power measurement settings contain settings that define certain aspects of those measurements.

The On/Off Power measurement settings are part of the "General Settings" tab of the "General Settings" dialog box.

**Number of Frames**

Defines the number of frames that are averaged to calculate a reliable power trace for On/Off Power measurements.

SCPI command:

[CONFigure\[:LTE\]:OOPower:NFRames](#) on page 154

Noise Correction

Turns noise correction for On/Off Power measurements on and off.

For more information see the manual of the analyzer.

SCPI command:

[\[SENSe\] \[:LTE\] :OOPower:NCORrection](#) on page 154

4.2 Configuring MIMO Measurement Setups

The MIMO analyzer configuration contains settings that configure the analyzers in a MIMO measurement setup.

The MIMO analyzer configuration is part of the "General Settings" tab of the "General Settings" dialog box.

For more information on the "MIMO Configuration" see ["MIMO Configuration"](#) on page 79. The parameters are the same as in the "Downlink Signal Characteristics" - if you change them in one place, they are also changed in the other.

	Nr	State	VISA RSC	Antenna Assignment
▶	1	Master	TCPIP::localhost::INSTR	Antenna 1 (2, 3, 4)
	2		555	Antenna 2
	3			Antenna 3
	4			Antenna 4

MIMO Analyzer Configuration

In case you perform measurements on a MIMO measurement setup, you can configure the connection of each analyzer in that setup.

The analyzer configuration table is made up of four columns and four rows. Each row represents one analyzer. The columns show the tasks for the analyzers.

- **Nr**
Shows the number of the analyzer.
- **State**
Shows if the analyzer is master or slave. Analyzer number 1 is always the master analyzer.
- **VISA RSC**
Button that opens a dialog box to configure the analyzer connection in the network (see below).
- **Antenna Assignment**
Shows the antenna that the analyzer measures.

Instrument Connection Configuration

The "Instrument Connection Configuration" dialog box contains functionality that is necessary to successfully establish a connection in a network of analyzers. The dialog box contains several elements.

- **Interface Type**
Selects the interface. You have to connect the analyzer via LAN interface or the IEEE bus (GPIB).
- **Number**
Number of the interface if the PC has more than one interfaces (e.g. several LAN cards).
- **Address**
Shows the instrument address. The type of content depends on the interface type.
 - **GPIB Address**
Primary GPIB address of the analyzer. Possible values are in the range from 0 to 31.
The default GPIB address for an R&S analyzer is 20.
Available for IEEE bus systems using the IEEE 488 protocol. The interface type is GPIB.
 - **IP Address or Computer Name**
Name or host address (TCP/IP) of the computer.
Available for LAN bus systems using either the VXI-11 protocol or a Rohde&Schwarz specific protocol (RSIB). The interface type is either LAN (VXI-11) or LAN (RSIB).
Contact your local IT support for information on free IP addresses.
The RSIB protocol is supported by all firmware version of the R&S analyzers.
The VXI-11 protocol is supported as of R&S FSQ firmware version 3.65 and by all firmware version of the R&S FSV(R) and R&S FSG.
 - **Complete VISA Resource String**
Allows to enter the complete VISA string manually.
Available for interface type "Free Entry".
- **Subsystem**
Shows the subsystem in use. Typically you do not have to change the subsystem.
- **VISA RSC**
Shows the complete VISA resource string.
- **Test Connection**
Button that tests the connection. If the connection has been established successfully, the software returns a PASSED message. If not, it shows a FAILED message.

SCPI command:

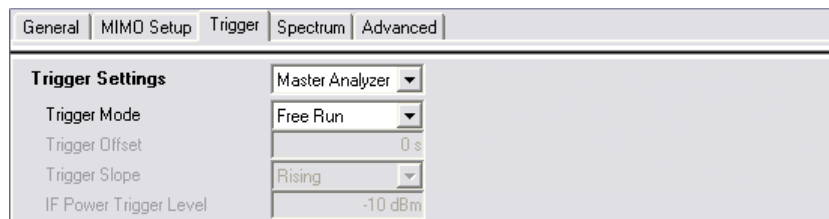
[CONFigure:ADDRess<analyzer>](#) on page 154

4.3 Triggering Measurements

The trigger settings contain settings that control triggered measurements.

You can select a trigger for any of the four possible analyzers in the measurement setup separately by selecting one of the analyzers from the dropdown menu next to the "Trigger Settings" label.

The trigger settings are part of the "General Settings" tab of the "General Settings" dialog box.



Configuring the Trigger

A trigger allows you to capture those parts of the signal that you are really interested in.

While the analyzer runs freely and analyzes all signal data in its default state, no matter if the signal contains information or not, a trigger initiates a measurement only under certain circumstances (the trigger event).

The analyzer supports several **trigger modes** or sources.

- Free Run
Starts the measurement immediately and measures continuously.
- External
The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/Gate" input.
- IF Power
The trigger event is the IF power level. The measurement starts when the IF power meets or exceeds a specified power trigger level.
- Trigger Unit FS-Z11
The R&S FS-Z11 is a trigger unit designed to control triggers in MIMO measurement setups.
For more information see [chapter 8.4.1.2, "Performing MIMO Measurements with a Trigger Unit"](#), on page 109 and the documentation of the R&S FS-Z11.

You can define a **power level** for an external and an IF power trigger.

For most trigger sources you can select the **trigger slope**. The trigger slope defines whether triggering occurs when the signal rises to the trigger level or falls down to it.

The measurement starts as soon as the trigger event happens. It may become necessary to start the measurement some time after the trigger event. In that case, define a **trigger offset** (or trigger delay). The trigger offset is the time that should pass between the trigger event and the start of the measurement.

The trigger offset may be a negative time. The trigger offset is then called a **pretrigger**.

The trigger offset is available for all trigger modes, except free run.

SCPI command:

Trigger mode:

`TRIGger [:SEQuence] :MODE` on page 155

Trigger level:

`TRIGger [:SEQuence] :LEVel<analyzer> [:EXTernal]` on page 156

`TRIGger [:SEQuence] :LEVel<analyzer> :POWer` on page 156

Trigger slope:

`TRIGger [:SEQuence] :SLOPe` on page 156

Trigger offset:

`TRIGger [:SEQuence] :HOLDoFF<analyzer>` on page 155

4.4 Spectrum Settings

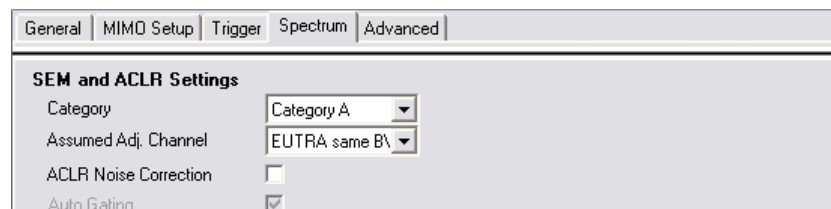
The spectrum settings contain settings to configure frequency sweep measurements (ACLR and SEM).

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

4.4.1 Configuring SEM and ACLR Measurements

The SEM (Spectrum Emission Mask) and ACLR (Adjacent Channel Leakage Ratio) settings contain settings that define aspects of those measurements.

The SEM and ACLR settings are part of the "General Settings" tab of the "General Settings" dialog box.



Category

Selects the type, category and option of the limit definitions for SEM measurements.

The software supports limit definitions for the following types of base stations:

- Wide Area base stations
- Local Area base stations
- Home base stations

For Wide Area base stations, several limit definitions are provided.

Category A and B are defined in ITU-R recommendation SM.329. For Category B operating band unwanted emissions, there are two options for the limits that may be applied regionally (Opt1 and Opt2).

The type and category you should use for the measurement depends on the category and option that the base station you are testing supports.

SCPI command:

[\[SENSe\]:POWer:SEM:CATegory](#) on page 157

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 157

Noise Correction

Turns noise correction on and off.

For more information see the manual of the analyzer.

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

SCPI command:

[\[SENSe\]:POWer:NCORrection](#) on page 157

Auto Gating

Turns gating for SEM and ACLR measurements on and off.

If on, the software evaluates the on-periods of an LTE TDD signal only. The software determines the location and length of the on-period from the "TDD UL/DL Allocations" and the "Configuration of the Special Subframe".

Auto gating is available for TDD measurements in combination with an external or IF power trigger.

If you are using an external trigger, the DUT has to send an LTE frame trigger.

SCPI command:

[\[SENSe\]:SWEep:EGATe:AUTO](#) on page 158

4.5 Advanced Settings

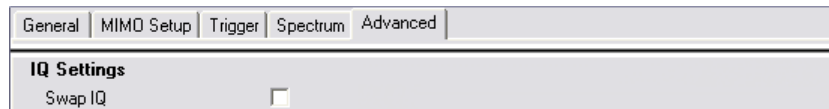
The advanced settings contain settings to configure the signal input and some global measurement analysis settings.

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

4.5.1 Controlling I/Q Data

The I/Q settings contain settings that control the I/Q data flow.

The I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



Swap I/Q

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

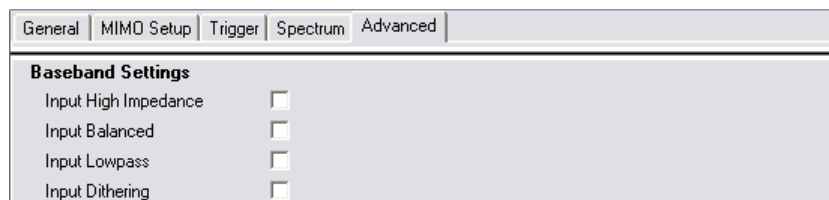
SCPI command:

[\[SENSe\]:SWAPiQ](#) on page 158

4.5.2 Configuring the Baseband Input

The baseband settings contain settings that configure the baseband input.

The baseband settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



High Impedance

Selects the impedance of the baseband input.

By default (high impedance is off), the impedance is 50 Ω.

If you turn the high impedance on, the impedance changes to 1 kΩ or 1 MΩ, depending on the configuration of the analyzer.

High impedance is available for a baseband input source.

SCPI command:

[INPut:IQ:IMPedance](#) on page 159

Balanced

Turns symmetric (or balanced) input on and off.

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

Balancing is available for a baseband input source.

SCPI command:

[INPut:IQ:BALanced\[:STATe\]](#) on page 159

Low Pass

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

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

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

The low pass filter is available for a baseband input source.

SCPI command:

[\[SENSe\]:IQ:LPASs\[:STATe\]](#) on page 159

Dither

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

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

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

Dithering is available for a baseband input source.

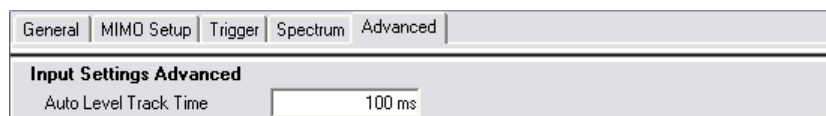
SCPI command:

[\[SENSe\]:IQ:DITHer\[:STATe\]](#) on page 159

4.5.3 Using Advanced Input Settings

The advanced input settings contain settings that configure the RF input.

The advanced input settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.

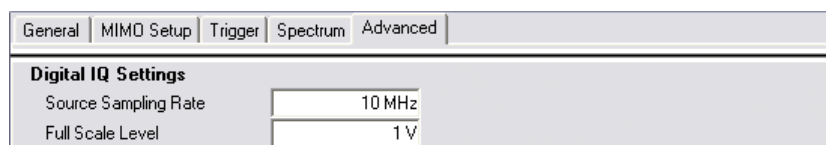


For more information see ["Defining a Reference Level"](#) on page 55.

4.5.4 Configuring the Digital I/Q Input

The digital I/Q settings contain settings that configure the digital I/Q input.

The digital I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



Sampling Rate (Input Data Rate)

Defines the data sample rate at the digital baseband input.

The sample rate is available for a digital baseband input source.

SCPI command:

[INPut<n>:DIQ:SRATe](#) on page 160

Full Scale Level

Defines the voltage corresponding to the maximum input value of the digital baseband input.

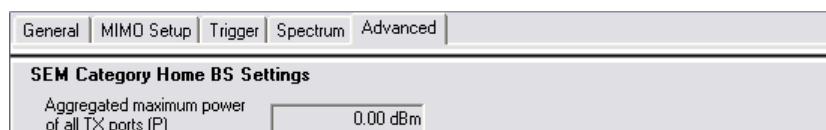
SCPI command:

[INPut<n>:DIQ:RANGe\[:UPPer\]](#) on page 160

4.5.5 Configuring Home Base Station Tests

The home base station settings contain settings that configure spectrum emission mask measurements for home base stations.

The SEM category Home BS settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



Aggregated Maximum Power Of All TX Ports (P)

Defines the aggregated maximum power of all TX ports of home base stations. The aggregate maximum power is required to calculate limit line values for SEM measurements on home base stations.

The parameter is available only if you have selected [SEM Category](#) "Home".

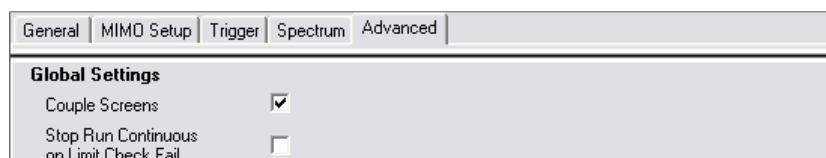
SCPI command:

[\[SENSe\]:POWER:SEM:CHBS:AMPower](#) on page 160

4.5.6 Global Settings

The global settings contain settings that are independent of other settings.

The global settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.



Couple Screens

Couples and decouples markers that have the same x-axis unit in the top and bottom result displays (e.g. both result displays have a frequency axis).

In case of the constellation diagram, the constellation selection is also coupled to the marker.

Stop Run Continuous On Limit Check Fail

Stops a continuous measurement if the signal fails any limit check in the currently active result display.

For example, the measurement would stop on an EVM PDSCH QPSK limit check fail if the result summary is active.

5 Demod Settings

The following chapter contains all settings that are available in the "Demodulation Settings" dialog box.

5.1 Configuring Downlink Signal Demodulation

The downlink demodulation settings contain settings that describe the signal processing and the way the signal is measured.

You can find the demodulation settings in the "Demod Settings" dialog box.

5.1.1 Selecting the Demodulation Method

The PDSCH demodulation settings contain settings that describe the way the PDSCH is demodulated during measurements.

The demodulation settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.



Auto PDSCH Demodulation

Turns automatic demodulation of the PDSCH on and off.

Turn on automatic PDSCH demodulation for automatic detection of the PDSCH resource allocation. The application is able to detect the PDSCH resource allocation by analyzing the protocol information in the PDCCH or by analyzing the physical signal. It then writes the results into the [PDSCH Configuration Table](#).

You can set the way the analyzer identifies the PDSCH resource allocation with "[PDSCH Subframe Configuration Detection](#)" on page 70.

If the automatic demodulation of the PDSCH is off, you have to configure the PDSCH manually. In that case, the application compares the demodulated LTE frame to the customized configuration. The application analyzes the frame only if both configurations are the same.

SCPI command:

[\[SENSe\] \[:LTE\]:DL:DEMod:AUTO](#) on page 161

PDSCH Subframe Configuration Detection

Selects the method of identifying the PDSCH resource allocation.

- Off
Uses the user configuration to demodulate the PDSCH subframe. If the user configuration does not match the frame that was measured, a bad EVM will result.

- PDCCH protocol
Sets the PDSCH configuration according to the data in the protocol of the PDCCH DCIs.
- Physical detection
Physical detection makes measurements on TDD E-TMs without a 20 ms trigger signal possible.

The "PDSCH Subframe Configuration Detection" is not available if you have turned on [Auto PDSCH Demodulation](#).

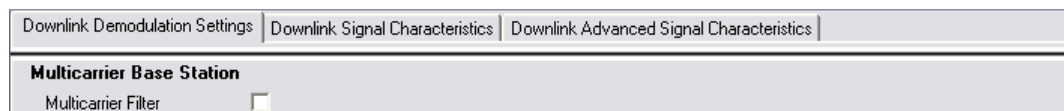
SCPI command:

[\[SENSe\] \[:LTE\] :DL:FORMat:PSCD](#) on page 161

5.1.2 Configuring Multicarrier Base Stations

The multicarrier base station settings contain settings to configure measurements on multicarrier base stations.

The multicarrier base station settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.



Multicarrier Filter

Turns the suppression of interference of neighboring carriers for tests on multiradio base stations on and off (e.g. LTE, WCDMA, GSM etc).

SCPI command:

[\[SENSe\] \[:LTE\] :DL:DEMod:MCFilter](#) on page 162

5.1.3 Configuring Parameter Estimation

The parameter estimation settings contain settings that estimate various parameters during the measurement.

The parameter estimation settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.



Boosting Estimation

Turns boosting estimation on and off.

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

SCPI command:

[\[SENSe\] \[:LTE\]:DL:DEMod:BEStimation](#) on page 162

Channel Estimation

Selects the method of channel estimation.

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

SCPI command:

[\[SENSe\] \[:LTE\]:DL:DEMod:CEStimation](#) on page 163

5.1.4 Compensating Signal Errors

The tracking settings contain settings that compensate for various common signal errors that may occur.

The tracking settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.



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 for the estimation of the phase error.
- "Pilot and Payload" Both reference signal and payload resource elements are used for the estimation of the phase error.

SCPI command:

[\[SENSe\] \[:LTE\]:DL:TRACking:PHASe](#) on page 163

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 163

5.1.5 Configuring EVM Measurements

The demodulation EVM settings contain settings that control the way the software calculates EVM results.

The demodulation EVM settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.

Downlink Demodulation Settings	Downlink Signal Characteristics	Downlink Advanced Signal Characteristics
EVM		
EVM Calculation Method	EVM 3GPP Definition	
PDSCH Reference Data	Auto Detect	

EVM Calculation Method

Selects the method to calculate the EVM.

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

SCPI command:

[\[SENSe\] \[:LTE\] :DL:DEMod:EVMCalc](#) on page 164

PDSCH Reference Data

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

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

SCPI command:

[\[SENSe\] \[:LTE\] :DL:DEMod:PRData](#) on page 164

5.1.6 Processing Demodulated Data

The demodulated data settings contain settings that control the way the software handles demodulated data.

The demodulated data settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.



Scrambling of Coded Bits

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

The scrambling of coded bits affects the bitstream results.

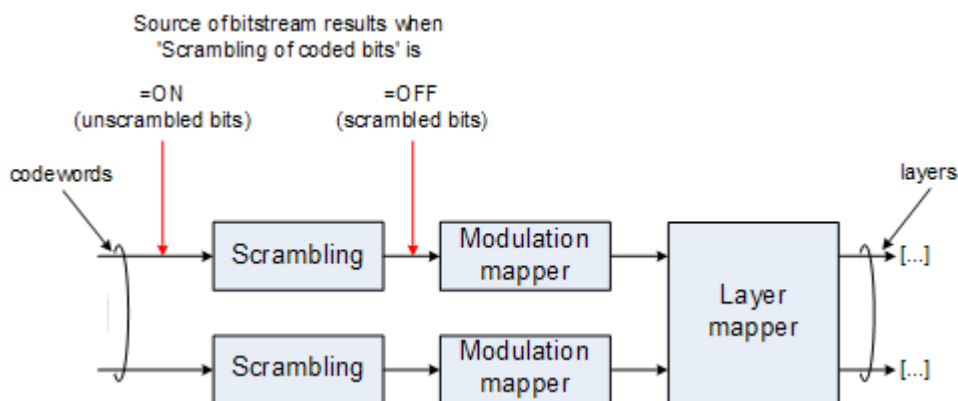


Fig. 5-1: Source for bitstream results if scrambling for coded bits is on and off

SCPI command:

[\[SENSe\] \[:LTE\]:DL:DEMod:CBSCrambling](#) on page 164

Decode All Control Channels

Turns the decoding of all control channels on and off.

If on, the software shows the decoding results in the "Channel Decoder Results" result display.

If off,

- the PBCH is decoded only if the [PHICH Duration](#) or the [PHICH N_g](#) are automatically determined
- the PDCCH is decoded only if the [PDSCH Subframe Configuration Detection](#) is set to PDCCH protocol.

If decoding of all control channels is off, measurement speed will increase.

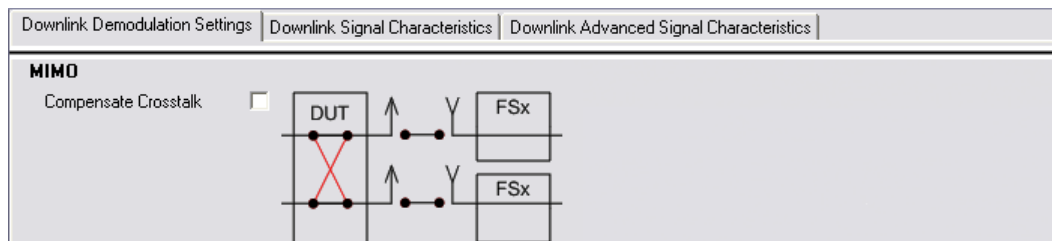
SCPI command:

[\[SENSe\] \[:LTE\]:DL:DEMod:DACHannels](#) on page 165

5.1.7 Configuring MIMO Setups

The MIMO settings contain settings that configure MIMO measurement setups.

The MIMO settings are part of the "Downlink Demodulation Settings" tab of the "Demodulation Settings" dialog box.



Compensate Crosstalk

Specifies if crosstalk produced by the device under test or over-the-air measurements will be compensated or not.

The crosstalk compensation must be activated for Time Alignment Error measurements. For more information see [chapter 8.5, "Performing Time Alignment Measurements"](#), on page 110.

SCPI command:

`CONFigure[:LTE]:DL:MIMO:CROSstalk` on page 165

5.2 Defining Downlink Signal Characteristics

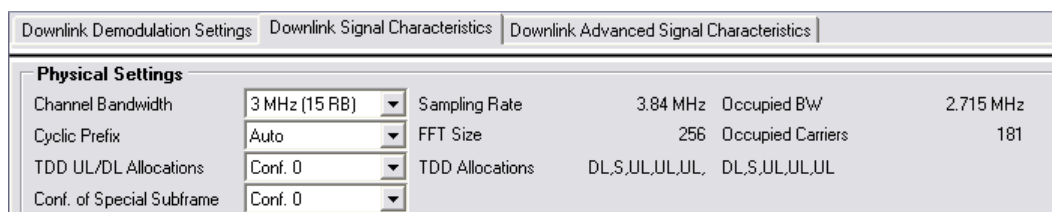
The downlink signal characteristics contain settings to describe the physical attributes and structure of a downlink LTE signal.

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

5.2.1 Defining the Physical Signal Characteristics

The physical signal characteristics contain settings to describe the physical attributes of a downlink LTE signal.

The physical settings are part of the "Downlink Signal Characteristics" tab of the "Demodulation Settings" dialog box.



Channel Bandwidth / Number of Resource Blocks

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

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

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

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

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

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

The software shows the currently selected LTE mode (including the bandwidth) in the header table.

Freq	1 GHz	CP/Cell ID	E
Mode	UL TDD, 10 MHz	Sync State	-

SCPI command:

[CONFigure\[:LTE\]:DL:BW](#) on page 165

[CONFigure\[:LTE\]:DL:NORB](#) on page 166

Cyclic Prefix

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

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

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

The software shows the currently selected cyclic prefix in the header table.

CP/Cell ID	Extended/Cell ID 190	Mag	
Sync State	---	Cap	

SCPI command:

[CONFigure\[:LTE\]:DL:CYCPrefix](#) on page 166

Configuring TDD Frames

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

TDD UL/DL Allocations

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

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

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

U = uplink

D = downlink

S = special subframe

Conf. of Special Subframe

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

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

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

SCPI command:

Subframe

[CONFigure\[:LTE\]:DL:TDD:UDConf](#) on page 166

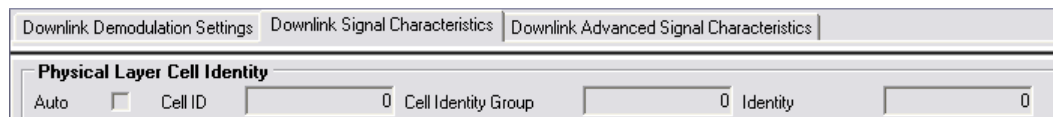
Special Subframe

[CONFigure\[:LTE\]:DL:TDD:SPSC](#) on page 166

5.2.2 Configuring the Physical Layer Cell Identity

The physical signal characteristics contain settings to describe the physical attributes of a downlink LTE signal.

The physical settings are part of the "Downlink Signal Characteristics" tab of the "Demodulation Settings" dialog box.



Configuring the Physical Layer Cell Identity

The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

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

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

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

$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the analyzer automatically updates the other two.

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

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

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

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

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

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

The software shows the currently selected cell ID in the header table.

CP/Cell ID	Extended/Cell ID 190	Ma
Sync State	---	Cap

SCPI command:

Cell ID:

[CONFigure\[:LTE\]:DL:PLC:CID](#) on page 167

Cell Identity Group:

[CONFigure\[:LTE\]:DL:PLC:CIDGroup](#) on page 167

[FETCh:PLC:CIDGroup?](#) on page 168

Identity

[CONFigure\[:LTE\]:DL:PLC:PLID](#) on page 168

[FETCh:PLC:PLID?](#) on page 168

5.2.3 Configuring MIMO Setups

The MIMO Configuration contains settings to configure MIMO test setups.

[MIMO Configuration](#).....79

MIMO Configuration

Selects the antenna configuration and test conditions for a MIMO system.

The MIMO **configuration** selects the number of transmit antennas in the system. 1-, 2-, and 4-antenna configurations are possible.

In setups with multiple antennas, **antenna selection** defines the antenna(s) you'd like to test. You can select the antenna(s) to test manually ("Antenna 1...4" and "All" menu items) or let the application decide which antenna to test ("Auto x Antenna" menu items).

In case of automatic detection the application analyzes the reference signal to select the antenna. It also determines the order in which the antennas are tested in.

Antenna 1	Tests antenna 1 only.
Antenna 2	Tests antenna 2 only.
Antenna 3	Tests antenna 3 only.
Antenna 4	Tests antenna 4 only.
All	Tests all antennas in the test setup in consecutive order (1-2-3-4). A corresponding number of analyzers is required.
Auto (1 antenna)	Automatically selects the antenna to test.
Auto (2 antennas)	Automatically selects the antennas to test in a test setup with two or four antennas. Requires 2 analyzers.
Auto (4 antennas)	Automatically selects the order in which the antennas are tested in. Available for 4-antenna configurations. Requires 4 analyzers.

For more information on MIMO measurements see [chapter 8.4, "MIMO Measurement Guide"](#), on page 106.

Note that the parameters are the same as in the "MIMO Settings" tab - if you change them in one place, they are also changed in the other.

SCPI command:

MIMO configuration

`CONFigure[:LTE]:DL:MIMO:CONFig` on page 168

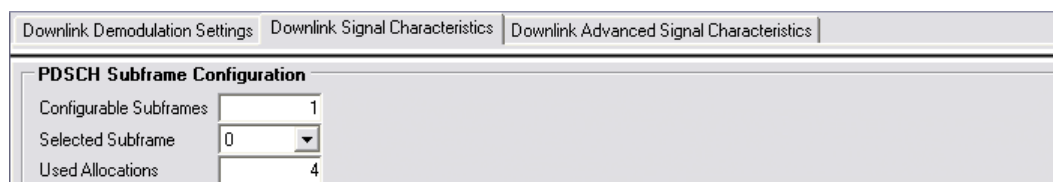
Antenna selection:

`CONFigure[:LTE]:DL:MIMO:ASElection` on page 169

5.2.4 Configuring PDSCH Subframes

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

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




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

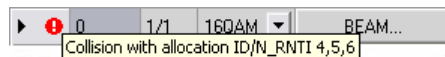
	ID / N_RNTI	Code Word	Modulation	Enhanced Settings	VRB Gap	Number of RB	Offset RB	Rho A (Power)/dB
▶	0	1/1	16QAM	...	0	4	6	0
	1	1/1	16QAM	...	0	2	10	0
	2	1/1	16QAM	...	0	4	0	0
	3	1/1	16QAM	...	0	2	4	0



Subframe configuration errors

If there are any errors or conflicts between allocations in one or more subframes, the application shows a  icon in the column at the left of the table.

When you move the mouse over the icon, the application shows the kind of error.



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


Then you can select a particular subframe that you want to customize in the "Selected Subframe" field. Enter the number of the subframe (starting with 0). The application updates the contents of the configuration table to the selected subframe.


Configuring PDSCH Allocations	81
Selecting the Precoding Scheme	83

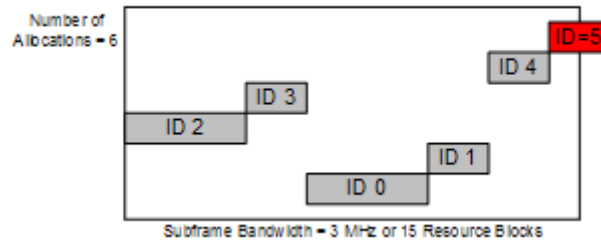
Configuring PDSCH Allocations

In the default state, each subframe contains one allocation. Add allocations with the "Used Allocations" parameter. The application expands the configuration table accordingly with one row representing one allocation. You can define a different number of allocations for each subframe you want to configure and configure up to 110 allocations in every subframe.

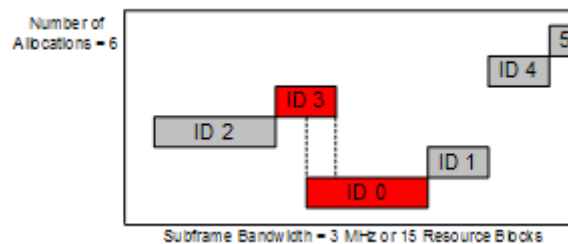
The configuration table contains the settings to configure the allocations.

- **ID/N_RNTI**
Selects the allocation's ID. The ID corresponds to the N_RNTI.
By default, the application assigns consecutive numbers starting with 0.
The ID, or N_RNTI, is the user equipment identifier for the corresponding allocation and is a number in the range from 0 to 65535. The order of the numbers is irrelevant. You can combine allocations by assigning the same number more than once. Combining allocations assigns those allocations to the same user. Allocations with the same N_RNTI share the same modulation scheme and power settings.
- **Code Word**
Shows the code word of the allocation.
The code word is made up out of two numbers. The first number is the number of the code word in the allocation. The second number is the total number of code words that the allocation includes. Thus, a table entry of "1/2" would mean that the row corresponds to code word 1 out of 2 code words in the allocation.
Usually one allocation corresponds to one code word. In case of measurements on a MIMO system (2 or 4 antennas) in combination with the "Spatial Multiplexing" precoding value, however, you can change the number of layers. Selecting 2 or more layers assigns two code words to the allocation. This results in an expansion of the configuration table. The allocation with the spatial multiplexing then comprises two rows instead of only one. Except for the modulation of the code word, which can be different, the contents of the second code word (row) are the same as the contents of the first code word.
- **Modulation**
Selects the modulation scheme for the corresponding allocation.
The modulation scheme for the PDSCH is either QPSK, 16QAM or 64QAM.
- **Enhanced Settings**
For more information see "[Selecting the Precoding Scheme](#)" on page 83.
- **Number of RB**
Defines the number of resource blocks the allocation covers. The number of resource blocks defines the size or bandwidth of the allocation.
If you allocate too many resource blocks compared to the bandwidth you have set, the application will show a  icon in the column at the left of the table.
- **Offset RB**
Sets the resource block at which the allocation begins.
A wrong offset for any allocation would lead to an overlap of allocations. In that case the application will show an error message.

- Power [dB]
Sets the boosting of the allocation. Boosting is the allocation's power relative to the reference signal power.
- Conflict
Move the mouse over the  icon to see details on the conflict. Possible conflicts are:
 - Allocation exceeds available bandwidth
A bandwidth error occurs when the number of resource blocks in the subframe exceeds the bandwidth you have set.



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



SCPI command:

Configurable Subframes:

[CONFigure\[:LTE\]:DL:CSUBframes](#) on page 170

Used Allocations:

[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALCount](#) on page 170

Modulation:

[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALLoc<allocation>\[:CW<Cwnum>\]:MODulation](#) on page 170

Number of RB:

[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount](#) on page 171

Offset RB:

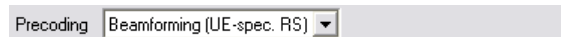
[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOffset](#) on page 171

Power:

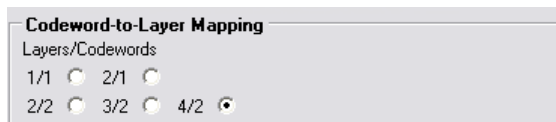
[CONFigure\[:LTE\]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWER](#) on page 171

Selecting the Precoding Scheme

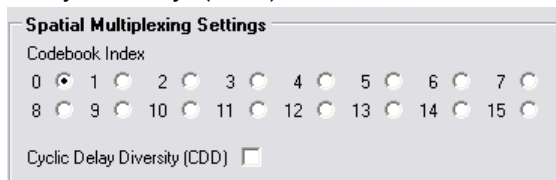
The "Enhanced Settings" contain the functionality to configure the precoding scheme of a physical channel. The analyzer supports several precoding schemes that you can select from a dropdown menu.



- None
Turns off precoding.
- Transmit Diversity
Turns on precoding for transmit diversity according to 3GPP TS 36.211.
- Spatial Multiplexing
Turns on precoding for spatial multiplexing according to 3GPP TS 36.211.
If you are using spatial multiplexing, you can also define the number of layers for any allocation and the codebook index.
The number of layers of an allocation in combination with the number of code words determines the layer mapping. The available number of layers depends on the number of transmission antennas. Thus, the maximum number of layers you can select is four.



The codebook index determines the precoding matrix. The available number of indices depends on the number of transmission antennas in use. The range is from 0 to 15. The analyzer automatically selects the codebook index if you turn the "Cyclic Delay Diversity" (CDD) on.



- Beamforming (UE Spec RS)
Turns on the precoding for beamforming.
If you are using beamforming, you can also define the number of layers and code-words (see "Spatial Multiplexing"), the scrambling identity and the single layer antenna port.
The mapping of antenna port to the physical antenna is fixed:
Port 5 and 7: Antenna 1
Port 8: Antenna 2
Port 9: Antenna 3
Port 10: Antenna 4



The scrambling identity (n_{SCID}) is available for antenna ports 7 and 8. It is used to initialize the sequence that generates UE specific reference signals according to 36.211 (section 6.10.3.1).

The single layer antenna port selects the preconfigured antenna port in single layer beamforming scenarios. Available if the codeword to layer mapping is "1/1".

SCPI command:

Precoding scheme:

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:
PRECoding[:SCHeme] on page 172

Layer mapping:

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:
PRECoding:CLMapping on page 172

Codebook index:

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:
PRECoding:CBIndex on page 172

Cyclic delay diversity:

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:
PRECoding:CDD on page 172

Scrambling identity:

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:
PRECoding:SCID on page 173

Single layer identity port:

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:
PRECoding:AP on page 171

5.3 Defining Advanced Signal Characteristics

The downlink advanced signal characteristics contain settings that describe the detailed structure of a downlink LTE signal.

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

5.3.1 Configuring the Synchronization Signal

The synchronization signal settings contain settings to describe the physical attributes and structure of the synchronization signal.

The synchronization signal settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.



P-/S-SYNC Tx Antenna

Selects the antenna that transmits the P-SYNC and the S-SYNC.

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

SCPI command:

[CONFigure\[:LTE\]:DL:SYNC:ANTenna](#) on page 173

P-SYNC Relative Power

Defines the power of the P-SYNC signals relative to the reference signal.

SCPI command:

[CONFigure\[:LTE\]:DL:SYNC:PPower](#) on page 174

S-SYNC Relative Power

Defines the power of the S-SYNC signals relative to the reference signal.

SCPI command:

[CONFigure\[:LTE\]:DL:SYNC:SPOwer](#) on page 174

5.3.2 Configuring the Reference Signal

The reference signal settings contain settings to describe the physical attributes and structure of the reference signal.

The reference signal settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.



Rel Power (Reference Signal)

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

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

SCPI command:

[CONFigure\[:LTE\]:DL:REFSig:POwer](#) on page 174

5.3.3 Configuring Positioning Reference Signals

The positioning reference signal settings contain settings to describe the physical attributes and structure of the positioning reference signal.

Positioning reference signals are used to estimate the position of the user equipment

Resource elements used by positioning reference signals are shown in blue color in the Allocation ID versus Symbol X Carrier measurement.

Note that PDSCH allocations will overwrite the positioning reference signal if they share a common resource block.

The positioning reference signal settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.

Positioning Reference Signals Settings					
Present	<input checked="" type="checkbox"/>	Configuration Index	<input type="text" value="0"/>	Rel. Power	<input type="text" value="0.000 dB"/>
Bandwidth	<input type="text" value="1.4 MHz (6 RB)"/>	Num. Subframes (N_PRS)	<input type="text" value="1"/>	Frame Number Offset	<input type="text" value="0"/>

Present

Turns the positioning reference signal on and off.

SCPI command:

[CONFigure\[:LTE\]:DL:PRSS:STATe](#) on page 175

Bandwidth

Defines the bandwidth and thus the number of resource blocks the positioning reference signal occupies.

Note that the PRS bandwidth has to be smaller than the channel bandwidth.

SCPI command:

[CONFigure\[:LTE\]:DL:PRSS:BW](#) on page 175

Configuration Index

Defines the PRS Configuration Index I_{PRS} as defined in 3GPP TS 36.211, table 6.10.4.3-1.

SCPI command:

[CONFigure\[:LTE\]:DL:PRSS:CI](#) on page 175

Num. Subframes (N_PRS)

Defines the number of consecutive DL subframes in that PRS are transmitted.

SCPI command:

[CONFigure\[:LTE\]:DL:PRSS:NPRS](#) on page 175

Relative Power (Positioning Reference Signal)

Defines the power of a PRS resource element in relation to the power of a common reference signal resource element.

SCPI command:

[CONFigure\[:LTE\]:DL:PRSS:POWer](#) on page 175

Frame Number Offset

Defines the system frame number of the current frame that you want to analyze.

Because the positioning reference signal and the CSI reference signal usually have a periodicity of several frames, for some reference signal configurations it is necessary to change the expected system frame number of the frame to be analyzed.

Note that if you define the frame number offset for either reference signal, it is automatically defined for both reference signals.

SCPI command:

[CONFigure\[:LTE\]:DL:SFNO](#) on page 176

5.3.4 Configuring Channel State Information Reference Signal

The channel state information reference signal (CSI-RS) settings contain settings to describe the physical attributes and structure of the Channel State Information Reference Signal (CSI-RS).

CSI-RS are used to estimate the channel properties of the signal propagation channel from the base station to the user equipment. This information is quantized and fed back to the base station. The base station makes use of this information for example to adjust the beamforming parameters.

The mapping of antenna port to the physical antenna is fix:

- Port 15: antenna 1
- Port 16: antenna 2
- Port 17: antenna 3
- Port 18: antenna 4

Resource elements used by CSI-RS are shown in yellow color in the Allocation ID versus Symbol X Carrier measurement.

The CSI-RS settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.

Downlink Demodulation Settings		Downlink Signal Characteristics		Downlink Advanced Signal Characteristics	
CSI Reference Signal					
Present	<input checked="" type="checkbox"/>	Configuration Index	<input type="text" value="0"/>	Rel. Power	<input type="text" value="0.000 dB"/>
Antenna Ports	<input type="text" value="1 Antenna Port"/>	Subframe Configuration	<input type="text" value="154"/>	Frame Number Offset	<input type="text" value="0"/>

Present

Turns the CSI reference signal on and off.

SCPI command:

[CONFigure\[:LTE\]:DL:CSIRs:STATe](#) on page 177

Antenna Ports

Defines the number of antenna ports that transmit the CSI reference signal.

The CSI reference signals are transmitted on one, two, four or eight antenna ports using

- $p = 15$
- $p = 15$ to 16
- $p = 15$ to 18
- $p = 15$ to 22

Note that the current software release supports a maximum number of 4 antennas.

SCPI command:

[CONFigure\[:LTE\]:DL:CSIRs:NAP](#) on page 176

Configuration Index

Defines the CSI reference signal configuration as defined in 3GPP TS 36.211, table 6.10.5.2-1/2

SCPI command:

`CONFigure[:LTE]:DL:CSIRs:CI` on page 176

Subframe Configuration

Defines the CSI reference signal subframe configuration index (I_CSI-RS) as defined in 3GPP TS 36.211, table 6.10.5.3-1.

SCPI command:

`CONFigure[:LTE]:DL:CSIRs:SCI` on page 177

Relative Power (CSI Reference Signal)

Defines the power of a CSI reference signal resource element in relation to the power of a common reference signal resource element.

SCPI command:

`CONFigure[:LTE]:DL:CSIRs:POWer` on page 177

Frame Number Offset

Defines the system frame number of the current frame that you want to analyze.

Because the positioning reference signal and the CSI reference signal usually have a periodicity of several frames, for some reference signal configurations it is necessary to change the expected system frame number of the frame to be analyzed.

Note that if you define the frame number offset for either reference signal, it is automatically defined for both reference signals.

SCPI command:

`CONFigure[:LTE]:DL:SFNO` on page 176

5.3.5 Defining the PDSCH Resource Block Symbol Offset

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 overwrites some resource elements of the PDSCH.

If Auto is selected, the Control Region for PDCCH (PRB Symbol Offset) value is detected from the PCFICH. For correct Demodulation of a 3GPP conform PCFICH signal, the Scrambling of Coded Bits has to be enabled.

SCPI command:

[CONFigure\[:LTE\]:DL:PSOffset](#) on page 181

5.3.6 Configuring the Control Channels

The control channel settings contain settings that describe the physical attributes and structure of the control channel.

The control channel settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.

Downlink Demodulation Settings				Downlink Signal Characteristics		Downlink Advanced Signal Characteristics	
Control Channel Settings							
PRB Symbol Offset (Control Region for PDCCH)	Auto (PCFICH)						
PBCH Present	<input checked="" type="checkbox"/>			PBCH Rel. Power		0.000 dB	
PCFICH Present	<input checked="" type="checkbox"/>			PCFICH Rel. Power		0.000 dB	
PHICH Duration	Auto (PBCH)	PHICH TDD m _i =1 (E-TM)	<input type="checkbox"/>				
PHICH N _g	Custom	PHICH Number of Groups	0	PHICH Rel. Power		-3.010 dB	
PDCCH Format	0	Number of PDCCHs	0	PDCCH Rel. Power		0.000 dB	

5.3.6.1 Configuring the PBCH

The physical broadcast channel (PBCH) carries system information for the user equipment. You can include or exclude the PBCH in the test setup and define the relative power of this channel.

PBCH Present

Includes or excludes the PBCH from the test setup.

SCPI command:

[CONFigure\[:LTE\]:DL:PBCH:STAT](#) on page 177

PBCH Relative Power

Defines the power of the PBCH relative to the reference signal.

SCPI command:

[CONFigure\[:LTE\]:DL:PBCH:POWer](#) on page 180

5.3.6.2 Configuring the PCFICH

The physical control format indicator channel (PCFICH) carries information about the format of the PDCCH. You can include or exclude the PCFICH in the test setup and define the relative power of this channel.

PCFICH Present

Includes or excludes the PCFICH from the test setup.

SCPI command:

[CONFigure\[:LTE\]:DL:PCFich:STAT](#) on page 178

PCFICH Relative Power

Defines the power of the PCFICH relative to the reference signal.

SCPI command:

[CONFigure\[:LTE\]:DL:PCFich:POWer](#) on page 180

5.3.6.3 Configuring the PHICH

The physical hybrid ARQ indicator channel (PHICH) contains the hybrid ARQ indicator. The hybrid ARQ indicator contains the acknowledgement / negative acknowledgments for uplink blocks.

You can set several specific parameters for the PHICH.

PHICH Duration

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

With a normal duration, all resource element groups of the PHICH are allocated on the first OFDM symbol.

With an extended duration, the resource element groups of the PHICH are distributed over three OFDM symbols for a normal subframe or over two symbols within a special subframe.

If you select Auto, the duration of PHICH is automatically determined and based on the PBCH decoding results.

Note that you have to turn on the PBCH for an automatic determination of the PHICH duration.

SCPI command:

[CONFigure\[:LTE\]:DL:PHICh:DURation](#) on page 178

PHICH TDD m_i=1 (E-TM)

Turns the special setting of the PHICH for the enhanced test models on and off.

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

The parameter is available if you have selected TDD.

SCPI command:

[CONFigure\[:LTE\]:DL:PHICh:MITM](#) on page 179

PHICH N_g

Sets the variable N_g.

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

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

SCPI command:

[CONFigure\[:LTE\]:DL:PHICH:NGParameter](#) on page 178

PHICH Number of Groups

Sets the number of PHICH groups contained in a subframe.

To select a number of groups, you have to set the [PHICH N_g](#) to "Custom".

SCPI command:

[CONFigure\[:LTE\]:DL:PHICH:NOGRoups](#) on page 179

PHICH Rel Power

Defines the power of the PHICH relative to the reference signal.

SCPI command:

[CONFigure\[:LTE\]:DL:PHICH:POWer](#) on page 180

5.3.6.4 Configuring the PDCCH

The physical downlink control channel (PDCCH) carries the downlink control information.

The PDCCH is always present. You can define several specific parameters for the PDCCH.

PDCCH Format

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

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

SCPI command:

[CONFigure\[:LTE\]:DL:PDCCh:FORMat](#) on page 179

Number of PDCCHs

Sets the number of physical downlink control channels.

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

SCPI command:

[CONFigure\[:LTE\]:DL:PDCCh:NOPD](#) on page 179

PDCCH Rel Power

Defines the power of the PDCCH relative to the reference signal.

SCPI command:

[CONFigure\[:LTE\]:DL:PDCCh:POWer](#) on page 180

5.3.7 Configuring the Shared Channel

The shared channel settings contain settings that describe the characteristics of the shared channels.

The shared channel settings are part of the "Downlink Advanced Signal Characteristics" tab of the "Demodulation Settings" dialog box.



PDSCH Power Ratio

Selects the PDSCH P_B parameter that defines the cell-specific ratio of rho_B to rho_A according to 3GPP TS 36.213, table 5.2-1.

The table below shows the resulting values as a function of the number of antennas.

PDSCH P_B	1 Tx antenna	2 and 4 Tx antennas
0	0.000 dB	0.969 dB
1	-0.969 dB	0.000 dB
2	-2.218 dB	-1.249 dB
3	-3.979 dB	-3.010 dB

If you select "p_B/p_A=1", the ratio is always 1, regardless of the number of antennas.

SCPI command:

[CONFigure\[:LTE\]:DL:PDSCh:PB](#) on page 181

6 Analyzing Measurement Results

The measurement application provides several tools to get more detailed information on the measurement results. The corresponding tools are part of the context menu.

- ▶ To access the context menu, click anywhere in the diagram grid with the right mouse button.

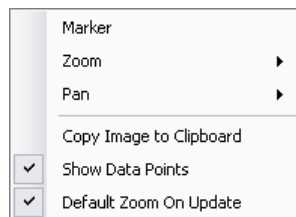


Fig. 6-1: Context menu

Using the marker

You can use a marker to get the coordinates of a single point in the diagram area.

- ▶ Open the context menu and select the "Marker" menu item.
When the marker is active, the software puts a check mark (☑) in front of the "Marker" menu item.

When you turn it on, the software positions the marker on the trace maximum. After that you can move it around freely to any point of the trace.



Marker positioning

If you try to put the marker on a coordinate not occupied by the trace, the software puts the marker to the nearest trace maximum (if you place it above the trace) or the nearest trace minimum (if you place it below the trace).

The marker coordinates are displayed in the upper left area of the diagram. The first number shows the vertical position, the second number the horizontal position of the marker including the units.



If you want to reposition the marker on the trace maximum after moving it around, you have to first deactivate the marker and then reactivate it.

Mkr: -8.920 dBm @ 38.141 ms

To deactivate the marker, open the context menu and reselect the "Marker" menu item.



Note that the marker is not available for all measurements and result displays.

Zooming into the diagram area

If you'd like to see parts of the diagram area in more detail, you can use the zoom.

- ▶ Open the context menu and select the "Zoom" menu item.
The software opens a submenu with several zooming options.

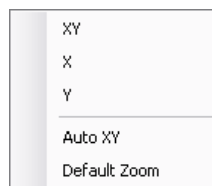


Fig. 6-2: Zooming options

- Zooming vertically and horizontally (XY)
Click on any point in the diagram area and draw a rectangle with the mouse. The rectangle defines the part of the diagram area you are zooming into.
- Zooming horizontally (X)
Click on any point in the diagram area and define the horizontal section of the diagram area you want to zoom into.
- Zooming vertically (Y)
Click on any point in the diagram area and define the vertical section of the diagram area you want to zoom into.
- Zooming automatically (Auto XY)
Automatically scales the diagram area so that the complete trace data is visible. Double-clicking on the diagram area has the same effect.
- Restoring the default zoom
The "Default Zoom" entry restores the default zoom.

The software also provides functionality to restore the default zoom each time when the display is updated.

- ▶ Open the context menu and select the "Default Zoom on Update" menu item.

Panning the trace

If you'd like to see parts of the measurement results that are outside the diagram area, you can move the contents of the diagram area. To move the contents of the diagram area, click anywhere in the diagram area and drag the contents of the diagram area until the parts you'd like to see are visible.



If there are parts of the trace data that are outside the visible display area, the software shows arrows to the right of the diagram area.

The arrows point in the direction where the invisible trace data is. If parts of the trace data is outside the visible area, the arrows are yellow. If all data in a particular direction is outside the visible area, the arrows turn red.



To make sure that the whole trace is always visible, you can use the automatic zoom ("Auto XY") available in the "Zoom" menu.

- ▶ Open the context menu and select the "Pan" menu item.
The software opens a submenu with several panning options.

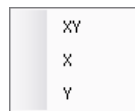


Fig. 6-3: Panning options

- Panning vertically and horizontally (XY)
Panning is possible in all directions.
- Panning horizontally (X)
Panning is possible to the left and right.
- Panning vertically (Y)
Panning is possible upwards and downwards.

Copying an image to the clipboard

If you want to document measurement results, you can move a copy of them to the clipboard of the operating system.

- ▶ Open the context menu and select the "Copy to Clipboard" menu item.

7 Data Management

For easy handling of special measurement configurations, the software allows you to import or export various kinds of data.

7.1 Importing and Exporting I/Q Data

Instead of capturing data directly through hardware components, you can also analyze data that has been recorded previously and saved in a file. On the same lines, it is also possible to save the data that has been captured with an analyzer for further analysis at a later time or for documentation.

You can store and load I/Q data in binary or ASCII format. For a correct display of the power, the I/Q data has to be scaled linearly in Volt (e.g. for the Capture Buffer result display).



Loading I/Q data

Load the contents of an I/Q data file into the software fast and easy by dragging and dropping the file somewhere into the user interface.

The software updates the I/Q data to be measured automatically.

All functionality to import and export data is in the "File" menu (or file manager) that you can access via the FILE key.

ASCII format (.dat format)

In case of the ASCII (.dat) format, the data is expected as I and Q values in alternating rows.

<I value 1>

<Q value 1>

<I value 2>

<Q value 2>

(...)

To be able to analyze previously recorded data, you have to set the [input source](#) to "File". When you start a measurement, the software will ask you to select a file that contains the data.

To save data, enter the file manager and save the data with "Save IQ Data".

Binary format (.iqw format)

In case of the binary .iqw format, the data is expected in 32-bit floating point format. This format is also known as Little Endian, LSB Order or Intel format.

Example:

The hexadecimal value 0x1D86E7BB would be decoded to -7.0655481E-3.

For single antenna measurements, the order of the I/Q data is either IQIQIQ... or II...IQQ...Q.

For MIMO measurements, you also have to consider the antenna in the order of the data, with alternating I and Q data for every antenna.

[I/Q][antenna index]([symbol index])

Example:

For a two antenna system, the string of data would like:

I0(0),Q0(0),I1(0),Q1(0),I0(1),Q0(1),I1(1),Q1(1),I0(2),Q0(2),...

Binary format (.iq.tar format)

In case of the .iq.tar format, the I/Q data is stored in a compressed format with the file extension .iq.tar.

An .iq.tar file contains I/Q data in binary format together with meta information that describes the nature and the source of data, e.g. the sample rate. The objective of the .iq.tar file format is to separate I/Q data from the meta information while still having both inside one file. In addition, the file format allows you to preview the I/Q data in a web browser, and allows you to include customized data.

An .iq.tar file must contain the following files.

- I/Q parameter XML file
Contains meta information about the I/Q data (e.g. sample rate). The filename can be defined freely, but there must be only one single I/Q parameter XML file inside an .iq.tar file.
- I/Q data binary file
Contains the binary I/Q data of all channels. There must be only one single I/Q data binary file inside an .iq.tar file.

Optionally, an .iq.tar file can contain the following file.

- I/Q preview XSLT file
Contains a stylesheet to display the I/Q parameter XML file and a preview of the I/Q data in a web browser.

7.2 Managing Frame Data

For fast access to the frame description (or structure of a signal), you can save it and again use it at a later time. To manage frame descriptions, enter the file manager and select "Save Demod Setup" to save the current setup or "Load Demod Setup" to restore a previously created setup.

The frame description contains the complete modulation structure of the signal.

The frame structure is defined in the xml file format. The file contains all parameters that are part of the demodulation settings. If you want to define more than one allocation, you can do so by adding additional PRB entries (<PRB> element).

Note the following restrictions for the frame description.

- You have to define at least one PRB.
- You can allocate a maximum of four frames.

The example below shows a typical frame description.

```
<FrameDefinition LinkDirection="downlink" TDDULDLAllocationConfiguration="0"
TDDSpecialSubframeConfiguration="0" RessourceBlocks="50" CP="auto" PSYNCBoostingdB="0"
SSYNCBoostingdB="0" PSSYNCTxAntenna="All" ReferenceSignalBoostingdB="0"
PBCHIsPresent="true" PBCHBoostingdB="0" PCFICHIsPresent="true" PCFICHBoostingdB="0"
PHICH_Ng="1" PHICHNumGroups="0" PHICHDuration="Normal" PHICHBoostingdB="-3.01"
PHICHTDDSetMiAccToETMs="false" NumberOfPDCCHs="0" PDCCHFormat="-1"
PDCCHBoostingdB="0" PSSYNCRetpetitionPeriod="10" DataSymbolOffsetSubFrame="-1"
MIMOConfiguration="1 Tx Antenna" MIMOAntennaSelection="Antenna 1"
PhysLayCellIDGrp="Auto" PhysLayID="Auto" RefSignal3GPPVersion="3"
N_c_fastforward="1600">
  <Frame>
    <Subframe>
      <PRBs>
        <PRB Start="0" Length="6" Boosting="0" Modulation="QPSK" Precoding="None"
          Layers="1" Codebook="0" CDD="0" N_RNTI="0"></PRB>
      </PRBs>
    </Subframe>
  </Frame>
  <stControl PhaseTracking="1" TimingTracking="0" ChannelEstimation="1"
    EVMCalculationMethod="1" CompensateCrosstalk="0" EnableScrambling="1"
    AutoDemodulation="1" AutoBoostingEstimation="1" SubframeConfDetect="2"
    RefDataSource="1" MulticarrierFilter="0"></stControl>
</FrameDefinition>
```

7.3 Customizing Reference Symbols

The software supports the use of customized iq and bit sequences for the reference signal, the P-SYNC and the S-SYNC. The modulation of the bit sequences is always QPSK.

Customizing bit sequences

To customize a bit sequence, create a text file in the ASCII format. Each line in the file must contain a 0 ('0' bit) or a 1 ('1' bit).

<QPSK symbol 1, I bit>

<QPSK symbol 1, Q bit>

<QPSK symbol 2, I bit>

<QPSK symbol 2, Q bit>

<QPSK symbol 3, I bit>

(...)

The length of the P-SYNC bit definition vector must be 144 (bits per symbol * carriers = 2 * 72). For S-SYNC and reference symbols, if not enough bits are available for the mapping, the bits are repeated. The length of the reference symbols bit definition vectors must be a multiple of 2.

Customizing iq sequences

To customize an iq sequence, create a binary file containing the complex valued iq symbols. Data is expected as 32-bit floating point data, Little Endian format (also known as LSB Order or Intel format, EXAMPLE: 0x1D86E7BB in hexadecimal notation will be decoded to -7.0655481E-3). The order of the data is IQIQIQ.

You can generate iqw-files of the correct format by applying the following Matlab code, assuming that x is the complex valued I/Q-symbol column vector and the file name is stored in sExportFileName as string:

```
% open file
fid = fopen(sExportFileName, 'w');

% make complex data real according to I Q I Q I Q ...
x = [real(x) imag(x)].';
fwrite(fid, x(:), 'float32');
fclose(fid);
```

The length of the P-SYNC iq symbol definition vector must be 144 (inphase/quadrature component * carriers = 2 * 72). For S-SYNC and reference symbols, if not enough iqw symbols are available for the mapping, the iqw symbols are repeated.

The pseudo-random sequence r^{PRS} defined in 3GPP TS 36.211 (v8.9.0) can be uploaded from a text or IQW file. The maximum length of rPRS may vary from slot to slot. Hence, the maximum composite length of all 20 sequences (20 slots per radio frame) rPRS is given by $340 * 2 * 20 = 13600$ symbols (i.e. 27200 Bits in case of QPSK text file). The data file is read out as follows:

- For QPSK, the first 680 bits are read out for the primary reference signal of the first slot. For I/Q file, the first 340 symbols are read out for the primary reference signal of the first slot.
- Then the next 680 bits (340 symbols for I/Q file) are read out for the secondary reference signal of the first slot.
- Then the next 680 bits (340 symbols for I/Q file) are read out for the primary reference signal of the second slot.
- ...
- If secondary reference signals are not used, then the corresponding data in the text file is skipped.
- If the data file contains a shorter list, the information is read out cyclically. Thus, if the reference signal sequence should be the same for each slot, it would be sufficient to have a list with $27200 \text{ bits} / 20 = 1360$ bits.

- Note that this approach also reflects the possibility to use a complex scrambling code as defined in 3GPP TS 25.213 as sequence r^{PRS} .

Importing bit and iq sequences

The bit/iq definition file must be placed in the same folder as the EUTRA/LTE application binary ("%Program folder%\Rohde-Schwarz\EUTRA LTE" by default).

- The name of the P-SYNC bit definition file must be `PSCHBitsQPSKUser.txt`.
- The name of the P-SYNC iq definition file must be `PSCHSymbolsUser.iqw`.
- The name of the S-SYNC bit definition file must be `SSCHBitsQPSKUser.txt`.
- The name of the S-SYNC iq definition file must be `SSCHSymbolsUser.iqw`.
- The name of the Reference Pilots bit definition file must be `PilotBitsQPSKUser.txt`.
- The name of the Reference Pilots iq definition file must be `PilotSymbolsUser.iqw`.

7.4 Importing and Exporting Limits

In addition to the limits defined by the standard, you can create and use customized limits. After you have created the file, you have to name it `Default.eutra_limits` and copy it into the same folder as the software binary ("%Program folder%\Rohde-Schwarz\EUTRA LTE" by default). The limits are automatically loaded when you start the software.

The limits you can customize work for the Result Summary.

Limits are defined in the xml file format. Any xml elements you do not want to define can be left out, either by making no entry or by deleting the corresponding element.

```
<Limits>
  <DL>
    <EVM>
      <PDSCHQPSK Mean="0.175"></PDSCHQPSK><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
      <PDSCH16QAM Mean="0.125"></PDSCH16QAM><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
      <PDSCH64QAM Mean="0.08"></PDSCH64QAM><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
      <PhysicalChannel></PhysicalChannel><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
      <PhysicalSignal></PhysicalSignal><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
      <All></All><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
    </EVM>
    <FrequencyError></FrequencyError><!--Unit: [Hz]-->
    <SamplingClockError></SamplingClockError><!--Unit [ppm]-->
    <TimeAlignmentError></TimeAlignmentError><!--Unit [ns]-->
    <IQOffset></IQOffset><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
    <IQGainImbalance></IQGainImbalance><!--Unit: linear (1 = 0 dB, 0.1 = -20 dB)-->
    <IQQuadraturError></IQQuadraturError><!--Unit: [°]-->
    <OSTP></OSTP><!--Unit: [W]-->
    <PowerTotal></PowerTotal><!--Unit: [W]-->
    <CrestFactor></CrestFactor><!--Unit: linear (1 = 0 dB, 10 = 10 dB)-->
    <OffPowSpectralDensity Limit="-85"></OffPowSpectralDensity><!--Unit: [dBm/MHz]-->
```

</DL>
</Limits>

8 Measurement Basics

This chapter provides background information on the measurements and result displays available with the LTE Analysis Software.

- [Symbols and Variables](#)..... 102
- [Overview](#)..... 103
- [The LTE Downlink Analysis Measurement Application](#)..... 103
- [MIMO Measurement Guide](#)..... 106
- [Performing Time Alignment Measurements](#)..... 110
- [Performing Transmit On/Off Power Measurements](#)..... 112

8.1 Symbols and Variables

The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{i,k}, \hat{a}_{i,k}$	data symbol (actual, decided)
$b_{i,k}$	boosting factor
$\Delta f, \Delta \hat{f}_{\text{coarse}}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{i,k}, \hat{H}_{i,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{t}_{\text{coarse}}, \hat{t}_{\text{fine}}$	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_{RE}	number of resource elements
n	subchannel index, subframe index
$n_{i,k}$	noise sample
Φ_l	common phase error
$r(i)$	received sample in the time domain

$r_{l,k}$, $r'_{l,k}$, $r''_{l,k}$	received sample (uncompensated, partially compensated, equalized) in the frequency domain
T	useful symbol time
T_g	guard time
T_s	symbol time

8.2 Overview

The digital signal processing (DSP) involves several stages until the software can present results like the EVM.



The contents of this chapter are structured like the DSP.

8.3 The LTE Downlink Analysis Measurement Application

The block diagram in [figure 8-1](#) shows the EUTRA/LTE downlink measurement application from the capture buffer containing the I/Q data to the actual analysis block. The outcome of the fully compensated reference path (green) are the estimates $\hat{a}_{l,k}$ of the transmitted data symbols $a_{l,k}$. Depending on the user-defined compensation, the received samples $r''_{l,k}$ of the measurement path (yellow) still contain the transmitted signal impairments of interest. The analysis block reveals these impairments by comparing the reference and the measurement path. Prior to the analysis, diverse synchronization and channel estimation tasks have to be accomplished.

8.3.1 Synchronization

The first of the synchronization tasks is to estimate the OFDM symbol timing, which coarsely estimates both timing and carrier frequency offset. The frame synchronization block determines the position of the P-/S-Sync symbols in time and frequency by using the coarse fractional frequency offset compensated capture buffer and the timing estimate \hat{t}_{coarse} to position the window of the FFT. If no P-/S-Sync is available in the signal, the reference signal is used for synchronization. The fine timing block prior to the FFT allows a timing improvement and makes sure that the EVM window is centered on the measured cyclic prefix of the considered OFDM symbol. For the 3GPP EVM calculation according to 3GPP TS 36.211 (v8.9.0), the block “window” produces three signals taken at the timing offsets $\Delta \tilde{c}$, $\Delta \tilde{h}_1$ and $\Delta \tilde{h}_2$. For the reference path, only the signal taken at the timing offset $\Delta \tilde{c}$ is used.

The LTE Downlink Analysis Measurement Application

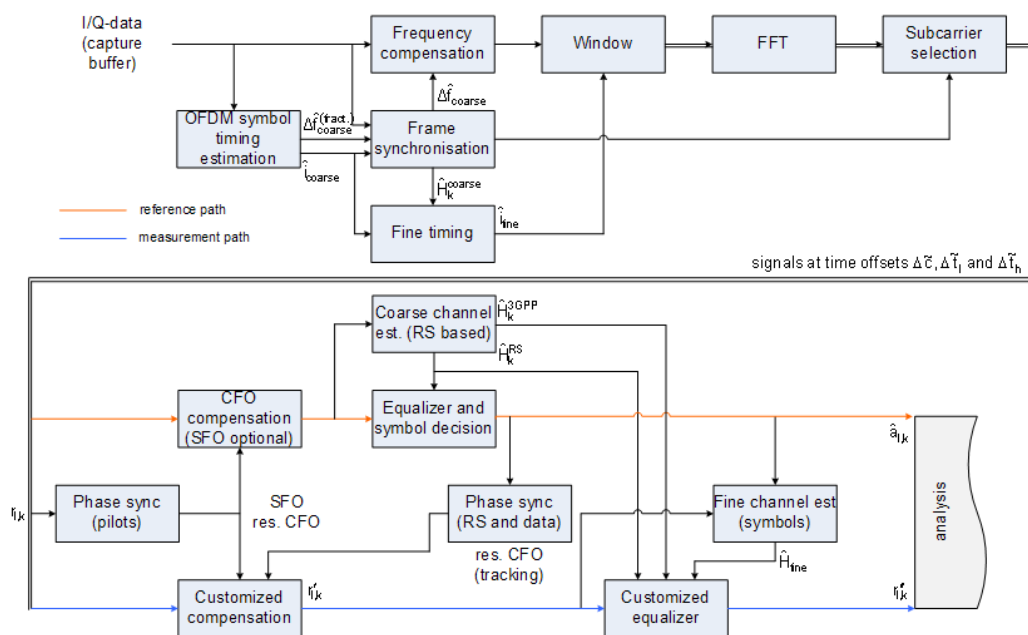


Fig. 8-1: Block diagram for the LTE DL measurement application

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

- the relative sampling frequency offset ζ (SFO)
- the residual carrier frequency offset Δf_{res} (CFO)
- the common phase error Φ_1 (CPE)

According to 3GPP TS 25.913 and 3GPP TR 25.892, the uncompensated samples can be expressed as

$$R_{l,k} = A_{l,k} \cdot H_{l,k} \cdot \underbrace{e^{j\Phi_1}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_s / N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_s / N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res. CFO} + N_{l,k} \tag{8 - 1}$$

where

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

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

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

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

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

8.3.2 Channel Estimation and Equalization

As shown in [figure 8-1](#), there is one coarse and one fine channel estimation block. The reference signal-based coarse estimation is tapped behind the CFO compensation block (SFO compensation can optionally be enabled) of the reference path. The coarse estimation block uses the reference signal symbols to determine estimates of the channel transfer function by interpolation in both time and frequency direction. A special channel estimation (\hat{H}_k^{3GPP}) as defined in 3GPP TS 36.211 is additionally generated. The coarse estimation results are used to equalize the samples of the reference path prior to symbol decision. Based on the decided data symbols, a fine channel estimation is optimally performed and then used to equalize the partially compensated samples of the measurement path.

8.3.3 Analysis

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

EVM

The error vector magnitude (EVM) measurement results 'EVM PDSCH QPSK/16-QAM/64-QAM' are calculated according to the specification in 3GPP TS 36.211.

All other EVM measurement results are calculated according to

$$EVM_{l,k} = \frac{|r_{l,k}'' - \hat{a}_{l,k}|}{b_{l,k} \sqrt{E \left\{ \left[\frac{a_{l,k}}{b_{l,k}} \right]^2 \right\}}} \quad (8 - 2)$$

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

$$EVM_{n,l} = \frac{|r_{l,k}'' - \hat{a}_{l,k}|}{b_{l,k}} \quad (8 - 3)$$

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{REdata}} \sum_l \sum_{k_{data}} EVM_{l,k_{data}}^2}$$
(8 - 4)

The number of resource elements taken into account is denoted by $N_{RE\ data}$.

I/Q imbalance

The I/Q imbalance can be written as

$$r(t) = I \Re\{s(t)\} + jQ \Im\{s(t)\}$$
(8 - 5)

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

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

$$\text{modulator gain balance} = |1 + \Delta Q|$$
(8 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$
(8 - 7)

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

Other measurement variables

Without going into detail, the EUTRA/LTE downlink measurement application additionally provides the following results.

- Total power
- Constellation diagram
- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

8.4 MIMO Measurement Guide

Measurements on LTE MIMO signals become available with option R&S FS(x)-K102(PC). Performing measurements on MIMO signals requires two or four analyzers - depending on the number of antennas in the MIMO system.

True MIMO measurements are useful to verify MIMO precoding implementations for setups where it is not possible to decode the transmit data using only one antenna (e.g. applying spatial multiplexing MIMO precoding with more than 1 layer) and to measure

the hardware performance of the MIMO transmitter hardware in a true MIMO measurement setup.

8.4.1 Setting Up MIMO Measurements

One analyzer is defined as the master analyzer. The master analyzer is the reference oscillator source for all slave analyzers. The REF IN of all slave analyzers must therefore be connected to the REF OUT of the master analyzer and all slave analyzers must be set to external reference (if two R&S SMUs are used, the second R&S SMU has to be set to external reference and the REF OUT of the first R&S SMU has to be connected to the REF IN of the second R&S SMU).

To ensure all analyzers capture the data at the same point in time, a trigger signal has to be used. The device under test (DUT) or R&S SMU must therefore provide a trigger signal. This trigger signal has to be connected to all analyzers (if two R&S SMUs are used, the second R&S SMU must be triggered by the first R&S SMU, too).

The [figure 8-2](#) shows a MIMO hardware setup with 2 (or optional 4) analyzers and 1 (or optional 2) 2-channel R&S SMUs.

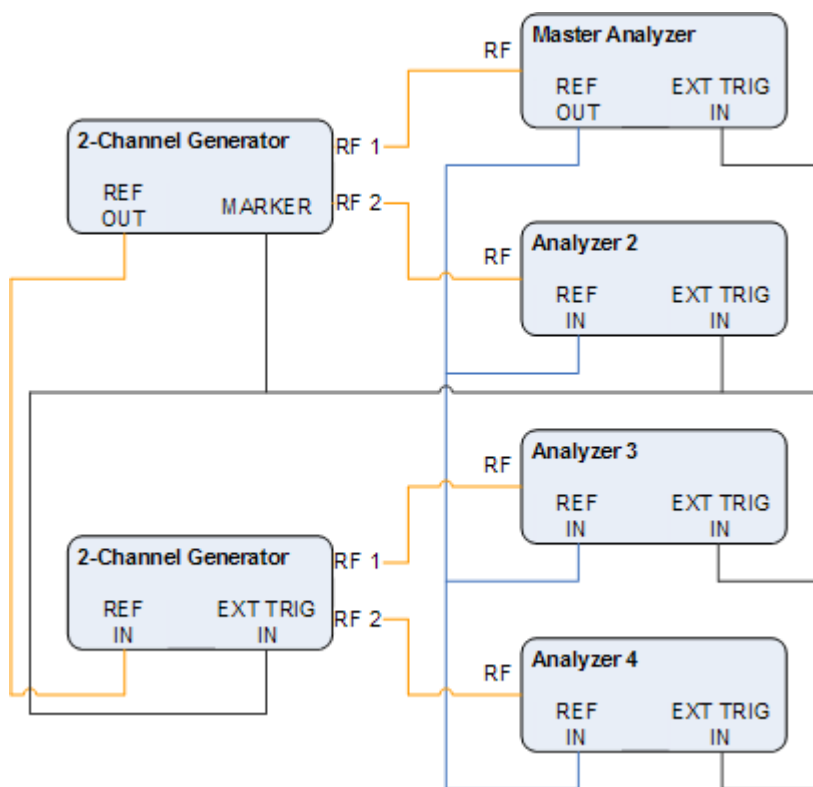


Fig. 8-2: MIMO Hardware Setup

8.4.1.1 Performing MIMO Measurements

The following measurement setups are possible without using special additional hardware.

Delayed trigger signal setup

Generally it is required to start the capturing of all antennas at the same point of time. The analyzers are connected to the application (R&S FSx-K10x) via GPIB or LAN connections which have a certain network delay. Since the network delay and tasks like auto-leveling require some time, a certain delay is introduced between the start of the measurement and the point in time when the trigger inputs of all analyzers are armed. To ensure that no trigger event occurs in this time frame, the user has to introduce a delay between starting the measurement (e.g. by pressing the „RUN SGL" button or initiating the measurement via remote control) and sending the trigger signal.

The expected time to arm the trigger of one analyzer depends on the GPIB/network conditions and the input settings. To estimate the delay, initiate a single run measurement using only one analyzer and measure the time until the „DSP" indicator flashes (note that this estimation also includes the time to transfer the I/Q samples from the instrument to the LTE software):



A typical delay to arm the trigger is 2 seconds per instrument.

The minimum delay of the trigger signal must now be greater than the measured time multiplied with the number of measured antennas (number of used analyzers) since the spectrum analyzers are initialized sequentially.

The usage of an LTE frame trigger is not possible for this measurement setup.

Frame trigger signal setup using identical LTE frames

In the special case that identical LTE frames are transmitted, i.e., all transmitted LTE frames use the same frame configuration and transmit exactly the same data, a special measurement setup is possible. In this case it is possible to use a frame trigger to start the measurement. The different analyzers capture data from different LTE frames but with equal content.

The problem with this measurement setup is that the phase variations of the reference oscillators of the different transmitted signals are not the same since the data are not captured at the same point in time.

As a result we get a phase error which degrades the EVM (see the figures below).

This measurement setup is therefore not recommended for measuring the hardware performance. One application to this measurement setup is, e.g., to check the MIMO precoding implementation.

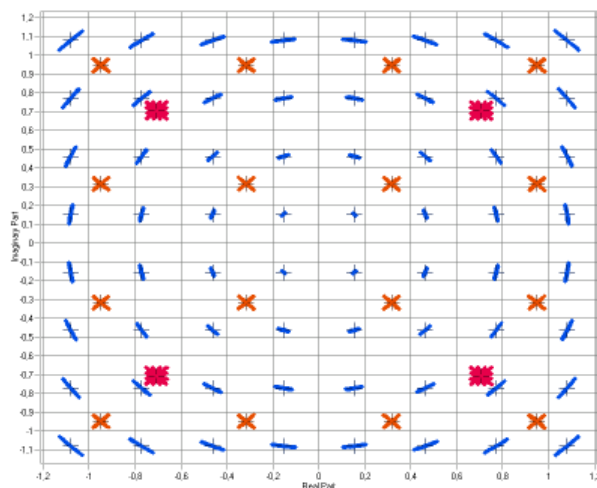


Fig. 8-3: Constellation diagram

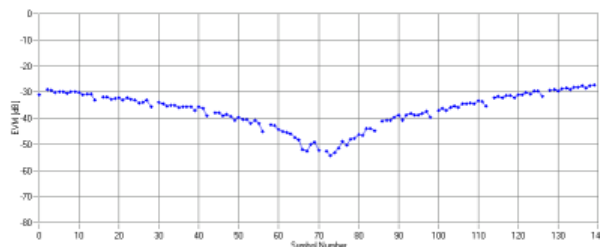


Fig. 8-4: EVM vs OFDM symbol number

8.4.1.2 Performing MIMO Measurements with a Trigger Unit

In MIMO test scenarios, you get the best results when all analyzers in the test setup simultaneously start to record the I/Q data. The trigger unit R&S FS-Z11 is a tool that makes sure that the measurement starts on all analyzers (master and slaves) at the same time.

Connecting the trigger unit to the analyzers

- ▶ Connect the NOISE SOURCE output of the master analyzer to the NOISE SOURCE CONTROL input of the trigger unit.
- ▶ Connect the EXT TRIG inputs of all analyzers (master **and** slaves) to the TRIG OUT 1 to 4 (or 1 and 2 in case of measurements on two antennas) of the trigger unit. The order is irrelevant, i.e. it would be no problem if you connect the master analyzer to the TRIG OUT 2 of the trigger unit.

With this setup, all analyzers (including the master analyzer) are triggered by the trigger unit.

The trigger unit also has a TRIG INPUT connector that you can connect an external trigger to. If you are using an external trigger, the external trigger supplies the trigger event. If

not, the analyzer noise source control supplies the trigger event. Note that if you do not use an external trigger, the TRIG INPUT must remain open.

To use the R&S FS-Z11 as the trigger source, you have to select it as the trigger source in the "General Settings" dialog box of the LTE measurement application. For more information see ["Configuring the Trigger"](#) on page 63.

8.5 Performing Time Alignment Measurements

The MIMO measurement application provides the possibility to perform time alignment measurements between the different antennas for 2 or 4 TX antenna MIMO configurations. The time alignment error values represent the time offset between the considered antenna and antenna 1 and will be displayed in the result summary. A schematic description of the results is provided in [figure 8-6](#).

A test setup for time alignment measurements is shown in [figure 8-5](#). The dashed connections are only required for 4 TX antenna MIMO configuration. For best measurement result accuracy it is recommended to use cables of the same length and identical combiners as adders.

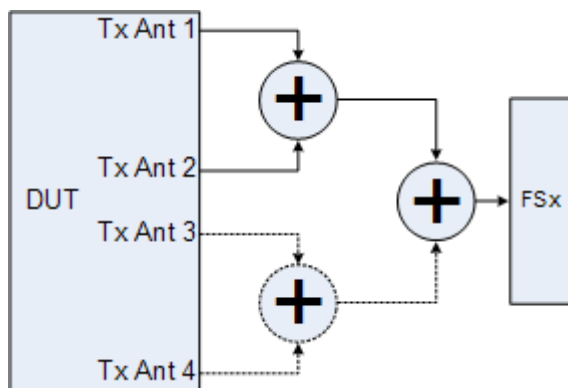
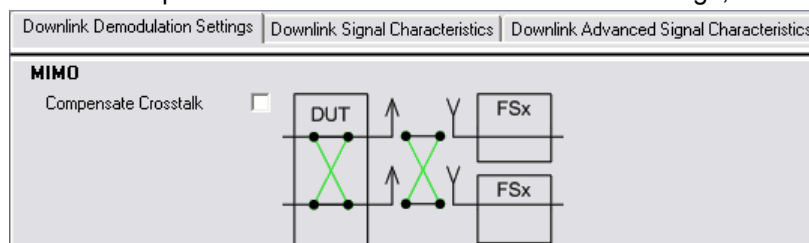


Fig. 8-5: Time alignment measurement hardware setup

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

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



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

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

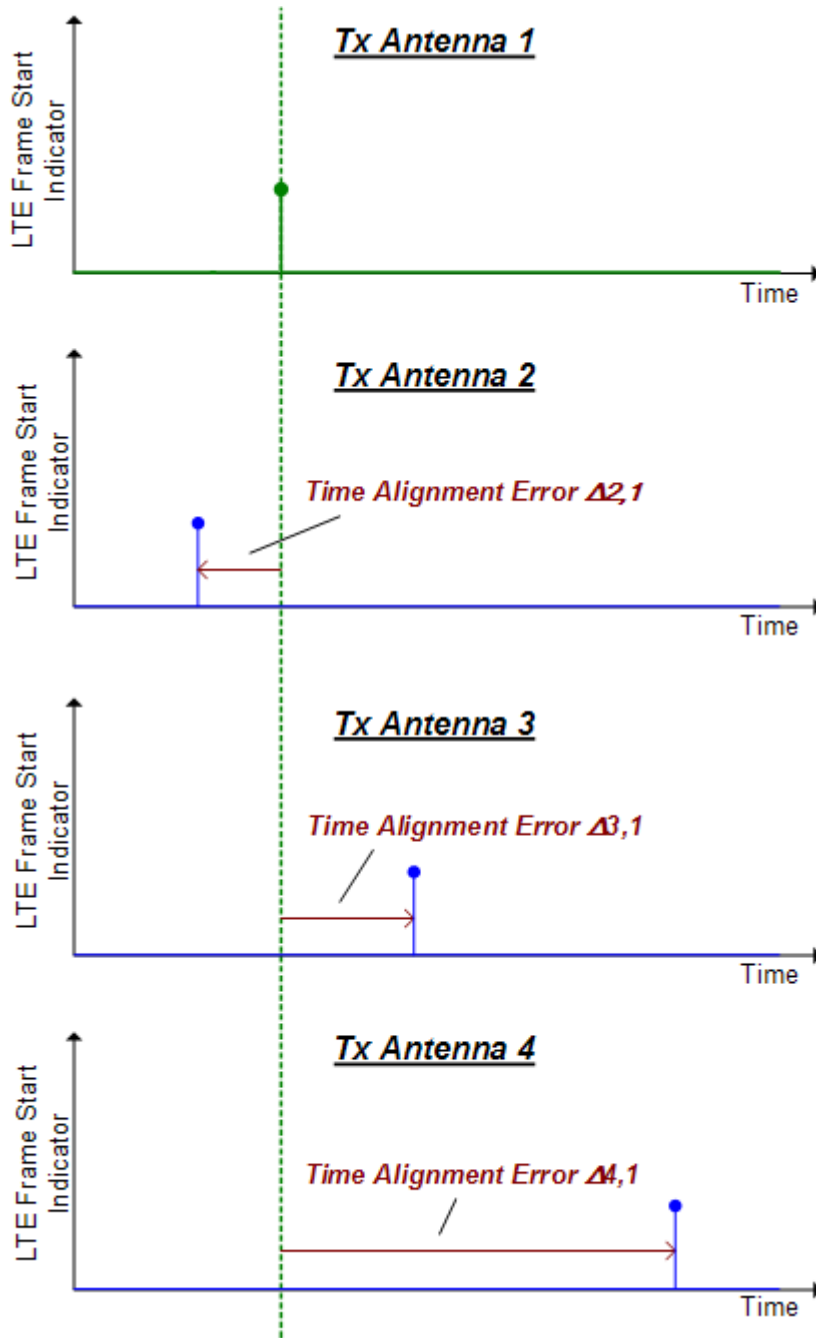
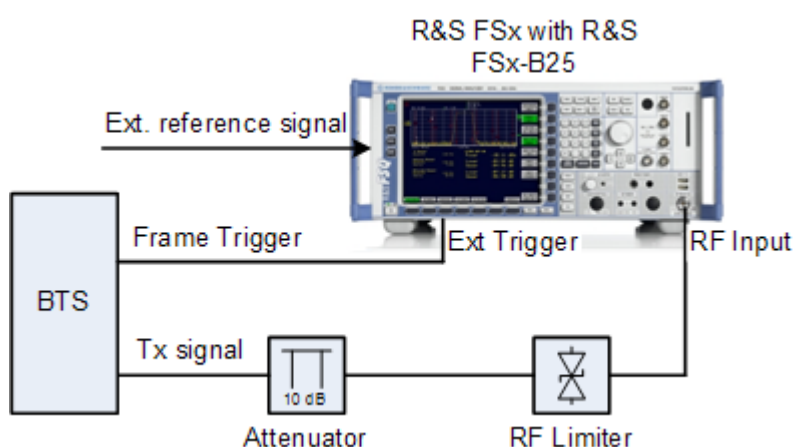


Fig. 8-6: Schematic description of the time alignment results

8.6 Performing Transmit On/Off Power Measurements

The technical specification in 3GPP TS 36.141 prescribes the measurement of the transmitter OFF power and the transmitter transient period of an EUTRA/LTE TDD base transceiver station (BTS) operating at its specified maximum output power. A special hardware setup is required for this measurement since the actual measurement is done at very low power during the transmitter OFF periods requiring low attenuation at the analyzer input. The signal power during the transmitter ON periods in this test scenario is usually higher than the specified maximum input power of the R&S FSx signal analyzer and will cause severe damage to the analyzer if the measurement is not set up appropriately.

Test setup



To protect the analyzer input from damage, an RF limiter has to be applied at the analyzer input connector, as can be seen in figure 2-16. Table 1.1 shows the specifications the used limiter has to fulfill.

Min. acceptable CW input power	BTS output power minus 10 dB
Min. acceptable peak input power	BTS peak output power minus 10 dB
Max. output leakage	20 dBm
Max. response time	1 μ s
Max. recovery time	1 μ s

An additional 10 dB attenuation should be placed in front of the RF limiter to absorb eventual reflected waves because of the high VSWR of the limiter. The allowed maximum CW input power of the attenuator must be lower than the maximum output power of the BTS.

Performing the measurement

For the transmit ON/OFF power measurements according to 36.141, 6.4, the test model E-TM1.1 has to be used. For more information on loading the test model settings see [chapter 7, "Data Management"](#), on page 96.

If an external trigger is used, before the actual measurement can be started, the timing must be adjusted by pressing the 'Adjust Timing' hotkey. The status display in the header of the graph changes from 'Timing not adjusted' to 'Timing adjusted' and the run hotkeys are released. Relevant setting changes again lead to a 'Timing not adjusted' status display.

If the adjustment fails, an error message is shown and the adjustment state is still "not adjusted". To find out what causes the synchronization failure, you should perform a regular EVM measurement (i.e. leave the ON/OFF Power measurement). Then you can use all the measurement results like EVM vs. Carrier to get more detailed information about the failure. The timing adjustment will succeed if the Sync State in the header is OK.

Using a R&S FSQ or R&S FSG it is recommended to use the external trigger mode since for high power signals a successful synchronization is not guaranteed under certain circumstances.

Pressing the 'Run Single' hotkey starts the averaging of the traces of the number of frames given in the 'General Settings' dialog. After performing all sweeps, the table in the upper half of the screen shows if the measurements pass or fail.

9 Remote Commands

When working via remote control, note that you have to establish a connection between your remote scripting tool and the software. Because the software runs directly on the PC and not an R&S instrument, you have to connect the remote scripting tool to your PC and not an instrument.

1. Start the software.
2. If you want to capture I/Q data from an analyzer, connect the software to that analyzer.
3. Start the remote scripting tool (e.g. Matlab) on the PC.
4. Connect the remote scripting tool to the local host (e.g. `TCPIC:LocalHost`)

9.1 Overview of Remote Command Suffixes

This chapter provides an overview of all suffixes used for remote commands in the LTE application.

Suffix	Description
<allocation>	Selects an allocation.
<analyzer>	Selects an analyzer for MIMO measurements.
<antenna>	Selects an antenna for MIMO measurements.
<cluster>	Selects a cluster (uplink only).
<cwnum>	Selects a codeword.
<k>	Selects a limit line. Irrelevant for the LTE application.
<m>	Selects a marker. Irrelevant for the LTE application.
<n>	Selects a measurement window.
<subframe>	Selects a subframe.
<t>	Selects a trace. Irrelevant for the LTE application.

9.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands') and request information ('query commands'). Some commands only work either way (setting only, query only), others work both ways (setting and query).

The syntax of a SCPI command consists of a so-called header and, in most cases, one or more parameters. A query command must append a question mark after the last header element, even if it contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

This chapter summarizes the most important characteristics that you need to know when working with SCPI commands. For a more complete description, refer to the manual of one of the R&S analyzers.



Remote command examples

Note that some remote command examples mentioned in this introductory chapter may not be supported by this application.

9.2.1 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letter. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQUency:CENTer` is the same as `SENS:FREQ:CENT`.

9.2.2 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't use a suffix for keywords that support one, it is treated as a 1.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

9.2.3 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix is recognized as a 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

[SENSe:]FREQuency:CENTer is the same as FREQuency:CENTer

With a numeric suffix in the optional keyword:

DISPlay[:WINDow<1...4>]:ZOOM:STATe

DISPlay:ZOOM:STATe ON enables the zoom in window 1 (no suffix).

DISPlay:WINDow4:ZOOM:STATe ON enables the zoom in window 4.

9.2.4 | (Vertical Stroke)

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

[SENSe:]BANDwidth|BWIDth[:RESolution]

In the short form without optional keywords, BAND 1MHZ would have the same effect as BWID 1MHZ.

9.2.5 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

LAYout:ADD:WINDow Spectrum,LEFT,MTABLE

Parameters may have different forms of values.

- [Numeric Values](#).....117
- [Boolean](#).....117
- [Text](#).....118
- [Character Strings](#).....118
- [Block Data](#).....118

9.2.5.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- **INF/NINF**
Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- **NAN**
Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

9.2.5.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

9.2.5.3 Text

Text parameters follow the syntactic rules of keywords. You can enter text using a short or a long form. For more information see [chapter 9.2.1, "Long and Short Form"](#), on page 115.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMAl`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

9.2.5.4 Character Strings

Strings are either text or number. They have to be in straight quotation marks. You can use a single quotation mark - ' - or a double quotation mark - " .

Example:

`INSTRument:DELeTe 'Spectrum'`

9.2.5.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a `NL^END` message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

9.3 Remote Commands to Select a Result Display

<code>CALCulate<n>:FEED</code>	118
<code>DISPlay[:WINDow<n>]:TABLE</code>	119

`CALCulate<n>:FEED <DispType>`

This command selects the measurement and result display.

Parameters:

<DispType>

String containing the short form of the result display.

'BEAM:URWM' (UE RS Weights Magnitude)**'BEAM URWP'** (UE RS Weights Phase)**'EVM:EVCA'** (EVM vs carrier result display)**'EVM:EVRP'** (EVM vs RB)**'EVM:EVSU'** (EVM vs symbol result display)**'EVM:FEVS'** (frequency error vs symbol result display)**'EVM:EVSU'** (EVM vs subframe result display)**'PVT:CBUF'** (capture buffer result display)**'PVT:OOP'** (on/off power result display)**'SPEC:SEM'** (spectrum emission mask)**'SPEC:ACP'** (ACLR)**'SPEC:PSPE'** (power spectrum result display)**'SPEC:PVRP'** (power vs RB PDSCH result display)**'SPEC:PVRR'** (power vs RB RS result display)**'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:BSTR'** (bitstream)**'STAT:CDR'** (channel decoder results)**'STAT:ASUM'** (allocation summary)**'STAT:CCDF'** (CCDF)**'STAT:SFLO'** (signal flow)**Example:**

CALC2:FEED 'PVT:CBUF'

Select Capture Buffer to be displayed on screen B.

DISPlay[:WINDow<n>]:TABLe <State>

This command turns the result summary on and off.

Parameters:

<State>

ON

Turns the result summary on and removes all graphical results from the screen.

OFF

Turns the result summary off and restores the graphical results that were previously set.

Example: `DISP:TABL OFF`
Turns the result summary off.

9.4 Remote Commands to Perform Measurements

<code>INITiate[:IMMediate]</code>	120
<code>INITiate:REFResh</code>	120
<code>[SENSe]:SYNC[:STATe]?</code>	120
<code>[SENSe][:LTE]:OOPower:ATIMing</code>	121
<code>CONFigure[:LTE]:DL:CONS:LOCation</code>	121
<code>CONFigure[:LTE]:DL:BF:AP</code>	121

INITiate[:IMMediate]

This command initiates a new measurement sequence.

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

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

Example: `INIT`
Initiates a new measurement.

Usage: Event

INITiate:REFResh

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

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

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

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

Usage: Event

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:

<State>

The string contains the following information.

- <OFDMSymbolTiming> is the coarse symbol timing
- <P-SYNCSynchronization> is the P-SYNC synchronization state
- <S-SYNCSynchronization> is the S-SYNC synchronization state

A zero represents a failure and a one represents a successful synchronization.

Example:

SYNC:STAT?

Would return, e.g. '1,1,0' if coarse timing and P-SYNC were successful but S-SYNC failed.

Usage:

Query only

[SENSe][:LTE]:OOPower:ATIMing

This command adjusts the timing for On/Off Power measurements.

Example:

OOP:ATIM

Adjusts the On/Off Power timing.

Usage:

Event

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

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

Parameters:

<Location>

AMD

After the MIMO decoder

BMD

Before the MIMO decoder

*RST: BMD

Example:

CONF:DL:CONS:LOC AMD

Use data from after the MIMO decoder.

CONFigure[:LTE]:DL:BF:AP <Port>

This command selects the antenna port for beamforming measurements.

The availability of ports depends on the number of transmit antennas and number of beamforming layers.

Parameters:

<Port>	AP_5_7 Antenna port 5/7.
	AP_8 Antenna port 8.
	AP_9 Antenna port 9.
	AP_10 Antenna port 10.

9.5 Remote Commands to Read Numeric Results

FETCh:SUMMary:CRESt[:AVERage]?	123
FETCh:CYCPrefix?	123
FETCh:SUMMary:EVM[:ALL]:MAXimum?	123
FETCh:SUMMary:EVM[:ALL]:MINimum?	123
FETCh:SUMMary:EVM[:ALL][:AVERage]?	123
FETCh:SUMMary:EVM:DSQP:MAXimum?	124
FETCh:SUMMary:EVM:DSQP:MINimum?	124
FETCh:SUMMary:EVM:DSQP[:AVERage]?	124
FETCh:SUMMary:EVM:DSST:MAXimum?	124
FETCh:SUMMary:EVM:DSST:MINimum?	124
FETCh:SUMMary:EVM:DSST[:AVERage]?	124
FETCh:SUMMary:EVM:DSSF:MAXimum?	124
FETCh:SUMMary:EVM:DSSF:MINimum?	124
FETCh:SUMMary:EVM:DSSF[:AVERage]?	124
FETCh:SUMMary:EVM:PCHannel:MAXimum?	125
FETCh:SUMMary:EVM:PCHannel:MINimum?	125
FETCh:SUMMary:EVM:PCHannel[:AVERage]?	125
FETCh:SUMMary:EVM:PSIGnal:MAXimum?	125
FETCh:SUMMary:EVM:PSIGnal:MINimum?	125
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?	125
FETCh:SUMMary:FERRor:MAXimum?	125
FETCh:SUMMary:FERRor:MINimum?	125
FETCh:SUMMary:FERRor[:AVERage]?	125
FETCh:SUMMary:GIMBalance:MAXimum?	126
FETCh:SUMMary:GIMBalance:MINimum?	126
FETCh:SUMMary:GIMBalance[:AVERage]?	126
FETCh:SUMMary:IQOFset:MAXimum?	126
FETCh:SUMMary:IQOFset:MINimum?	126
FETCh:SUMMary:IQOFset[:AVERage]?	126
FETCh:SUMMary:OSTP:MAXimum?	126
FETCh:SUMMary:OSTP:MINimum?	126
FETCh:SUMMary:OSTP[:AVERage]?	126
FETCh:SUMMary:POWer:MAXimum?	127
FETCh:SUMMary:POWer:MINimum?	127
FETCh:SUMMary:POWer[:AVERage]?	127

FETCh:SUMMary:QUADerror:MAXimum?	127
FETCh:SUMMary:QUADerror:MINimum?	127
FETCh:SUMMary:QUADerror[:AVERage]?	127
FETCh:SUMMary:RSTP:MAXimum?	127
FETCh:SUMMary:RSTP:MINimum?	127
FETCh:SUMMary:RSTP[:AVERage]?	127
FETCh:SUMMary:SERRor:MAXimum?	127
FETCh:SUMMary:SERRor:MINimum?	127
FETCh:SUMMary:SERRor[:AVERage]?	127
FETCh:SUMMary:TAE<antenna>?	128
FETCh:SUMMary:TFRame?	128

FETCh:SUMMary:CRESt[:AVERage]?

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

Return values:

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

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

Usage: Query only

FETCh:CYCPrefix?

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

Return values:

<PrefixType> The command returns -1 if no valid result has been detected yet.
NORM
Normal cyclic prefix length detected
EXT
Extended cyclic prefix length detected

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

Usage: Query only

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

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

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

This command queries the EVM of all resource elements.

Return values:

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

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

Usage: Query only

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

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

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

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

Usage: Query only

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

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

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

Example: `FETC:SUMM:EVM:DSST?`
Returns the PDSCH 16QAM EVM.

Usage: Query only

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

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

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

Example: `FETC:SUMM:EVM:DSSF?`
Returns the PDSCH 64QAM EVM.

Usage: Query only

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

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

Return values:

<EVM> <numeric value>

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

Example: FETC : SUMM : EVM : PCH ?
Returns the mean value.

Usage: Query only

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

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

Return values:

<EVM> <numeric value>

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

Example: FETC : SUMM : EVM : PSIG ?
Returns the mean value.

Usage: Query only

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

This command queries the frequency error.

Return values:

<FreqError> <numeric value>

Minimum, maximum or average frequency error, depending on the last command syntax element.
Default unit: Hz

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

Usage: Query only

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

This command queries the I/Q gain imbalance.

Return values:

<GainImbalance> <numeric value>

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

Default unit: dB

Example:

`FETC:SUMM:GIMB?`

Returns the current gain imbalance in dB.

Usage:

Query only

FETCh:SUMMary:IQOffset:MAXimum?**FETCh:SUMMary:IQOffset:MINimum?****FETCh:SUMMary:IQOffset[:AVERage]?**

This command queries the I/Q offset.

Return values:

<IQOffset> <numeric value>

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

Default unit: dB

Example:

`FETC:SUMM:IQOF?`

Returns the current IQ-offset in dB

Usage:

Query only

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

This command queries the OSTP.

Return values:

<OSTP> <numeric value>

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

Default unit: dBm

Example:

`FETC:SUMM:OSTP?`

Returns the current average OSTP value.

Usage:

Query only

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

This command queries the total power.

Return values:

<Power> <numeric value>
 Minimum, maximum or average power, depending on the last command syntax element.
 Default unit: dBm

Example: FETC:SUMM:POW?
 Returns the total power in dBm

Usage: Query only

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

This command queries the quadrature error.

Return values:

<QuadError> <numeric value>
 Minimum, maximum or average quadrature error, depending on the last command syntax element.
 Default unit: deg

Example: FETC:SUMM:QUAD?
 Returns the current mean quadrature error in degrees.

Usage: Query only

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

This command queries the RSTP as shown in the result summary.

Return values:

<RSTP> RSTP in dBm.

Example: FETC:SUMM:RSTP?
 Queries the RSTP.

Usage: Query only

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

This command queries the sampling error.

Return values:**<SamplingError>** <numeric value>

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

Default unit: ppm

Example:

FETC:SUMM:SERR?

Returns the current mean sampling error in ppm.

Usage:

Query only

FETCh:SUMMary:TAE<antenna>?

This command queries the time alignment error.

Suffix:**<antenna>** 2..4

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

Return values:**<TimeAlignError>**

Time alignment error of antenna 1 and another antenna.

Usage:

Query only

FETCh:SUMMary:TFRame?

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

Return values:**<TrigToFrame>** <numeric value>

Default unit: s

Example:

FETC:SUMM:TFR?

Returns the trigger to frame value.

Usage:

Query only

9.6 Remote Commands to Read Trace Data

- [Using the TRACe\[:DATA\] Command](#).....128
- [Reading Out Limit Check Results](#).....140

9.6.1 Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example:

```
TRAC:DATA? TRACE1
```

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat [:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe [:DATA] ?`).

• Adjacent Channel Leakage Ratio	129
• Allocation Summary	130
• Bit Stream	130
• Capture Buffer	131
• CCDF	131
• Channel Decoder Results	132
• Channel Flatness	132
• Channel Flatness Difference	133
• Channel Group Delay	133
• Constellation Diagram	133
• EVM vs Carrier	134
• EVM vs RB	134
• EVM vs Symbol	135
• EVM vs Subframe	135
• Frequency Error vs Symbol	135
• On/Off Power	136
• Power Spectrum	136
• Power vs RB RS	136
• Power vs RB PDSCH	137
• Spectrum Emission Mask	137
• UE RS Weights Magnitude	137
• UE RS Weights Phase	138
• Return Value Codes	138

9.6.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- TRACE1

Returns one value for each trace point of trace 1 (yellow). Trace 1 contains the absolute power values measured with a 1 MHz RBW.

<absolute power>, ...

The unit is always dBm.

- **TRACE2**
Returns one value for each trace point of trace 1 (green). Trace 1 contains the absolute power values measured with a 1 MHz RBW.
TRACE2 is available for relative ACLR measurements.
- **LIST**
Returns the contents of the ACLR table.

9.6.1.2 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

<subframe>, <allocation ID>, <number of RB>, <relative power>, <modulation>, <absolute power>, <EVM>, ...

The unit for <absolute power> is always dBm. The unit for <relative power> is always dB. The unit for <EVM> depends on [UNIT:EVM](#). All other values have no unit.

The <allocation ID> and <modulation> are encoded. For the code assignment see [chapter 9.6.1.23, "Return Value Codes"](#), on page 138.

Note that the data format of the return values is always ASCII.

Example:

Allocation Summary		Selection		Antenna: 1		
Sub-frame	Alloc. ID	Number of RB	Rel. Power/dB	Modulation	Power per RE/dBm	EVM/%
0	RS Ant1		0,000	QPSK	-45,546	0,733
	P-SYNC		-0,007	CAZAC	-42,558	0,254
	S-SYNC		0,005	RBPSK	-42,546	0,251

TRAC:DATA? TRACE1 would return:

```
0, -5, 0, 0.00000000000000, 2, -45.5463829153428, 7.33728660354122E-05,
0, -3, 0, 0.0073997452251, 6, -42.5581007463452, 2.54197349219455E-05,
0, -4, 0, 0.0052647197362, 1, -42.5464220485716, 2.51485275782241E-05,
...
```

9.6.1.3 Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream for each line of the table.

<subframe>, <allocation ID>, <codeword>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>, ...

All values have no unit. The format of the bitstream depends on [Bit Stream Format](#).

The <allocation ID>, <codeword> and <modulation> are encoded. For the code assignment see [chapter 9.6.1.23, "Return Value Codes"](#), on page 138.

For symbols or bits that are not transmitted, the command returns

- "FF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

Note that the data format of the return values is always ASCII.

Example:

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

TRAC:DATA? TRACE1 would return:

```
0, -12, 0, 2, 0, 01, 01, 00, 02, 03, 00, 01, 02, 01, 02, 01, ...
<continues like this until the next data block starts or the end of data is
reached>
0, -12, 0, 2, 32, 03, 02, 03, 03, 03, 03, 01, 03, 00, 03, ...
```

9.6.1.4 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer.

<absolute power>, ...

The unit is always dBm.

The following parameters are supported.

- TRACE1

9.6.1.5 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
 - Returns the probability values (y-axis).
 - <# of values>, <probability>, ...
 - The unit is always %.
 - The first value that is returned is the number of the following values.
- TRACE2

Returns the corresponding power levels (x-axis).
 <# of values>, <relative power>, ...

The unit is always dB.

The first value that is returned is the number of the following values.

9.6.1.6 Channel Decoder Results

For the Channel Decoder Results, the number and type of return values depend on the parameter.

- PBCH

Returns the results for the PBCH if PBCH decoding (or CRC check) was successful. The results are made up out of six values.
 <subframe>, <# of antennas>, <system bandwidth>, <frame>, <PHICH duration>, <PHICH resource>
 The unit for <system bandwidth> is Hz. All other values have no unit.
 The <PHICH duration> and <PHICH resource> are encoded. For the code assignment see [chapter 9.6.1.23, "Return Value Codes"](#), on page 138.
 If PBCH decoding was not successful, the command returns NAN.
- PCFICH

Returns the results for the PCFICH. The results are made up out of two parameters.
 <subframe>, <number of symbols for PDCCH>
 The values have no unit.
- PHICH

Returns the results for the PHICH. The results are made up out of three values for each line of the table.
 <subframe>, <ACK/NACK>, <relative power>
 The unit for <relative power> is dB. All other values have no unit.
 The <ACK/NACK> is encoded. For the code assignment see [chapter 9.6.1.23, "Return Value Codes"](#), on page 138.
- PDCCH

Returns the results for the PDCCH. The results are made up out of seven values for each line of the table.
 <subframe>, <RNTI>, <DCI format>, <PDCCH format>, <CCE offset>, <# of transmitted bits>, [stream of binary numbers]
 The values have no unit.
 The [stream of binary numbers] is a list of binary numbers separated by comma.
 The <DCI format> and <PDCCH format> are encoded. For the code assignment see [chapter 9.6.1.23, "Return Value Codes"](#), on page 138.

9.6.1.7 Channel Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

<relative power>, ...

The unit is always dB.

The following parameters are supported.

- TRACE1
Returns the average power over all subframes.
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.8 Channel Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

`<relative power>, ...`

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
Returns the average power over all subframes.
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.9 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

`<group delay>, ...`

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
Returns the group delay.

9.6.1.10 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

```

<I[SF0][Symb0][Carrier1]>, <Q[SF0][Symb0][Carrier1]>, ..., <I[SF0][Symb0][Carrier(n)]>, <Q[SF0][Symb0][Carrier(n)]>,
<I[SF0][Symb1][Carrier1]>, <Q[SF0][Symb1][Carrier1]>, ..., <I[SF0][Symb1][Carrier(n)]>, <Q[SF0][Symb1][Carrier(n)]>,
<I[SF0][Symb(n)][Carrier1]>, <Q[SF0][Symb(n)][Carrier1]>, ..., <I[SF0][Symb(n)][Carrier(n)]>, <Q[SF0][Symb(n)][Carrier(n)]>,
<I[SF1][Symb0][Carrier1]>, <Q[SF1][Symb0][Carrier1]>, ..., <I[SF1][Symb0][Carrier(n)]>, <Q[SF1][Symb0][Carrier(n)]>,
<I[SF1][Symb1][Carrier1]>, <Q[SF1][Symb1][Carrier1]>, ..., <I[SF1][Symb1][Carrier(n)]>, <Q[SF1][Symb1][Carrier(n)]>,
<I[SF(n)][Symb(n)][Carrier1]>, <Q[SF(n)][Symb(n)][Carrier1]>, ..., <I[SF(n)][Symb(n)][Carrier(n)]>, <Q[SF(n)][Symb(n)][Carrier(n)]>

```

With SF = subframe and Symb = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
Returns all constellation points included in the selection.

9.6.1.11 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

```
<EVM>, ...
```

The unit depends on [UNIT:EVM](#).

The following parameters are supported.

- TRACE1
Returns the average EVM over all subframes
- TRACE2
Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.12 EVM vs RB

For the EVM vs RB result display, the command returns one value for each resource block that has been analyzed.

```
<EVM>, ...
```

The unit depends on [UNIT:EVM](#).

The following parameters are supported.

- TRACE1
Returns the average power for each resource block over all subframes.
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.13 EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

<EVM>, ...

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on [UNIT:EVM](#).

The following parameters are supported.

- TRACE1

9.6.1.14 EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

<EVM>, ...

The unit depends on [UNIT:EVM](#).

The following parameters are supported.

- TRACE1

9.6.1.15 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

<frequency error>, ...

The unit is always Hz.

The following parameters are supported.

- TRACE1

9.6.1.16 On/Off Power

For the On/Off Power measurement, the number and type of return values depend on the parameter.

- TRACE1
Returns the power for the Off power regions.
<absolute power>, ...
The unit is always dBm.
- TRACE2
Returns the power for the transient regions.
<absolute power>, ...
The unit is always dBm.
- LIST
Returns the contents of the On/Off Power table. For each line, it returns seven values.
<off period start limit>, <off period stop limit>, <time at delta to limit>, <absolute off power>, <distance to limit>, <falling transient period>, <rising transient period>, ...
The unit for the <absolute off power> is dBm. The unit for the <distance to limit> is dB. The unit for the <transient periods> is µs. All other values have the unit s.

9.6.1.17 Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

<power>, ...

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

9.6.1.18 Power vs RB RS

For the Power vs RB RS, the command returns one value for each resource block of the reference signal that has been analyzed.

<absolute power>, ...

The unit is always dBm.

The following parameters are supported.

- TRACE1
Returns the average power over all subframes
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3

Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.19 Power vs RB PDSCH

For the Power vs RB PDSCH, the command returns one value for each resource block of the PDSCH that has been analyzed.

`<absolute power>, ...`

The unit is always dBm.

The following parameters are supported.

- TRACE1
Returns the average power over all subframes
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

9.6.1.20 Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- TRACE1
Returns one value for each trace point.
`<absolute power>, ...`
The unit is always dBm.
- LIST
Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns nine values.
`<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, ...`
The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

9.6.1.21 UE RS Weights Magnitude

For the UE RS Weights Magnitude result display, the command returns one value for each subcarrier that has been analyzed.

`<Magnitude>, ...`

The unit dB.

The following parameters are supported.

- **TRACE1**
Returns the magnitude of the measured weights of the reference signal (RS) carriers over one subframe.

9.6.1.22 UE RS Weights Phase

For the UE RS Weights Phase result display, the command returns one value for each subcarrier that has been analyzed.

<Phase>, ...

The unit degrees.

The following parameters are supported.

- **TRACE1**
Returns the phase of the measured weights of the reference signal (RS) carriers over one subframe.

9.6.1.23 Return Value Codes

This chapter contains a list for encoded return values.

<ACK/NACK>

The range is {-1...1}.

- **1** = ACK
- **0** = NACK
- **-1** = DTX

<allocation ID>

Represents the allocation ID. 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>

Represents the codeword of an allocation. The range is {0...2}.

- 0 = 1/1
- 1 = 1/2
- 2 = 2/2

<DCI format>

Represents the DCi format. The value is a number in the range {0...103}.

- 0 = DCI format 0
- 10 = DCI format 1
- 11 = DCI format 1A
- 12 = DCI format 1B
- 13 = DCI format 1C
- 14 = DCI format 1D
- 20 = DCI format 2
- 21 = DCI format 2A
- 22 = DCI format 2B
- 30 = DCI format 3
- 31 = DCI format A
- 103 = DCI format 0/3/3A

<modulation>

Represents the modulation scheme. The range is {0...8}.

- 0 = unrecognized
- 1 = RBPSK
- 2 = QPSK
- 3 = 16QAM
- 4 = 64QAM
- 5 = 8PSK
- 6 = PSK
- 7 = mixed modulation
- 8 = BPSK

<number of symbols or bits>

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

<PHICH duration>

Represents the PHICH duration. The range is {1...2}.

- 1 = normal
- 2 = extended

<PHICH resource>

Represents the parameter N_g . The range is {1...4}.

- 1 = N_g 1/6
- 2 = N_g 1/2
- 3 = N_g 1
- 4 = N_g 2

TRACe[:DATA]? <Result>

This command returns the trace data for the current measurement or result display.

For more information see [chapter 9.6.1, "Using the TRACe\[:DATA\] Command"](#), on page 128.

Query parameters:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

LIST

PBCH

PCFICH

PHICH

PDCCH

Usage: Query only

9.6.2 Reading Out Limit Check Results

- [Checking Limits for Graphical Result Displays](#).....140
- [Checking Limits for Numerical Result Display](#).....143

9.6.2.1 Checking Limits for Graphical Result Displays

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?	140
CALCulate<n>:LIMit<k>:ACPower:ALternate:RESult?	141
CALCulate<n>:MARKer<m>:FUNctio:n:POWer:RESult[:CURRent]?.....	142
CALCulate<n>:LIMit<k>:OOPower:OFFPower?	142
CALCulate<n>:LIMit<k>:OOPower:TRANSient?	143

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Query parameters:

<Result>

ALL

Queries the overall limit check results.

REL

Queries the channel power limit check results.

ABS

Queries the distance to the limit line.

Return values:

<LimitCheck>

Returns two values, one for the upper and one for the lower adjacent channel.

1

Limit check has passed.

0

Limit check has failed.

Example:`CALC:LIM:ACP:ACH:RES? ALL`

Queries the results of the adjacent channel limit check.

Usage:

Query only

CALCulate<n>:LIMit<k>:ACPpower:ALTErnate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Query parameters:

<Result>

ALL

Queries the overall limit check results.

REL

Queries the channel power limit check results.

ABS

Queries the distance to the limit line.

Return values:

<LimitCheck>

Returns two values, one for the upper and one for the lower alternate channel.

1

Limit check has passed.

0

Limit check has failed.

Example:`CALC:LIM:ACP:ALT:RES? ALL`

Queries the results of the alternate channel limit check.

Usage:

Query only

CALCulate<n>:MARKer<m>:FUNction:Power:RESult[:CURRent]?

This command queries the current results of the ACLR measurement or the total signal power level of the SEM measurement.

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

Suffix:

<m> 1

Query parameters:

CPOW This parameter queries the signal power of the SEM measurement.

Return values:

<Result>

SEMResults

Power level in dBm.

ACLRResults

Relative power levels of the ACLR channels. The number of return values depends on the number of transmission and adjacent channels. The order of return values is:

- <TXChannelPower> is the power of the transmission channel in dBm
- <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
- <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
- <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
- <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
- (...)
- <nthLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
- <nthUpperAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example:

CALC1:MARK:FUNC:POW:RES?

Returns the current ACLR measurement results.

Usage:

Query only

CALCulate<n>:LIMit<k>:OOPower:OFFPower?

This command queries the results of the limit check in the "Off" periods of On/Off Power measurements.

Return values:

<OOPResults> Returns one value for every "Off" period.

1
Limit check has passed.

0
Limit check has failed.

Example:

CALC:LIM:OOP:OFFP?
Queries the results for the limit check during the signal Off periods.

Usage:

Query only

CALCulate<n>:LIMit<k>:OOPower:TRANsient?

This command queries the results of the limit check during the transient periods of the On/Off power measurement.

Query parameters:

<Result> **ALL**
Queries the overall limit check results.

FALLing
Queries the limit check results of falling transients.

RISing
Queries the limit check results of rising transients.

Return values:

<OOPResults> Returns one value for every "Off" period.

1
Limit check has passed.

0
Limit check has failed.

Example:

CALC:LIM:OOP:TRAN? RIS
Queries the limit check of rising transients.

Usage:

Query only

9.6.2.2 Checking Limits for Numerical Result Display

CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL]:MAXimum:RESult.....	144
CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL]:AVERAge]:RESult?.....	144
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP:MAXimum:RESult.....	144
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP[:AVERAge]:RESult?.....	144
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF:MAXimum:RESult.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF[:AVERAge]:RESult?.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST:MAXimum:RESult.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST[:AVERAge]:RESult?.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel:MAXimum:RESult.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel[:AVERAge]:RESult?.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal:MAXimum:RESult.....	146

CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGNal[:AVERAge]:RESult?.....	146
CALCulate<n>:LIMit<k>:SUMMary:FERRor:MAXimum:RESult.....	146
CALCulate<n>:LIMit<k>:SUMMary:FERRor[:AVERAge]:RESult?.....	146
CALCulate<n>:LIMit<k>:SUMMary:GIMBalance:MAXimum:RESult.....	147
CALCulate<n>:LIMit<k>:SUMMary:GIMBalance[:AVERAge]:RESult?.....	147
CALCulate<n>:LIMit<k>:SUMMary:IQOFFset:MAXimum:RESult.....	147
CALCulate<n>:LIMit<k>:SUMMary:IQOFFset[:AVERAge]:RESult?.....	147
CALCulate<n>:LIMit<k>:SUMMary:QUADerror:MAXimum:RESult.....	147
CALCulate<n>:LIMit<k>:SUMMary:QUADerror[:AVERAge]:RESult?.....	147
CALCulate<n>:LIMit<k>:SUMMary:SERRor:MAXimum:RESult.....	148
CALCulate<n>:LIMit<k>:SUMMary:SERRor[:AVERAge]:RESult?.....	148

CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL]:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL][:AVERAge]:RESult?

This command queries the results of the EVM limit check of all resource elements.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example:

CALC:LIM:SUMM:EVM:RES?

Queries the limit check.

Usage:

Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP[:AVERAge]:RESult?

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

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example:

CALC:LIM:SUMM:EVM:DSQP:RES?

Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF[:AVERage]:RESult?

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

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:DSSF:RES?`
 Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST[:AVERage]:RESult?

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

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:DSST:RES?`
 Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel[:AVERage]:RESult?

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

Return values:

<LimitCheck>

The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example:

```
CALC:LIM:SUMM:EVM:PCH:RES?
```

Queries the limit check.

Usage:

Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal:MAXimum:RESult

CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal[:AVERage]:RESult?

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

Return values:

<LimitCheck>

The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example:

```
CALC:LIM:SUMM:EVM:PSIG:RES?
```

Queries the limit check.

Usage:

Query only

CALCulate<n>:LIMit<k>:SUMMary:FERRor:MAXimum:RESult

CALCulate<n>:LIMit<k>:SUMMary:FERRor[:AVERage]:RESult?

This command queries the result of the frequency error limit check.

Return values:

<LimitCheck>

The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example: `CALC:LIM:SUMM:SERR:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:GIMBalance:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:GIMBalance[:AVERage]:RESult?

This command queries the result of the gain imbalance limit check.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example: `CALC:LIM:SUMM:GIMB:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:IQOFfset:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:IQOFfset[:AVERage]:RESult?

This command queries the result of the I/Q offset limit check.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example: `CALC:LIM:SUMM:IQOF:MAX:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:QUADerror:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:QUADerror[:AVERage]:RESult?

This command queries the result of the quadrature error limit check.

Return values:

<LimitCheck>

The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example:

```
CALC:LIM:SUMM:QUAD:RES?
```

Queries the limit check.

Usage:

Query only

CALCulate<n>:LIMit<k>:SUMMary:SERRor:MAXimum:RESult

CALCulate<n>:LIMit<k>:SUMMary:SERRor[:AVERage]:RESult?

This command queries the results of the sampling error limit check.

Return values:

<LimitCheck>

The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED

Limit check has failed.

PASSED

Limit check has passed.

NOTEVALUATED

Limits have not been evaluated.

Example:

```
CALC:LIM:SUMM:SERR:RES?
```

Queries the limit check.

Usage:

Query only

9.7 Remote Commands to Configure General Settings

9.7.1 Remote Commands for General Settings

This chapter contains remote control commands necessary to control the general measurement settings.

For more information see [chapter 4.1, "Configuring the Measurement"](#), on page 53.

9.7.1.1 Defining General Signal Characteristics

CONFigure[:LTE]:DUPLexing.....	149
CONFigure[:LTE]:LDIRection.....	149
[SENSe]:FREQUENCY:CENTer.....	149

CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>	TDD Time division duplex
	FDD Frequency division duplex
*RST:	FDD

Example:

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

CONFigure[:LTE]:LDIRection <Direction>

This command selects the link direction

Parameters:

<Direction>	DL Downlink
	UL Uplink

Example:

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

[SENSe]:FREQUENCY:CENTer <Frequency>

This command sets the center frequency for RF measurements.

Parameters:

<Frequency>	<numeric value>
Range:	fmin to fmax
*RST:	1 GHz
Default unit:	Hz

Example:

```
FREQ:CENT 2GHZ
Set the center frequency to 2 GHz.
```

9.7.1.2 Selecting the Input Source

SENSe:INPut.....	150
------------------	-----

SENSe:INPut <Source>

This command selects the signal source.

Parameters:

<Source>	RF Select radio frequency input as signal source.
	AIQ Select analog I/Q input (baseband) as signal source.
	DIQ Select digital I/Q input as signal source.

Example:

```
INP DIQ
Select digital I/Q as signal source.
```

9.7.1.3 Configuring the Input Level

[SENSe]:POWer:AUTO<analyzer>[:STATe].....	150
CONFigure:POWer:EXPEcted:RF<analyzer>.....	150
CONFigure:POWer:EXPEcted:IQ<analyzer>.....	151
INPut<n>:ATTenuation<analyzer>.....	151
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet.....	151

[SENSe]:POWer:AUTO<analyzer>[:STATe] <State>

This command initiates a measurement that determines the ideal reference level.

Parameters:

<State>	OFF Performs no automatic reference level detection.
	ON Performs an automatic reference level detection before each measurement.
	ONCE Performs an automatic reference level once.
	*RST: ON

Example:

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

CONFigure:POWer:EXPEcted:RF<analyzer> <RefLevel>

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

Parameters:

<RefLevel>	*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.
```

CONFigure:POWer:EXPeCted:IQ<analyzer> <RefLevel>

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

Parameters:

<RefLevel> <numeric value>
 Range: 31.6 mV to 5.62 V
 *RST: 1 V
 Default unit: V

Example:

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

INPut<n>:ATTenuation<analyzer> <Attenuation>

This command sets the RF attenuation level.

Parameters:

<Attenuation> <numeric value>
 *RST: 5 dB
 Default unit: dB

Example:

INP:ATT 10
 Defines an RF attenuation of 10 dB.

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

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

Parameters:

<Attenuation> <numeric value>
 *RST: 0
 Default unit: dB

Example:

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

9.7.1.4 Configuring the Data Capture

[SENSe]:SWEep:TIME.....	151
[SENSe][:LTE]:FRAMe:COUNT:STATe.....	152
[SENSe][:LTE]:FRAMe:COUNT.....	152
[SENSe][:LTE]:FRAMe:COUNT:AUTO.....	152

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength> Numeric value in seconds.
 Default unit: s

Example: `SWE:TIME 40`
 Defines a capture time of 40 seconds.

[SENSe][:LTE]:FRAMe:COUNT:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<State> **ON**
 You can set the number of frames to analyze.

OFF
 The analyzer analyzes a single sweep.

*RST: ON

Example: `FRAM:COUN:STAT ON`
 Turns manual setting of number of frames to analyze on.

[SENSe][:LTE]:FRAMe:COUNT <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes> <numeric value>

*RST: 1

Example: `FRAM:COUN:STAT ON`
 Activates manual input of frames to be analyzed.

`FRAM:COUN 20`
 Analyzes 20 frames.

[SENSe][:LTE]:FRAMe:COUNT:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State> **ON**
 Selects the number of frames to analyze according to the LTE standard.

OFF
 Turns manual selection of the frame number on.

Example: `FRAM:COUN:AUTO ON`
 Turns automatic selection of the analyzed frames on.

9.7.1.5 Configuring Measurement Results

UNIT:EVM.....	153
UNIT:BSTR.....	153
[SENSe][:LTE]:ANTenna:SElect.....	153
[SENSe][:LTE]:SUBFrame:SElect.....	153

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit>	DB EVM results returned in dB
	PCT EVM results returned in %
*RST:	PCT

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

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit>	SYMBOLS Displays the bit stream using symbols
	BITS Displays the bit stream using bits
*RST:	SYMBOLS

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

[SENSe][:LTE]:ANTenna:SElect <Antenna>

Configures which antenna shall be used for analysis.

Parameters:

<Antenna>	<numeric value>
*RST:	1

Example: SENS:ANT:SEL 2
Select antenna 2 for analysis.

[SENSe][:LTE]:SUBFrame:SElect <Subframe>

This command selects the subframe to be analyzed.

Parameters:

<Subframe> ALL | <numeric value>

ALL

Select all subframes

0...39

Select a single subframe

*RST: ALL

Example:

SUBF:SEL ALL

Select all subframes for analysis.

9.7.1.6 Configuring On/Off Power Measurements

[SENSe][:LTE]:OOPower:NCORrection.....	154
CONFigure[:LTE]:OOPower:NFRames.....	154

[SENSe][:LTE]:OOPower:NCORrection <NoiseCorrection>

This command turns noise correction for On/Off Power measurements on and off.

Parameters:

<NoiseCorrection> ON | OFF

CONFigure[:LTE]:OOPower:NFRames <Frames>

This command defines the number of frames that are analyzed for On/Off Power measurements.

Parameters:

<Frames> <numeric value>

Example:

CONF:OOP:NFR 10

Defines 10 frames to be analyzed.

9.7.2 Configuring MIMO Measurement Setups

Commands useful to configure MIMO setups described elsewhere:

- [CONFigure\[:LTE\]:DL:MIMO:ASElection](#) on page 169
- [CONFigure\[:LTE\]:DL:MIMO:CONFig](#) on page 168

CONFigure:ADDRESS<analyzer>.....	154
----------------------------------	-----

CONFigure:ADDRESS<analyzer> <Address>

This command defines the network address of an analyzer in a MIMO measurement setup.

Parameters:

<Address> String containing the address of the analyzer.
Connections are possible via TCP/IP or GPIB. Depending on the type of connection, the string has the following syntax.
'GPIB[board]::<PrimaryAddress>[:<SecondaryAddress>][:INSTR]'
'TCPIP[board]::<HostAddress>[:<LANDeviceName>][:INSTR]'
Elements in square brackets are optional.

Example:

```
CONF:ADDR 'TCPIP::192.168.0.1'
```

Defines a TCP/IP connection for the first analyzer in the test setup.

```
CONF:ADDR 'GPIB::28'
```

Defines a GPIB connection for the first analyzer in the test setup.

9.7.3 Using a Trigger

TRIGger[:SEquence]:MODE.....	155
TRIGger[:SEquence]:HOLDoff<analyzer>.....	155
TRIGger[:SEquence]:LEVel<analyzer>[:EXTeRnal].....	156
TRIGger[:SEquence]:LEVel<analyzer>:POWeR.....	156
TRIGger[:SEquence]:SLOPe.....	156

TRIGger[:SEquence]:MODE <Source>

This command selects the trigger source.

Parameters:

<Source>

EXTeRnal
Selects external trigger source.

IMMeDiate
Selects free run trigger source.

POWeR
Selects IF power trigger source.

TUNit
Selects the trigger unit R&S FS-Z11 as the trigger source.

```
*RST:      IMMeDiate
```

Example:

```
TRIG:MODE EXT
```

Selects an external trigger source.

TRIGger[:SEquence]:HOLDoff<analyzer> <Offset>

This command defines the trigger offset.

Parameters:

<Offset> <numeric value>
*RST: 0 s
Default unit: s

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

TRIGger[:SEQuence]:LEVel<analyzer>[:EXternal] <Level>

This command defines the level for an external trigger.

Parameters:

<Level> Range: 0.5 V to 3.5 V
 *RST: 1.4 V
 Default unit: V

Example: TRIG:LEV 2V
Defines a trigger level of 2 V.

TRIGger[:SEQuence]:LEVel<analyzer>:POWer <Level>

This command defines the trigger level for an IF power trigger.

Parameters:

<Level> Default unit: DBM

Example: TRIG:LEV:POW 10
Defines a trigger level of 10 dBm.

TRIGger[:SEQuence]:SLOPe <Slope>

This command selects the trigger slope.

Parameters:

<Slope> **POSitive**
 Triggers a measurement when the signal rises to the trigger level.
 NEGative
 Triggers a measurement when the signal falls to the trigger level.

Example: TRIG:SLOP POS
Selects a positive trigger slope.

9.7.4 Configuring Spectrum Measurements

- [Configuring SEM and ACLR Measurements](#).....156

9.7.4.1 Configuring SEM and ACLR Measurements

[SENSe]:POWer:SEM:CATegory	157
[SENSe]:POWer:ACHannel:AACHannel	157
[SENSe]:POWer:NCORrection	157
[SENSe]:SWEp:EGATe:AUTO	158

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

This command selects the SEM limit category as defined in 3GPP TS 36.104.

Parameters:

<Category> A | B | B1 | B2 | LARE | HOME

A
Category A (Wide Area base station)

B1
Category B Opt 1 (Wide Area base station)

B2
Category B Opt 2 (Wide Area base station)

HOME
Home base station

LARE
Local Area base station

*RST: A

Example:

POW:SEM:CAT B
Selects SEM category B.

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

This command selects the assumed adjacent channel carrier for ACLR measurements.

Parameters:

<Channel> **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:

POW:ACH:AACH UTRA384
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

[SENSe]:POWer:NCORrection <State>

This command turns noise correction for ACLR measurements on and off.

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

POW:NCOR ON
 Activates noise correction.

[SENSe]:SWEep:EGATe:AUTO <State>

This command turns auto gating for SEM and ACLR measurements on and off.

This command is available for TDD measurements in combination with an external or IF power trigger.

Parameters:

<State> **ON**
 Evaluates the on-period of the LTE signal only.
OFF
 Evaluates the complete signal.

Example:

SWE:EGAT:AUTO ON
 Turns auto gating on.

9.7.5 Remote Commands for Advanced Settings

This chapter contains all remote control commands to control the advanced settings.

For more information on advanced settings see [chapter 4.5, "Advanced Settings"](#), on page 65.

9.7.5.1 Controlling I/Q Data

[\[SENSe\]:SWAPiq.....158](#)

[SENSe]:SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

SWAP ON
 Turns a swap of the I and Q branches on.

9.7.5.2 Configuring the Baseband Input

INPut:IQ:IMPedance.....	159
INPut:IQ:BALanced[:STATe].....	159
[SENSe]:IQ:LPASs[:STATe].....	159
[SENSe]:IQ:DITHer[:STATe].....	159

INPut:IQ:IMPedance <Impedance>

This command selects the input impedance for I/Q inputs.

Parameters:

<Impedance> LOW | HIGH
 *RST: LOW

Example:

INP:IQ:IMP LOW
 Selects low input impedance for I/Q input.

INPut:IQ:BALanced[:STATe] <State>

This command selects if the I/Q inputs are symmetrical (balanced) or asymmetrical (unbalanced)

Parameters:

<State> ON | OFF
 *RST: ON

Example:

INP:IQ:BAL ON
 Specifies symmetrical (balanced) IQ inputs.

[SENSe]:IQ:LPASs[:STATe] <State>

This command turns a baseband input lowpass filter on and off.

Parameters:

<State> ON | OFF
 *RST: ON

Example:

IQ:LPAS ON
 Activate the input lowpass.

[SENSe]:IQ:DITHer[:STATe] <State>

This command adds or removes a noise signal into the signal path (dithering).

Parameters:

<State> ON | OFF
 *RST: OFF

Example:

IQ:DITH ON
 Activate input dithering.

9.7.5.3 Using Advanced Input Settings

[SENSe]:POWer:AUTO<analyzer>:TIME.....160

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

This command defines the track time for the auto level process.

Parameters:

<Time> <numeric value>
 *RST: 100 ms
 Default unit: s

Example:

POW:AUTO:TIME 200ms
 An auto level track time of 200 ms gets set.

9.7.5.4 Configuring the Digital I/Q Input

The digital I/Q input is available with option R&S FSQ-B17 or R&S FSV-B17.

INPut<n>:DIQ:RANGe[:UPPer].....160

INPut<n>:DIQ:SRATe.....160

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

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

Parameters:

<ScaleLevel> *RST: 1 V
 Default unit: V

Example:

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

INPut<n>:DIQ:SRATe <SampleRate>

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

Parameters:

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

Example:

INP:DIQ:SRAT 10MHZ
 Defines a sampling rate of 10 MHz.

9.7.5.5 Configuring Home Base Stations

[SENSe]:POWer:SEM:CHBS:AMPower.....160

[SENSe]:POWer:SEM:CHBS:AMPower <Power>

This command defines the aggregated maximum power for home base stations.

Parameters:

<Power> Numeric value that defines the maximum aggregate power.
 Default unit: dBm

Example:

POW:SEM:CHBS:AMP 0
 Defines a power of 0 dBm.

9.8 Remote Command to Configure the Demodulation

- [Remote Commands for PDSCH Demodulation Settings](#)..... 161
- [Remote Commands for DL Signal Characteristics](#)..... 165
- [Remote Commands for DL Advanced Signal Characteristics](#)..... 173

9.8.1 Remote Commands for PDSCH Demodulation Settings

This chapter contains remote commands necessary to define PDSCH demodulation.

For more information see [chapter 5.1, "Configuring Downlink Signal Demodulation"](#), on page 70.

9.8.1.1 Selecting the Demodulation Method

[SENSe][:LTE]:DL:DEMod:AUTO	161
[SENSe][:LTE]:DL:FORMat:PSCD	161

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

This command turns automatic demodulation for downlink signals on and off.

Parameters:

<State> ON | OFF
 *RST: ON

Example:

DL:DEM:AUTO ON
 Activates the auto-demodulation for DL.

[SENSe][:LTE]:DL:FORMat:PSCD <Format>

This command selects the method of identifying the PDSCH resource allocation.

Parameters:

<Format>

OFF

Applies the user configuration of the PDSCH subframe regardless of the signal characteristics.

PDCCH

Identifies the configuration according to the data in the PDCCH DCIs.

PHYDET

Manual PDSCH configuration: analysis only if the actual subframe configuration matches the configured one.

Automatic PDSCH configuration: physical detection of the configuration.

*RST: PHYD

Example:

DL:FORM:PSCD OFF

Applies the user configuration and does not check the received signal

9.8.1.2 Configuring Multicarrier Base Stations

[SENSe][:LTE]:DL:DEMod:MCFilter.....162

[SENSe][:LTE]:DL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State>

ON | OFF

*RST: OFF

Example:

DL:DEM:MCF ON

Turns suppression on of neighboring carriers on.

9.8.1.3 Configuring Parameter Estimation

[SENSe][:LTE]:DL:DEMod:BESTimation.....162

[SENSe][:LTE]:DL:DEMod:CESTimation.....163

[SENSe][:LTE]:DL:DEMod:BESTimation <State>

This command turns boosting estimation for downlink signals on and off.

Parameters:

<State>

ON | OFF

*RST: ON

Example:

DL:DEM:BEST ON

Turns boosting estimation on.

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

This command selects the channel estimation type for downlink signals.

Parameters:

<Type> **TGPP**
 3GPP EVM definition

PIL
 Optimal, pilot only

PILP
 Optimal, pilot and payload

*RST: TGPP

Example:

DL:DEM:CEST TGPP
 Use 3GPP EVM definition for channel estimation.

9.8.1.4 Compensating Measurement Errors

[SENSe][:LTE]:DL:TRACking:PHASe.....	163
[SENSe][:LTE]:DL:TRACking:TIME.....	163

[SENSe][:LTE]:DL:TRACking:PHASe <Type>

This command selects the phase tracking type for downlink signals.

Parameters:

<Type> **OFF**
 Deactivate phase tracking

PIL
 Pilot only

PILP
 Pilot and payload

*RST: OFF

Example:

DL:TRAC:PHAS PILPAY
 Use pilots and payload for phase tracking.

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

This command turns timing tracking for downlink signals on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example:

DL:TRAC:TIME ON
 Activates timing tracking.

9.8.1.5 Configuring EVM Measurements

[SENSe][:LTE]:DL:DEMod:EVMCalc.....	164
[SENSe][:LTE]:DL:DEMod:PRData.....	164

[SENSe][:LTE]:DL:DEMod:EVMCalc <Calculation>

This command selects the EVM calculation method for downlink signals.

Parameters:

<Calculation>	TGPP 3GPP definition
	OTP Optimal timing position
	*RST: TGPP

Example:

DL:DEM:EVMC TGPP
Use 3GPP method.

[SENSe][:LTE]:DL:DEMod:PRData <Reference>

This command the type of reference data to calculate the EVM for the PDSCH.

Parameters:

<Reference>	AUTO Automatic identification of reference data.
	ALL0 Reference data is 0, according to the test model definition.

Example:

DL:DEM:PRD ALL0
Sets the reference data of the PDSCH to 0.

9.8.1.6 Processing Demodulated Data

[SENSe][:LTE]:DL:DEMod:CBSCrambling.....	164
[SENSe][:LTE]:DL:DEMod:DACHannels.....	165

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

This command turns scrambling of coded bits for downlink signals on and off.

Parameters:

<State>	ON OFF
	*RST: ON

Example:

DL:DEM:CBSC ON
Activate scrambling of coded bits.

[SENSe][:LTE]:DL:DEMod:DACHannels <State>

This command turns the decoding of all control channels on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example:

DL:DEM:DACH ON
Turns decoding of all control channels on.

9.8.1.7 Configuring MIMO Setups

CONFigure[:LTE]:DL:MIMO:CROStalk.....165

CONFigure[:LTE]:DL:MIMO:CROStalk <State>

This command turns MIMO crosstalk compensation on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example:

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

9.8.2 Remote Commands for DL Signal Characteristics

This chapter contains remote commands necessary to define downlink signal characteristics.

For more information see [chapter 5.2, "Defining Downlink Signal Characteristics"](#), on page 75.

9.8.2.1 Defining the Physical Signal Characteristics

CONFigure[:LTE]:DL:BW.....165
CONFigure[:LTE]:DL:NORB.....166
CONFigure[:LTE]:DL:CYCPrefix.....166
CONFigure[:LTE]:DL:TDD:UDConf.....166
CONFigure[:LTE]:DL:TDD:SPSC.....166

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

This command selects the downlink bandwidth.

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 |
BW20_00
*RST: BW10_00

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

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

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

Parameters:

<ResourceBlocks> <numeric value>
*RST: 50

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

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

This command selects the cyclic prefix for downlink signals.

Parameters:

<PrefixLength> **NORM**
Normal cyclic prefix length
EXT
Extended cyclic prefix length
AUTO
Automatic cyclic prefix length detection
*RST: AUTO

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

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

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

Parameters:

<Configuration> Range: 0 to 6
*RST: 0

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

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

Selects the configuration of a TDD special subframe.

Parameters:

<Configuration> <numeric value>

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

Range: 0 to 8

*RST: 0

Example:

CONF:DL:CYCP NORM

Selects normal cyclic prefix.

CONF:DL:TDD:SPSC 7

Selects subframe configuration 7, available only with a normal cyclic prefix.

9.8.2.2 Configuring the Physical Layer Cell Identity

CONFigure[:LTE]:DL:PLC:CID.....	167
CONFigure[:LTE]:DL:PLC:CIDGroup.....	167
CONFigure[:LTE]:DL:PLC:PLID.....	168
FETCH:PLC:CIDGroup?.....	168
FETCH:PLC:PLID?.....	168

CONFigure[:LTE]:DL:PLC:CID <CellId>

This command defines the cell ID.

Parameters:

<CellId>

AUTO

Automatically defines the cell ID.

<numeric value>

Number of the cell ID.

Range: 0 to 503

Example:

CONF:DL:PLC:CID 12

Defines the cell ID 12.

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

This command selects the cell ID group for downlink signals.

Parameters:

<GroupNumber>

AUTO

Automatic selection

0...167

Manual selection

*RST: AUTO

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

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

This command defines the physical layer cell identity for ownlink signals.

Parameters:

<Identity> **AUTO**
 Automatic selection
 0...2
 Manual selection
 *RST: AUTO

Example: `CONF:DL:PLC:PLID 1`
 Selects physical layer cell ID 2.

FETCh:PLC:CIDGroup?

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

Return values:

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

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

Usage: Query only

FETCh:PLC:PLID?

This command queries the cell identity that has been detected.

Return values:

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

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

Usage: Query only

9.8.2.3 Configuring MIMO Setups

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

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

Parameters:

<NofAntennas> **TX1**
 Use one Tx-antenna

TX2
 Use two Tx-antennas

TX4
 Use four Tx-antennas

*RST: TX1

Example:

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

CONFigure[:LTE]:DL:MIMO:ASElection <Antenna>

This command selects the antenna for measurements with MIMO setups.

Parameters:

<Antenna> **ANT1 | ANT2 | ANT3 | ANT4**
 Select a single antenna to be analyzed

ALL
 Select all antennas to be analyzed

AUT1 | AUT2 | AUT4
 Automatically selects the antenna(s) to be analyzed.
 AUT1 tests a single antenna, AUT2 tests two antennas, AUT4
 tests four antennas.

*RST: ANT1

Example:

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

9.8.2.4 Configuring PDSCH Subframes

CONFigure[:LTE]:DL:CSUBframes.....	170
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALCount.....	170
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:UEID.....	170
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]: MODulation.....	170
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount.....	171
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOffset.....	171
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWER.....	171
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:AP.....	171
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CBIndex.....	172
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CLMapping.....	172
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CDD.....	172
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding[:SCHeme].....	172
CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:SCID.....	173

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

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

Parameters:

<NofSubframes> Range: 0 to 39
 *RST: 1

Example:

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

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

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

Parameters:

<NofAllocations> <numeric value>
 *RST: 1

Example:

CONF:DL:SUBF2:ALC 5
 Defines 5 allocations for subframe 2.

CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:UEID <ID>

This command defines the ID or N_RNTI.

Parameters:

<ID> ID of the user equipment.

Example:

CONF:DL:SUBF2:ALL5:UEID 5
 Assigns the ID 5 to allocation 5 in subframe 2.

**CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[:CW<Cwnum>]:
MODulation <Modulation>**

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

Suffix:

<Cwnum> 1..n
 Selects the codeword.

Parameters:

<Modulation> **QPSK**
 QPSK modulation
 QAM16
 16QAM modulation
 QAM64
 64QAM modulation
 *RST: QPSK

Remote Command to Configure the Demodulation

Example: `CONF:DL:SUBF2:ALL5:CW2:MOD QAM64`
 Selects a 64QAM modulation for the second codeword of allocation 5 in subframe 2.

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

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

Parameters:
 <ResourceBlocks> <numeric value>
 *RST: 6

Example: `CONF:DL:SUBF2:ALL5:RBC 25`
 Defines 25 resource block for allocation 5 in subframe 2.

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

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

Parameters:
 <Offset> <numeric value>
 *RST: 0

Example: `CONF:DL:SUBF2:ALL5:RBOF 3`
 Defines a resource block offset of 3 for allocation 5 in subframe 2.

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

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

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

Example: `CONF:DL:SUBF2:ALL5:POW -1.3`
 Defines a relative power of 1.3 dB for allocation 5 in subframe 2.

CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:AP
 <Port>

This command selects the antenna port for the beamforming scheme.

The command is available if the codeword to layer mapping is 1/1.

Parameters:
 <Port> 5 | 7 | 8

Remote Command to Configure the Demodulation

Example: `CONF:DL:SUBF2:ALL3:PREC:AP 5`
 Selects antenna port 5 for beamforming in allocation 3 in subframe 2.

**CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:
 CBIndex <CBIndex>**

This command selects the codebook index for an allocation with spatial multiplexing precoding scheme.

Parameters:
 <CBIndex> 0...15
 *RST: 1

Example: `CONF:DL:SUBF2:ALL4:PREC:CBIN 3`
 Selects codebook index 3 for allocation 4 in subframe number 2.

**CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:
 CLMapping <Mapping>**

This command selects the codeword to layer mapping.

Parameters:
 <Mapping> LC11 | LC21 | LC22 | LC32 | LC42

Example: `CONF:DL:SUBF2:ALL3:PREC:CLM LC11`
 Assigns codeword-to-layer mapping 1/1 to allocation 3 in subframe 2.

**CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:
 CDD <State>**

This command turns the cyclic delay diversity of an allocation with spatial multiplexing precoding scheme on and off.

Parameters:
 <State> ON | OFF
 *RST: OFF

Example: `CONF:DL:SUBF2:ALL3:PREC:CDD ON`
 Turns the cyclic delay diversity for allocation 3 in subframe 2 on.

**CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding[:
 SCHEME] <Scheme>**

This command selects the precoding scheme of an allocation.

Parameters:

<Scheme> **NONE**
Do not use a precoding scheme.

BF
Use beamforming scheme.

SPM
Use spatial multiplexing scheme.

TXD
Use transmit diversity scheme.

*RST: NONE

Example:

```
CONF:DL:SUBF2:ALL3:PREC:SCH SPM
```

Selects the spatial multiplexing precoding scheme for allocation 3 in subframe 2.

**CONFigure[:LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:
SCID <ID>**

This command selects the scrambling identity (nSCID).

The command is available for antenna ports 7 and 8.

Parameters:

<ID> 0 | 1

Example:

```
CONF:DL:SUBF2:ALL4:PREC:SCID 1
```

Selects scrambling identity 1 for allocation 4 in subframe 2.

9.8.3 Remote Commands for DL Advanced Signal Characteristics

This chapter contains remote commands necessary to define advanced downlink signal characteristics.

For more information see [chapter 5.3, "Defining Advanced Signal Characteristics"](#), on page 84.

9.8.3.1 Configuring the Synchronization Signal

CONFigure[:LTE]:DL:SYNC:ANTenna.....	173
CONFigure[:LTE]:DL:SYNC:PPOWer.....	174
CONFigure[:LTE]:DL:SYNC:SPOWer.....	174

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

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

Parameters:

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

*RST: ALL

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

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

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

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

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

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

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

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

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

9.8.3.2 Configuring the Reference Signal

[CONFigure\[:LTE\]:DL:REFSig:POWer](#).....174

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

This command defines the relative power of the reference signal.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

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

9.8.3.3 Configuring the Positioning Reference Signal

[CONFigure\[:LTE\]:DL:PRSS:STATe](#).....175

[CONFigure\[:LTE\]:DL:PRSS:BW](#).....175

[CONFigure\[:LTE\]:DL:PRSS:Cl](#).....175

Remote Command to Configure the Demodulation

CONFigure[LTE]:DL:PRSS:NPRS.....	175
CONFigure[LTE]:DL:PRSS:POWer.....	175
CONFigure[LTE]:DL:SFNO.....	176

CONFigure[LTE]:DL:PRSS:STATE <State>

This command turns the positioning reference signal on and off.

Parameters:

<State> ON | OFF

Example:

```
CONF:DL:PRSS:STAT ON
```

Turns the positioning reference signal on.

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

This command defines the bandwidth of the positioning reference signal.

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 |
BW20_00
*RST: BW1_40
Default unit: MHz

Example:

```
CONF:DL:PRSS:BW BW5_00
```

Defines a 5 MHz bandwidth for the positioning reference signal.

CONFigure[LTE]:DL:PRSS:CI <PRSSConfiguration>

This command selects the configuration index of the Positioning Reference Signal.

Parameters:

<PRSSConfiguration> Number of the configuration index.

Example:

```
CONF:DL:PRSS:CI 2
```

Selects configuration index 2 for the positioning reference signal.

CONFigure[LTE]:DL:PRSS:NPRS <NofDLSubframes>

This command defines the number of subframes the Positioning Reference Signal occupies.

Parameters:

<NofDLSubframes> 1 | 2 | 4 | 6

Example:

```
CONF:DL:PRSS:NPRS 1
```

Defines 1 subframe for the positioning reference signal.

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

This command defines the relative power of the Positioning Reference Signal.

Remote Command to Configure the Demodulation

Parameters:

<Power> Default unit: dB

Example:

CONF:DL:PRSS:POW 1

Defines a relative power of 1 dB for the positioning reference signal.

CONFigure[:LTE]:DL:SFNO <Offset>

This command defines the frame number offset for the positioning reference signal.

Parameters:

<Offset> <numeric value>

Example:

CONF:DL:SFNO 4

Defines a frame number offset of 4.

9.8.3.4 Configuring the CSI Reference Signal

CONFigure[:LTE]:DL:CSIRs:CI.....	176
CONFigure[:LTE]:DL:CSIRs:NAP.....	176
CONFigure[:LTE]:DL:CSIRs:POWer.....	177
CONFigure[:LTE]:DL:CSIRs:SCI.....	177
CONFigure[:LTE]:DL:CSIRs:STATe.....	177

CONFigure[:LTE]:DL:CSIRs:CI <CSIRSConfiguration>

This command selects the configuration index for the CSI reference signal.

Parameters:

<CSIRSConfiguration>MNEM

Number of the configuration index.

Range: 0 to 31

Example:

CONF:DL:CSIR:CI 12

Selects configuration index 12 for the CSI reference signal.

CONFigure[:LTE]:DL:CSIRs:NAP <Ports>

This command selects the number of antenna ports that transmit the CSI reference signal.

Parameters:

<Ports> **TX1**
TX2
TX3
TX4

Example:

CONF:DL:CSIR:NAP 2

Selects 2 antenna ports for the CSI reference signal transmission.

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

This command defines the relative power of the CSI reference signal.

Parameters:

<Power> Default unit: dB

Example:

CONF:DL:CSIR:POW 1

Defines a relative power of 1 dB for the CSI reference signal.

CONFigure[:LTE]:DL:CSIRs:SCI <CSIRSSubframeConfig>

This command defines the subframe configuration for the CSI reference signal.

Parameters:

<CSIRSSubframeConfig> Number that selects the subframe configuration.

Range: 0 to 154

Example:

CONF:DL:CSIR:SCI 4

Selects subframe configuration 4 for the CSI reference signal.

CONFigure[:LTE]:DL:CSIRs:STATe <State>

This command turns the CSI reference signal on and off.

Parameters:

<State> ON | OFF

Example:

CONF:DL:CSIR:STAT ON

Turns the CSI reference signal on.

9.8.3.5 Configuring the Control Channel

CONFigure[:LTE]:DL:PBCH:STAT.....	177
CONFigure[:LTE]:DL:PCFich:STAT.....	178
CONFigure[:LTE]:DL:PHICH:DURation.....	178
CONFigure[:LTE]:DL:PHICH:NGParameter.....	178
CONFigure[:LTE]:DL:PDCCh:FORMat.....	179
CONFigure[:LTE]:DL:PHICH:MITM.....	179
CONFigure[:LTE]:DL:PHICH:NOGRoups.....	179
CONFigure[:LTE]:DL:PDCCh:NOPD.....	179
CONFigure[:LTE]:DL:PBCH:POWer.....	180
CONFigure[:LTE]:DL:PCFich:POWer.....	180
CONFigure[:LTE]:DL:PHICH:POWer.....	180
CONFigure[:LTE]:DL:PDCCh:POWer.....	180

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

This command turns the PBCH on and off.

Remote Command to Configure the Demodulation

Parameters:

<State> ON | OFF
 *RST: ON

Example:

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

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

This command turns the PCFICH on and off.

Parameters:

<State> ON | OFF
 *RST: ON

Example:

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

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

This command selects the PHICH duration.

Parameters:

<Duration> **NORM**
 Normal
EXT
 Extended
 *RST: NORM

Example:

CONF:DL:PHICH:DUR NORM
 Selects normal PHICH duration.

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

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

Parameters:

<Ng> NG1_6 | NG1_2 | NG1 | NG2 | NGCUSTOM
 Select NG_CUSTOM to customize N_g . You can then define the variable as you like with [CONFigure\[:LTE\]:DL:PHICH:NOGRoups](#).
 *RST: NG1_6

Remote Command to Configure the Demodulation

Example: `CONF:DL:PHIC:NGP NG1_6`
 Sets N_g to 1/6. The number of PHICH groups in the subframe depends on the number of resource blocks.

`CONF:DL:PHIC:NGP NG_CUSTOM`
 Define a customized value for N_g .

`CONF:DL:PHIC:NOGR 5`
 Directly sets the number of PHICH groups in the subframe to 5.

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

This command selects the PDCCH format.

Parameters:

<Format> -1 | 0 | 1 | 2 | 3
 *RST: -1

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

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

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

Parameters:

<State> ON | OFF
 *RST: OFF

Example: `CONF:DL:PHICH:MITM ON`
 Activates PHICH TDD $m_i=1$ (E-TM)

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

This command sets the number of PHICH groups.

Parameters:

<NofGroups> <numeric value>
 *RST: 0

Example: `CONF:DL:PHICH:NOGR 5`
 Sets number of PHICH groups to 5.

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

This command sets the number of PDCCHs.

Parameters:

<NofPDCCH> <numeric value>
 *RST: 0

Remote Command to Configure the Demodulation

Example: `CONF:DL:PDCCH:NO PD 3`
Sets the number of DPCCCHs to 3.

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

This command defines the relative power of the PBCH.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

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

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

This command defines the relative power of the PCFICH.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

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

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

This command defines the relative power of the PHICH.

Parameters:

<Power> <numeric value>
*RST: -3.01 dB
Default unit: DB

Example: `CONF:DL:PHIC:POW -1.3`
Sets the relative power to -1.3 dB.

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

This command defines the relative power of the PDCCH.

Parameters:

<Power> <numeric value>
*RST: 0 dB
Default unit: DB

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

9.8.3.6 Defining the PDSCH Resource Block Symbol Offset

CONFigure[:LTE]:DL:PSOffset <Offset>

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

The offset applies to all subframes.

Parameters:

<Offset>	AUTO Automatically determines the symbol offset.
	<numeric value> Manual selection of the symbol offset.
	Range: 0 to 4
	*RST: AUTO

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

9.8.3.7 Configuring Shared Channels

CONFigure[:LTE]:DL:PDSCh:PB.....181

CONFigure[:LTE]:DL:PDSCh:PB <PDSChPB>

This command selects the PDSCH power ratio.

Note that the power ratio depends on the number of antennas in the system.

Parameters:

<PDSChPB>	Numeric value that defines PDSCH P_B which defines the power ratio in dB.
	0
	1
	2
	3
	See PDSCH Power Ratio for an overview of resulting power ratios.
	RAT1 Ratio = 1, regardless of the number of antennas.

Example: CONF:DL:PDSC:PB 3
Selects the PDSCH P_B '3'.

9.9 Configuring the Software

CONFigure:PRESet.....182
DISPlay[:WINDow<n>]:SElect.....182

CONFigure:PRESet

Initiates a preset to the default state of the software, and, if connected to an analyzer, also presets the analyzer.

Example: `CONF:PRES`
Presets the software.

Usage: Event

DISPlay[:WINDow<n>]:SElect

This command selects the measurement window.

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

Usage: Event

9.10 Managing Files

FORMat[:DATA]	182
MMEMory:LOAD:DEModsetting	182
MMEMory:LOAD:IQ:STATE	183
MMEMory:LOAD:TMOD:DL	183
MMEMory:STORe:DEModsetting	183

FORMat[:DATA] [<Format>]

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

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

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

MMEMory:LOAD:DEModsetting <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Setting parameters:
<Path> String containing the path and name of the file.

Example: `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

Usage: Setting only

MMEMory:LOAD:IQ:STATe <Path>

This command restores I/Q data from a file.

Parameters:

1

Setting parameters:

<Path> String containing the path and name of the source file.

Example:

```
MMEM:LOAD:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'
```

Loads IQ data from the specified file.

Usage:

Setting only

MMEMory:LOAD:TMOD:DL <TestModel>

This command loads an EUTRA test model (E-TM).

The test models are in accordance with 3GPP TS 36.141.

Setting parameters:

<TestModel>	'E-TM1_1__10MHz' EUTRA Test Model 1.1 (E-TM1.1)
	'E-TM1_2__10MHz' EUTRA Test Model 1.2 (E-TM1.2)
	'E-TM2__10MHz' EUTRA Test Model 2 (E-TM2)
	'E-TM3_1__10MHz' EUTRA Test Model 3.1 (E-TM3.1)
	'E-TM3_2__10MHz' EUTRA Test Model 3.2 (E-TM3.2)
	'E-TM3_3__10MHz' EUTRA Test Model 3.3 (E-TM3.3)

Example:

```
MMEM:LOAD:TMOD:DL 'E-TM2__10MHz'
```

Selects test model 2 for a 10 MHz bandwidth.

Usage:

Setting only

MMEMory:STORe:DEModsetting <Path>

Stores the current demodulation settings to a file. The resulting file type is "*.allocation". Existing files will be overwritten.

Setting parameters:

<Path>

Example:

```
MMEM:STOR:DEM 'D:\USER\Settingsfile.allocation'
```

Usage:

Setting only

List of Commands

CALCulate<n>:FEED.....	118
CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?.....	140
CALCulate<n>:LIMit<k>:ACPower:ALternate:RESult?.....	141
CALCulate<n>:LIMit<k>:OOPower:OFFPower?.....	142
CALCulate<n>:LIMit<k>:OOPower:TRANSient?.....	143
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP:MAXimum:RESult.....	144
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSQP[:AVERAge]:RESult?.....	144
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF:MAXimum:RESult.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSSF[:AVERAge]:RESult?.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST:MAXimum:RESult.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:DSST[:AVERAge]:RESult?.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel:MAXimum:RESult.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel[:AVERAge]:RESult?.....	145
CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal:MAXimum:RESult.....	146
CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal[:AVERAge]:RESult?.....	146
CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL]:MAXimum:RESult.....	144
CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL][:AVERAge]:RESult?.....	144
CALCulate<n>:LIMit<k>:SUMMary:FERRor:MAXimum:RESult.....	146
CALCulate<n>:LIMit<k>:SUMMary:FERRor[:AVERAge]:RESult?.....	146
CALCulate<n>:LIMit<k>:SUMMary:GIMBalance:MAXimum:RESult.....	147
CALCulate<n>:LIMit<k>:SUMMary:GIMBalance[:AVERAge]:RESult?.....	147
CALCulate<n>:LIMit<k>:SUMMary:IQOffset:MAXimum:RESult.....	147
CALCulate<n>:LIMit<k>:SUMMary:IQOffset[:AVERAge]:RESult?.....	147
CALCulate<n>:LIMit<k>:SUMMary:QUADerror:MAXimum:RESult.....	147
CALCulate<n>:LIMit<k>:SUMMary:QUADerror[:AVERAge]:RESult?.....	147
CALCulate<n>:LIMit<k>:SUMMary:SERRor:MAXimum:RESult.....	148
CALCulate<n>:LIMit<k>:SUMMary:SERRor[:AVERAge]:RESult?.....	148
CALCulate<n>:MARKer<m>:FUNctIon:POWer:RESult[:CURRent]?.....	142
CONFigure:ADDReSS<analyzer>.....	154
CONFigure:POWer:EXPeCted:IQ<analyzer>.....	151
CONFigure:POWer:EXPeCted:RF<analyzer>.....	150
CONFigure:PRESet.....	182
CONFigure[:LTE]:DL:BF:AP.....	121
CONFigure[:LTE]:DL:BW.....	165
CONFigure[:LTE]:DL:CONS:LOCation.....	121
CONFigure[:LTE]:DL:CSIRs:CI.....	176
CONFigure[:LTE]:DL:CSIRs:NAP.....	176
CONFigure[:LTE]:DL:CSIRs:POWer.....	177
CONFigure[:LTE]:DL:CSIRs:SCI.....	177
CONFigure[:LTE]:DL:CSIRs:STATe.....	177
CONFigure[:LTE]:DL:CSUBframes.....	170
CONFigure[:LTE]:DL:CYCPrefix.....	166
CONFigure[:LTE]:DL:MIMO:ASElection.....	169
CONFigure[:LTE]:DL:MIMO:CONFig.....	168
CONFigure[:LTE]:DL:MIMO:CROStalk.....	165

CONFigure[LTE]:DL:NORB.....	166
CONFigure[LTE]:DL:PBCH:POWer.....	180
CONFigure[LTE]:DL:PBCH:STAT.....	177
CONFigure[LTE]:DL:PCFich:POWer.....	180
CONFigure[LTE]:DL:PCFich:STAT.....	178
CONFigure[LTE]:DL:PDCCh:FORMat.....	179
CONFigure[LTE]:DL:PDCCh:NOPD.....	179
CONFigure[LTE]:DL:PDCCh:POWer.....	180
CONFigure[LTE]:DL:PDSch:PB.....	181
CONFigure[LTE]:DL:PHICh:DURation.....	178
CONFigure[LTE]:DL:PHICh:MITM.....	179
CONFigure[LTE]:DL:PHICh:NGParameter.....	178
CONFigure[LTE]:DL:PHICh:NOGRoups.....	179
CONFigure[LTE]:DL:PHICh:POWer.....	180
CONFigure[LTE]:DL:PLC:CID.....	167
CONFigure[LTE]:DL:PLC:CIDGroup.....	167
CONFigure[LTE]:DL:PLC:PLID.....	168
CONFigure[LTE]:DL:PRSS:BW.....	175
CONFigure[LTE]:DL:PRSS:CI.....	175
CONFigure[LTE]:DL:PRSS:NPRS.....	175
CONFigure[LTE]:DL:PRSS:POWer.....	175
CONFigure[LTE]:DL:PRSS:STATe.....	175
CONFigure[LTE]:DL:PSOffset.....	181
CONFigure[LTE]:DL:REFSig:POWer.....	174
CONFigure[LTE]:DL:SFNO.....	176
CONFigure[LTE]:DL:SUBFrame<subframe>:ALCount.....	170
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:POWer.....	171
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:AP.....	171
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CBINdex.....	172
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CDD.....	172
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:CLMapping.....	172
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding:SCID.....	173
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:PRECoding[.SCHeme].....	172
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBCount.....	171
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:RBOffset.....	171
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>:UEID.....	170
CONFigure[LTE]:DL:SUBFrame<subframe>:ALLoc<allocation>[.CW<Cwnum>]:MODulation.....	170
CONFigure[LTE]:DL:SYNC:ANTenna.....	173
CONFigure[LTE]:DL:SYNC:PPOWer.....	174
CONFigure[LTE]:DL:SYNC:SPOWer.....	174
CONFigure[LTE]:DL:TDD:SPSC.....	166
CONFigure[LTE]:DL:TDD:UDConf.....	166
CONFigure[LTE]:DUPLexing.....	149
CONFigure[LTE]:LDIRection.....	149
CONFigure[LTE]:OOPower:NFRames.....	154
DISPlay[.WINDow<n>]:SElect.....	182
DISPlay[.WINDow<n>]:TABLe.....	119
DISPlay[.WINDow<n>]:TRACe<t>:Y[.SCALE]:RLEVel:OFFSet.....	151

FETCh:CYCPrefix?	123
FETCh:PLC:CIDGroup?	168
FETCh:PLC:PLID?	168
FETCh:SUMMary:CRESt[:AVERAge]?	123
FETCh:SUMMary:EVM:DSQP:MAXimum?	124
FETCh:SUMMary:EVM:DSQP:MINimum?	124
FETCh:SUMMary:EVM:DSQP[:AVERAge]?	124
FETCh:SUMMary:EVM:DSSF:MAXimum?	124
FETCh:SUMMary:EVM:DSSF:MINimum?	124
FETCh:SUMMary:EVM:DSSF[:AVERAge]?	124
FETCh:SUMMary:EVM:DSST:MAXimum?	124
FETCh:SUMMary:EVM:DSST:MINimum?	124
FETCh:SUMMary:EVM:DSST[:AVERAge]?	124
FETCh:SUMMary:EVM:PCHannel:MAXimum?	125
FETCh:SUMMary:EVM:PCHannel:MINimum?	125
FETCh:SUMMary:EVM:PCHannel[:AVERAge]?	125
FETCh:SUMMary:EVM:PSIGnal:MAXimum?	125
FETCh:SUMMary:EVM:PSIGnal:MINimum?	125
FETCh:SUMMary:EVM:PSIGnal[:AVERAge]?	125
FETCh:SUMMary:EVM[:ALL]:MAXimum?	123
FETCh:SUMMary:EVM[:ALL]:MINimum?	123
FETCh:SUMMary:EVM[:ALL][:AVERAge]?	123
FETCh:SUMMary:FERRor:MAXimum?	125
FETCh:SUMMary:FERRor:MINimum?	125
FETCh:SUMMary:FERRor[:AVERAge]?	125
FETCh:SUMMary:GIMBalance:MAXimum?	126
FETCh:SUMMary:GIMBalance:MINimum?	126
FETCh:SUMMary:GIMBalance[:AVERAge]?	126
FETCh:SUMMary:IQOFfset:MAXimum?	126
FETCh:SUMMary:IQOFfset:MINimum?	126
FETCh:SUMMary:IQOFfset[:AVERAge]?	126
FETCh:SUMMary:OSTP:MAXimum?	126
FETCh:SUMMary:OSTP:MINimum?	126
FETCh:SUMMary:OSTP[:AVERAge]?	126
FETCh:SUMMary:POWer:MAXimum?	127
FETCh:SUMMary:POWer:MINimum?	127
FETCh:SUMMary:POWer[:AVERAge]?	127
FETCh:SUMMary:QUADerror:MAXimum?	127
FETCh:SUMMary:QUADerror:MINimum?	127
FETCh:SUMMary:QUADerror[:AVERAge]?	127
FETCh:SUMMary:RSTP:MAXimum?	127
FETCh:SUMMary:RSTP:MINimum?	127
FETCh:SUMMary:RSTP[:AVERAge]?	127
FETCh:SUMMary:SERRor:MAXimum?	127
FETCh:SUMMary:SERRor:MINimum?	127
FETCh:SUMMary:SERRor[:AVERAge]?	127
FETCh:SUMMary:TAE<antenna>?	128
FETCh:SUMMary:TFRame?	128

FORMat[:DATA].....	182
INITiate:REFResh.....	120
INITiate[:IMMediate].....	120
INPut:IQ:BALanced[:STATe].....	159
INPut:IQ:IMPedance.....	159
INPut<n>:ATTenuation<analyzer>.....	151
INPut<n>:DIQ:RANGe[:UPPer].....	160
INPut<n>:DIQ:SRATe.....	160
MMEMory:LOAD:DEModsetting.....	182
MMEMory:LOAD:IQ:STATe.....	183
MMEMory:LOAD:TMOD:DL.....	183
MMEMory:STORE:DEModsetting.....	183
SENSe:INPut.....	150
TRACe[:DATA]?.....	140
TRIGger[:SEQuence]:HOLDoff<analyzer>.....	155
TRIGger[:SEQuence]:LEVel<analyzer>:POWer.....	156
TRIGger[:SEQuence]:LEVel<analyzer>[:EXTeRnal].....	156
TRIGger[:SEQuence]:MODE.....	155
TRIGger[:SEQuence]:SLOPe.....	156
UNIT:BSTR.....	153
UNIT:EVM.....	153
[SENSe]:FREQuency:CENTer.....	149
[SENSe]:IQ:DITHer[:STATe].....	159
[SENSe]:IQ:LPASs[:STATe].....	159
[SENSe]:POWer:ACHannel:AACHannel.....	157
[SENSe]:POWer:AUTO<analyzer>:TIME.....	160
[SENSe]:POWer:AUTO<analyzer>[:STATe].....	150
[SENSe]:POWer:NCORrection.....	157
[SENSe]:POWer:SEM:CATegory.....	157
[SENSe]:POWer:SEM:CHBS:AMPower.....	160
[SENSe]:SWAPiQ.....	158
[SENSe]:SWEep:EGATe:AUTO.....	158
[SENSe]:SWEep:TIME.....	151
[SENSe]:SYNC[:STATe]?.....	120
[SENSe][:LTE]:ANTenna:SElect.....	153
[SENSe][:LTE]:DL:DEMod:AUTO.....	161
[SENSe][:LTE]:DL:DEMod:BEStimation.....	162
[SENSe][:LTE]:DL:DEMod:CBSCrambling.....	164
[SENSe][:LTE]:DL:DEMod:CEStimation.....	163
[SENSe][:LTE]:DL:DEMod:DACHannels.....	165
[SENSe][:LTE]:DL:DEMod:EVMCalc.....	164
[SENSe][:LTE]:DL:DEMod:MCFilter.....	162
[SENSe][:LTE]:DL:DEMod:PRData.....	164
[SENSe][:LTE]:DL:FORMat:PSCD.....	161
[SENSe][:LTE]:DL:TRACking:PHASe.....	163
[SENSe][:LTE]:DL:TRACking:TIME.....	163
[SENSe][:LTE]:FRAMe:COUNT.....	152
[SENSe][:LTE]:FRAMe:COUNT:AUTO.....	152

[SENSe][:LTE]:FRAMe:COUNT:STATe.....	152
[SENSe][:LTE]:OOPower:ATIMing.....	121
[SENSe][:LTE]:OOPower:NCORrection.....	154
[SENSe][:LTE]:SUBFrame:SElect.....	153

Index

A

ACLR	39
Allocation ID vs symbol x carrier	49
Allocation summary	47
Auto Detection (Cell Identity)	78
Auto PDSCH Demodulation	70

B

Balanced Input	66
Bit stream	48
Boosting estimation	71

C

Capture buffer	30
Capture Time	57
CCDF	46
Cell ID	78
Cell Identity Group	78
Channel Bandwidth	75
Channel decoder results	49
Channel Estimation	72
Channel flatness	42
Channel flatness difference	43
Channel flatness group delay	43
Configurable Subframes	80
Configuration Table	80
Constellation diagram	44
Constellation Selection	45

D

Digital Input Data Rate	67
Dither	67

E

Error in Subframes	80
EVM Calculation Method	73
EVM vs Carrier	33
EVM vs RB	35
EVM vs subframe	35
EVM vs symbol	34
EVM vs symbol x carrier	35
External Attenuation	56

F

Frequency	54
Frequency error vs symbol	36
Full Scale Level	68

H

Header Table	23
Home base station	68

I

Identity (Physical Layer)	78
Input Source	54
Interface	22

L

Low Pass	66
----------------	----

M

Measurement	
ACLR	39
allocation summary	47
alloc ID vs sym x carrier	49
beamforming	51
bit stream	48
capture buffer	30
CCDF	46
channel decoder results	49
channel flatness	42
channel flatness difference	43
channel flatness group delay	43
constellation	44
EVM (error vector magnitude)	33
EVM vs carrier	33
EVM vs RB	35
EVM vs subframe	35
EVM vs symbol	34
EVM vs sym x carr	35
freq err vs symbol	36
list	28
misc	46
numerical	28
on/off power	31
power spectrum	40
power vs RB PDSCH	41
power vs RB RS	42
power vs sym x carr	32
PVT (power over time)	30
result summary	28
signal flow	46
spectrum	37
spectrum mask	37
statistics	46
UE Specific RS Weights (Magnitude)	51
UE Specific RS Weights (Phase)	52
Multicarrier filter	71

N

Number of RB	75
Numerical results	28

O

On/off power	31
--------------------	----

P

P-/S-SYNC Tx antenna	84
PBCH	89
PCFICH	89
PDSCH reference data	73
PDSCH subframe detection	70
Phase Error	72
PHICH	90
Power spectrum	40
Power vs RB PDSCH	41

Power vs RB RS	42
Power vs symbol x carrier	32
PRB symbol offset	88
P-SYNC Relative Power	85

R

Reference Level	55
Relative power (P-SYNC)	85
Relative power (reference signal)	85
Relative power (S-SYNC)	85
Resource Blocks	75
Result Display	
Constellation Selection	45
Result summary	28

S

Scrambling of coded bits	74
Screen Layout	22
Selected Subframe	80
Setting	
P-/S-SYNC Tx antenna	84
Settings	
Auto	78
Auto PDSCH Demod	70
Balanced	66
boosting estimation	71
Capture Time	57
Cell ID	78
Cell Identity Group	78
Channel Bandwidth	75
Channel Estimation	72
Configurable Subframes	80
Configuration Table	80
Digital Input Data Rate	67
Dither	67
Error in Subframe	80
EVM Calculation Method	73
Ext Att	56
Frequency	54
Full Scale Level	68
Identity	78
Low Pass	66
multicarrier filter	71
Number of RB	75
PBCH	89
PCFICH	89
PDSCH reference data	73
PDSCH subframe detection	70
Phase	72
PHICH	90
PRB symbol offset	88
P-SYNC relative power	85
Ref Level	55
relative power	85
Scrambling of coded bits	74
Selected Subframe	80
Source	54
S-SYNC relative power	85
Standard	53
Swap I/Q	66
TDD UL/DL Allocations	77
Timing	73
Trigger level	63
Trigger mode	63

Trigger offset	63
Used Allocations	80
Signal flow	46
Softkey	
Const Selection	45
Software license	16
Source (Input)	54
Spectrum mask	37
Standard Selection	53
Status Bar	23
Subframe Configuration Table	80
Subframe Error	80
Swap I/Q	66

T

TDD UL/DL Allocations	77
Timing Error	73
Title Bar	23
Trigger level	63
Trigger mode	63
Trigger offset	63

U

UE Specific RS Weights (Magnitude)	51
UE Specific RS Weights (Phase)	52
Used Allocations	80