Software Manual

TETRA II Analysis

Applications Firmware
R&S® FS-K110

ROHDE & SCHWARZ

Test and Measurement

This Software Manual describes the Applications Firmware R&S FS-K110 for the following models:

- R&S®FSQ
- R&S®FSU (with FSU B73 installed)

Basic Safety Instructions

Always read through and comply with the following safety instructions!

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

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

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

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

Symbols and safety labels

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

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

Tags and their meaning

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

⚠ **DANGER**	indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ **WARNING**	indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ **CAUTION**	indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	indicates the possibility of incorrect operation which can result in damage to the product. In the product documentation, the word ATTENTION is used synonymously.

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

Operating states and operating positions

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

1. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products: predefined operating position is always with the housing floor facing down, IP protection 2X, pollution severity 2, overvoltage category 2, use only indoors, max. operating altitude 2000 m above sea level, max. transport altitude 4500 m above sea level. A tolerance of ±10 % shall apply to the nominal voltage and ±5 % to the nominal frequency.

2. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves). An installation that is not carried out as described in the product documentation could result in personal injury or death.

3. Do not place the product on heat-generating devices such as radiators or fan heaters. The ambient temperature must not exceed the maximum temperature specified in the product documentation or in the data sheet. Product overheating can cause electric shock, fire and/or serious personal injury or death.

Electrical safety

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

1. Prior to switching on the product, always ensure that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.

2. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with an earthing contact and protective earth connection.

3. Intentionally breaking the protective earth connection either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.

4. If the product does not have a power switch for disconnection from the AC supply network, the plug of the connecting cable is regarded as the disconnecting device. In such cases, always ensure that the power plug is easily reachable and accessible at all times (corresponding to the length of connecting cable, approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply network. If products without power switches are integrated into racks or systems, a disconnecting device must be provided at the system level.

5. Never use the product if the power cable is damaged. Check the power cable on a regular basis to ensure that it is in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, you can ensure that the cable will not be damaged and that no one can be hurt by, for example, tripping over the cable or suffering an electric shock.

6. The product may be operated only from TN/TT supply networks fused with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).

7. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket. Otherwise, sparks that result in fire and/or injuries may occur.

8. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.

9. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) should be taken to avoid any hazards.

10. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC60950-1/EN60950-1 or IEC61010-1/EN 61010-1 standards that apply in each case.

11. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.

12. If a product is to be permanently installed, the connection between the PE terminal on site and the product's PE conductor must be made first before any other connection is made. The product may be installed and connected only by a licensed electrician.

13. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.

14. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the person operating the product will be exposed to the danger of an electric shock.

15. Any object that is not designed to be placed in the openings of the housing must not be used for this purpose. Doing so can cause short circuits inside the product and/or electric shocks, fire or injuries.

16. Unless specified otherwise, products are not liquid-proof (see also section "Operating states and operating positions", item 1. Therefore, the equipment must be protected against penetration by liquids. If the necessary precautions are not taken, the user may suffer electric shock or the product itself may be damaged, which can also lead to personal injury.

17. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product has been moved from a cold to a warm environment. Penetration by water increases the risk of electric shock.

18. Prior to cleaning the product, disconnect it completely from the power supply (e.g. AC supply network or battery). Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluents for cellulose lacquers.

Operation

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

2. Before you move or transport the product, read and observe the section titled "Transport".

3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens) such as nickel cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties) when using a Rohde & Schwarz product, consult a physician immediately to determine the cause and to prevent health problems or stress.

4. Before you start processing the product mechanically and/or thermally, or before you take it apart, be sure to read and pay special attention to the section titled "Waste disposal", item 1.

5. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn babies require increased protection, pregnant women must be protected by appropriate measures. Persons with pacemakers may also be exposed to risks from electromagnetic radiation. The employer/operator must evaluate workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the potential danger.

6. Should a fire occur, the product may release hazardous substances (gases, fluids, etc.) that can cause health problems. Therefore, suitable measures must be taken, e.g. protective masks and protective clothing must be worn.

7. If a laser product (e.g. a CD/DVD drive) is integrated into a Rohde & Schwarz product, absolutely no other settings or functions may be used as described in the product documentation. The objective is to prevent personal injury (e.g. due to laser beams).

Repair and service

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

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

Batteries and rechargeable batteries/cells

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

1. Cells must not be taken apart or crushed.

2. Cells or batteries must not be exposed to heat or fire. Storage in direct sunlight must be avoided. Keep cells and batteries clean and dry. Clean soiled connectors using a dry, clean cloth.

3. Cells or batteries must not be short-circuited. Cells or batteries must not be stored in a box or in a drawer where they can short-circuit each other, or where they can be short-circuited by other conductive materials. Cells and batteries must not be removed from their original packaging until they are ready to be used.

4. Keep cells and batteries out of the hands of children. If a cell or a battery has been swallowed, seek medical aid immediately.

5. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.

6. If a cell develops a leak, the fluid must not be allowed to come into contact with the skin or eyes. If contact occurs, wash the affected area with plenty of water and seek medical aid.

7. Improperly replacing or charging cells or batteries that contain alkaline electrolytes (e.g. lithium cells) can cause explosions. Replace cells or batteries only with the matching Rohde & Schwarz type (see parts list) in order to ensure the safety of the product.

8. Cells and batteries must be recycled and kept separate from residual waste. Rechargeable batteries and normal batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.

Transport

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

2. Handles on the products are designed exclusively to enable personnel to transport the product. It is therefore not permissible to use handles to fasten the product to or on transport equipment such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport or lifting. Observe the safety regulations of the manufacturer of the means of transport or lifting. Noncompliance can result in personal injury or material damage.

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

Waste disposal

1. If products or their components are mechanically and/or thermally processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.

2. If handling the product releases hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation. The improper disposal of hazardous substances or fuels can cause health problems and lead to environmental damage.

Informaciones elementales de seguridad

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

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

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

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

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

Símbolos y definiciones de seguridad

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

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

Palabras de señal y su significado

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

⚠ **PELIGRO**	PELIGRO identifica un peligro inminente con riesgo elevado que provocará muerte o lesiones graves si no se evita.
⚠ **ADVERTENCIA**	ADVERTENCIA identifica un posible peligro con riesgo medio de provocar muerte o lesiones (graves) si no se evita.
⚠ **ATENCIÓN**	ATENCIÓN identifica un peligro con riesgo reducido de provocar lesiones leves o moderadas si no se evita.
AVISO	AVISO indica la posibilidad de utilizar mal el producto y, como consecuencia, dañarlo. En la documentación del producto se emplea de forma sinónima el término CUIDADO.

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

Estados operativos y posiciones de funcionamiento

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

1. Si no se convino de otra manera, es para los productos Rohde & Schwarz válido lo que sigue: como posición de funcionamiento se define por principio la posición con el suelo de la caja para abajo, modo de protección IP 2X, grado de suciedad 2, categoría de sobrecarga eléctrica 2, uso solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar, transporte hasta 4500 m sobre el nivel del mar. Se aplicará una tolerancia de ±10 % sobre el voltaje nominal y de ±5 % sobre la frecuencia nominal.

2. No sitúe el producto encima de superficies, vehículos, estantes o mesas, que por sus características de peso o de estabilidad no sean aptos para él. Siga siempre las instrucciones de instalación del fabricante cuando instale y asegure el producto en objetos o estructuras (p. ej. paredes y estantes). Si se realiza la instalación de modo distinto al indicado en la documentación del producto, pueden causarse lesiones o incluso la muerte.

3. No ponga el producto sobre aparatos que generen calor (p. ej. radiadores o calefactores). La temperatura ambiente no debe superar la temperatura máxima especificada en la documentación del producto o en la hoja de datos. En caso de sobrecalentamiento del producto, pueden producirse choques eléctricos, incendios y/o lesiones graves con posible consecuencia de muerte.

Seguridad eléctrica

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

1. Antes de la puesta en marcha del producto se deberá comprobar siempre que la tensión preseleccionada en el producto coincida con la de la red de alimentación eléctrica. Si es necesario modificar el ajuste de tensión, también se deberán cambiar en caso dado los fusibles correspondientes del producto.

2. Los productos de la clase de protección I con alimentación móvil y enchufe individual solamente podrán enchufarse a tomas de corriente con contacto de seguridad y con conductor de protección conectado.

3. Queda prohibida la interrupción intencionada del conductor de protección, tanto en la toma de corriente como en el mismo producto. La interrupción puede tener como consecuencia el riesgo de que el producto sea fuente de choques eléctricos. Si se utilizan cables alargadores o regletas de enchufe, deberá garantizarse la realización de un examen regular de los mismos en cuanto a su estado técnico de seguridad.

4. Si el producto no está equipado con un interruptor para desconectarlo de la red, se deberá considerar el enchufe del cable de conexión como interruptor. En estos casos se deberá asegurar que el enchufe siempre sea de fácil acceso (de acuerdo con la longitud del cable de conexión, aproximadamente 2 m). Los interruptores de función o electrónicos no son aptos para el corte de la red eléctrica. Si los productos sin interruptor están integrados en bastidores o instalaciones, se deberá colocar el interruptor en el nivel de la instalación.

5. No utilice nunca el producto si está dañado el cable de conexión a red. Compruebe regularmente el correcto estado de los cables de conexión a red. Asegúrese, mediante las medidas de protección y de instalación adecuadas, de que el cable de conexión a red no pueda ser dañado o de que nadie pueda ser dañado por él, p. ej. al tropezar o por un choque eléctrico.

6. Solamente está permitido el funcionamiento en redes de alimentación TN/TT aseguradas con fusibles de 16 A como máximo (utilización de fusibles de mayor amperaje solo previa consulta con el grupo de empresas Rohde & Schwarz).

7. Nunca conecte el enchufe en tomas de corriente sucias o llenas de polvo. Introduzca el enchufe por completo y fuertemente en la toma de corriente. La no observación de estas medidas puede provocar chispas, fuego y/o lesiones.

8. No sobrecargue las tomas de corriente, los cables alargadores o las regletas de enchufe ya que esto podría causar fuego o choques eléctricos.

9. En las mediciones en circuitos de corriente con una tensión U_{eff} > 30 V se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).

10. Para la conexión con dispositivos informáticos como un PC o un ordenador industrial, debe comprobarse que éstos cumplan los estándares IEC60950-1/EN60950-1 o IEC61010-1/EN 61010-1 válidos en cada caso.

11. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. Esto pone a descubierto los cables y componentes eléctricos y puede causar lesiones, fuego o daños en el producto.

12. Si un producto se instala en un lugar fijo, se deberá primero conectar el conductor de protección fijo con el conductor de protección del producto antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efectuadas por un electricista especializado.

13. En el caso de dispositivos fijos que no estén provistos de fusibles, interruptor automático ni otros mecanismos de seguridad similares, el circuito de alimentación debe estar protegido de modo que todas las personas que puedan acceder al producto, así como el producto mismo, estén a salvo de posibles daños.

14. Todo producto debe estar protegido contra sobretensión (debida p. ej. a una caída del rayo) mediante los correspondientes sistemas de protección. Si no, el personal que lo utilice quedará expuesto al peligro de choque eléctrico.

15. No debe introducirse en los orificios de la caja del aparato ningún objeto que no esté destinado a ello. Esto puede producir cortocircuitos en el producto y/o puede causar choques eléctricos, fuego o lesiones.

16. Salvo indicación contraria, los productos no están impermeabilizados (ver también el capítulo "Estados operativos y posiciones de funcionamiento", punto 1). Por eso es necesario tomar las medidas necesarias para evitar la entrada de líquidos. En caso contrario, existe peligro de choque eléctrico para el usuario o de daños en el producto, que también pueden redundar en peligro para las personas.

17. No utilice el producto en condiciones en las que pueda producirse o ya se hayan producido condensaciones sobre el producto o en el interior de éste, como p. ej. al desplazarlo de un lugar frío a otro caliente. La entrada de agua aumenta el riesgo de choque eléctrico.

18. Antes de la limpieza, desconecte por completo el producto de la alimentación de tensión (p. ej. red de alimentación o batería). Realice la limpieza de los aparatos con un paño suave, que no se deshilache. No utilice bajo ningún concepto productos de limpieza químicos como alcohol, acetona o diluyentes para lacas nitrocelulósicas.

Funcionamiento

1. El uso del producto requiere instrucciones especiales y una alta concentración durante el manejo. Debe asegurarse que las personas que manejen el producto estén a la altura de los requerimientos necesarios en cuanto a aptitudes físicas, psíquicas y emocionales, ya que de otra manera no se pueden excluir lesiones o daños de objetos. El empresario u operador es responsable de seleccionar el personal usuario apto para el manejo del producto.

2. Antes de desplazar o transportar el producto, lea y tenga en cuenta el capítulo "Transporte".

3. Como con todo producto de fabricación industrial no puede quedar excluida en general la posibilidad de que se produzcan alergias provocadas por algunos materiales empleados, los llamados alérgenos (p. ej. el níquel). Si durante el manejo de productos Rohde & Schwarz se producen reacciones alérgicas, como p. ej. irritaciones cutáneas, estornudos continuos, enrojecimiento de la conjuntiva o dificultades respiratorias, debe avisarse inmediatamente a un médico para investigar las causas y evitar cualquier molestia o daño a la salud.

4. Antes de la manipulación mecánica y/o térmica o el desmontaje del producto, debe tenerse en cuenta imprescindiblemente el capítulo "Eliminación", punto 1.

5. Ciertos productos, como p. ej. las instalaciones de radiocomunicación RF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. Deben tomarse todas las medidas necesarias para la protección de las mujeres embarazadas. También las personas con marcapasos pueden correr peligro a causa de la radiación electromagnética. El empresario/operador tiene la obligación de evaluar y señalizar las áreas de trabajo en las que exista un riesgo elevado de exposición a radiaciones.

6. Tenga en cuenta que en caso de incendio pueden desprenderse del producto sustancias tóxicas (gases, líquidos etc.) que pueden generar daños a la salud. Por eso, en caso de incendio deben usarse medidas adecuadas, como p. ej. máscaras antigás e indumentaria de protección.

7. En caso de que un producto Rohde & Schwarz contenga un producto láser (p. ej. un lector de CD/DVD), no debe usarse ninguna otra configuración o función aparte de las descritas en la documentación del producto, a fin de evitar lesiones (p. ej. debidas a irradiación láser).

Reparación y mantenimiento

1. El producto solamente debe ser abierto por personal especializado con autorización para ello. Antes de manipular el producto o abrirlo, es obligatorio desconectarlo de la tensión de alimentación, para evitar toda posibilidad de choque eléctrico.

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

Baterías y acumuladores o celdas

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

1. No deben desmontarse, abrirse ni triturarse las celdas.

2. Las celdas o baterías no deben someterse a calor ni fuego. Debe evitarse el almacenamiento a la luz directa del sol. Las celdas y baterías deben mantenerse limpias y secas. Limpiar las conexiones sucias con un paño seco y limpio.

3. Las celdas o baterías no deben cortocircuitarse. Es peligroso almacenar las celdas o baterías en estuches o cajones en cuyo interior puedan cortocircuitarse por contacto recíproco o por contacto con otros materiales conductores. No deben extraerse las celdas o baterías de sus embalajes originales hasta el momento en que vayan a utilizarse.

4. Mantener baterías y celdas fuera del alcance de los niños. En caso de ingestión de una celda o batería, avisar inmediatamente a un médico.

5. Las celdas o baterías no deben someterse a impactos mecánicos fuertes indebidos.

6. En caso de falta de estanqueidad de una celda, el líquido vertido no debe entrar en contacto con la piel ni los ojos. Si se produce contacto, lavar con agua abundante la zona afectada y avisar a un médico.

7. En caso de cambio o recarga inadecuados, las celdas o baterías que contienen electrolitos alcalinos (p. ej. las celdas de litio) pueden explotar. Para garantizar la seguridad del producto, las celdas o baterías solo deben ser sustituidas por el tipo Rohde & Schwarz correspondiente (ver lista de recambios).

8. Las baterías y celdas deben reciclarse y no deben tirarse a la basura doméstica. Las baterías o acumuladores que contienen plomo, mercurio o cadmio deben tratarse como residuos especiales. Respete en esta relación las normas nacionales de eliminación y reciclaje.

Transporte

1. El producto puede tener un peso elevado. Por eso es necesario desplazarlo o transportarlo con precaución y, si es necesario, usando un sistema de elevación adecuado (p. ej. una carretilla elevadora), a fin de evitar lesiones en la espalda u otros daños personales.

2. Las asas instaladas en los productos sirven solamente de ayuda para el transporte del producto por personas. Por eso no está permitido utilizar las asas para la sujeción en o sobre medios de transporte como p. ej. grúas, carretillas elevadoras de horquilla, carros etc. Es responsabilidad suya fijar los productos de manera segura a los medios de transporte o elevación. Para evitar daños personales o daños en el producto, siga las instrucciones de seguridad del fabricante del medio de transporte o elevación utilizado.

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

Eliminación

1. Si se trabaja de manera mecánica y/o térmica cualquier producto o componente más allá del funcionamiento previsto, pueden liberarse sustancias peligrosas (polvos con contenido de metales pesados como p. ej. plomo, berilio o níquel). Por eso el producto solo debe ser desmontado por personal especializado con formación adecuada. Un desmontaje inadecuado puede ocasionar daños para la salud. Se deben tener en cuenta las directivas nacionales referentes a la eliminación de residuos.

2. En caso de que durante el trato del producto se formen sustancias peligrosas o combustibles que deban tratarse como residuos especiales (p. ej. refrigerantes o aceites de motor con intervalos de cambio definidos), deben tenerse en cuenta las indicaciones de seguridad del fabricante de dichas sustancias y las normas regionales de eliminación de residuos. Tenga en cuenta también en caso necesario las indicaciones de seguridad especiales contenidas en la documentación del producto. La eliminación incorrecta de sustancias peligrosas o combustibles puede causar daños a la salud o daños al medio ambiente.

Qualitätszertifikat
Certificate of quality
Certificat de qualité

Certified Quality System
ISO 9001

Certified Environmental System
ISO 14001

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

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

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

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

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

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

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Customer Support

Technical support – where and when you need it

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

Up-to-date information and upgrades

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

USA & Canada	Monday to Friday 8:00 AM – 8:00 PM	(except US public holidays) Eastern Standard Time (EST)
	Tel. from USA From outside USA Fax	888-test-rsa (888-837-8772) (opt 2) +1 410 910 7800 (opt 2) +1 410 910 7801
	E-mail	CustomerSupport@rohde-schwarz.com
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ROHDE & SCHWARZ

Contents

1 General Information

The Rohde & Schwarz FS-K110 application extends the functionality of the R&S FSQ or R&S FSU spectrum analyzer to enable TETRA Release 2 (TEDS) measurements according to the standards [1] and [2] (please refer to page 124).

This manual supports the user in working with R&S FS-K110. It aids the preparation, execution and evaluation of a measurement and gives many helpful hints and examples.

For the user wanting to make a quick start to using R&S FS-K110, the Quick Start Guide section below works step-by-step through an ordinary measurement. The remainder of this section describes all of the basic information about how the R&S FS-K110 application works, without covering measurements in detail. A detailed description of all measurement modes, settings and results can be found in section 2. Section 4 covers remote control operation of R&S FS-K110.

This section covers the following subjects:

Introduction to R&S FS-K110 measurements

- Installation

- Starting the application

- Exiting the application

- Quick start guide – allows the user to get up-and-running in minimum time

- Navigation

- Save/recall – saving & recalling user settings & measurement results

- Printing

Introduction to R&S FS-K110 TETRA2 Measurements

The use of an R&S FSQ or R&S FSU spectrum analyzer with its high sensitivity enables the accurate and reproducible measurement of a TETRA Release II Device Under Test (DUT).

- R&S FS-K110 Supports measurements of the physical layer of TETRA Release II (ETSI EN 300 392-2 V3.2.1) TEDS signals that are listed in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

Table 1   Supported Slot types

Slot or burst type	Payload QAM	Number of sub carriers channel bandwidth
Normal Downlink (NDB)	4 or 8 or 16	8, 16, 32, 48 25 KHz, 50 KHz, 100 KHz, 150 KHz
Normal Uplink (NUB)	4 or 8 or 16	8, 16, 32, 48 25 KHz, 50 KHz, 100 KHz, 150 KHz
Control Uplink (CB)	4 or 8 or 16	8, 16, 32, 48 25 KHz, 50 KHz, 100 KHz, 150 KHz
Random Access (RAB)	4	8 25 KHz

- R&S FS-K110 does not support TETRA Release 1 signals (phase modulation). Those signals can be measured with the base system spectrum analyzer respectively the Vector Signal Analyzer option FS-K70.

- All measurements are based on the same buffer of captured IQ data, no swept measurements.

- All measurements are done this way:
  - The specified slots are searched in the captured IQ data.
  - If suitable slots are found they are demodulated and the exact slot start and end is calculated internally. Modulation errors are calculated.
  - Suitable ranges from that IQ data are then cut out exactly aligned to the slot's timing. Those ranges of IQ data are processed according to the different implemented measurements. Results are shown.
- Not only the measurement(s) currently seen on the display, but ALL measurements the application offers are always calculated on each found slot in the background.
  This means, if "EVM versus Symbols" for example is selected as active measurement and one RUN SGL measurement that demodulates 100 slots is started, it is clear that afterwards the Min/Max/Average/Current traces of "EVM versus symbols" calculated of 100 slots can be seen on the screen. But after this single sweep the application also allows the user to switch to any other measurement and see the "Phase Error versus Symbols", "Magnitude Error versus Symbols", etc, results of the same 100 slots.

Modulation measurements:
  – Constellation diagram (selectable subcarrier and selectable symbol type)
  – Constellation diagram per subcarrier
  – IQ offset and IQ imbalance
  – Quadrature error
  – Amplitude droop
  – Carrier frequency error
  – Error Vector Magnitude (EVM) per subcarrier or symbol
  – EVM of whole slot. For all symbols or for certain combinations of symbol types
  – Magnitude Error per symbol and for whole slot.

- Phase Error per symbol and for whole slot.

- Power versus Time

- Adjacent Channel Power (Absolute and Relative) due to Modulation

- Adjacent Channel Power (Absolute and Relative) due to Transients

- FFT during found slots.

- Data symbol and Header symbol bit information

- Capture time selectable up to 1.53 seconds, multiple sweeps possible for large number of bursts

Installation

From the analyzer select firmware update.

➢ Press the SETUP hardkey followed by NEXT, FIRMWARE UPDATE and finally the FIRMWARE UPDATE softkey. Following the instructions displayed.

Once the installation has completed the analyzer will reboot.

Once the option has been installed it needs to be activated:

➢ Start up the analyzer.

➢ Press the *SETUP* hardkey, followed by the *GENERAL SETUP* softkey and then the *OPTIONS* softkey. A list of the options currently activated is displayed.

➢ Press the *INSTALL OPTION* softkey. A dialog is displayed allowing the option key to be entered.
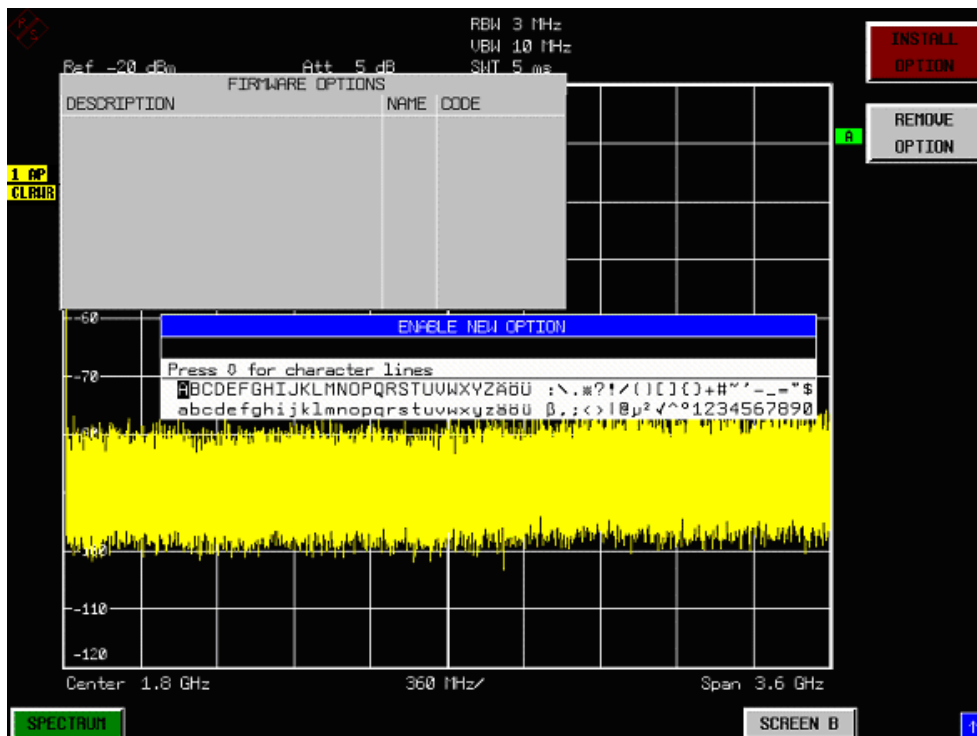
➢ Enter the option key supplied with the R&S FS-K110 software.

➢ When a valid option key has been supplied a dialog will be displayed explaining that a reboot is required to complete this operation. Select OK in this dialog and the instrument will be rebooted.

➢ When the analyzer starts after the reboot a new hotkey will be displayed at the bottom of the display labelled *TETRA2*. In addition an entry for the R&S FS-K110 option will be displayed in the *FIRMWARE OPTIONS* dialog.
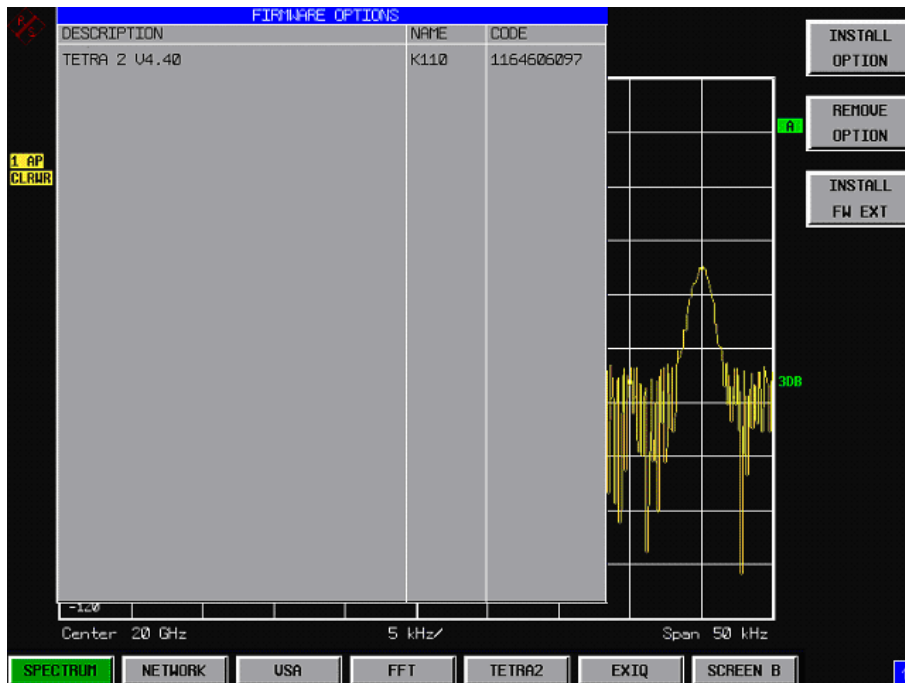
Starting the Application

Power up the R&S FSQ or R&S FSU spectrum analyzer. When R&S FS-K110 is correctly installed there will be a hotkey labelled *TETRA2* at the bottom of the screen. Press the *TETRA2* hotkey to start R&S FS-K110.

Note that if the spectrum analyzer is powered down whilst R&S FS-K110 is active, then when the spectrum analyzer is powered up again it will start up in the R&S FS-K110 application.

Exiting the Application

To exit the R&S FS-K110 option, press the *SPECTRUM* hotkey at the bottom of the screen. This will cause the option to exit and the spectrum analyzer to be activated.

Quick Start Guide

This section helps the user to quickly become familiar with R&S FS-K110 by working step-by-step through an ordinary measurement. (Refer to section 2 for a detailed reference guide.)

For this example a DUT will be used. The DUT will be connected to the analyzer using the RF input of the analyzer. The DUT will generate a Control Uplink Burst (CB), with 32 subcarriers, and a payload modulation of 64 QAM.

Setting up the Measurement

➢ Start the R&S FS-K110 application.

➢ Press the *GENERAL SETTINGS* softkey to open the General Settings view.
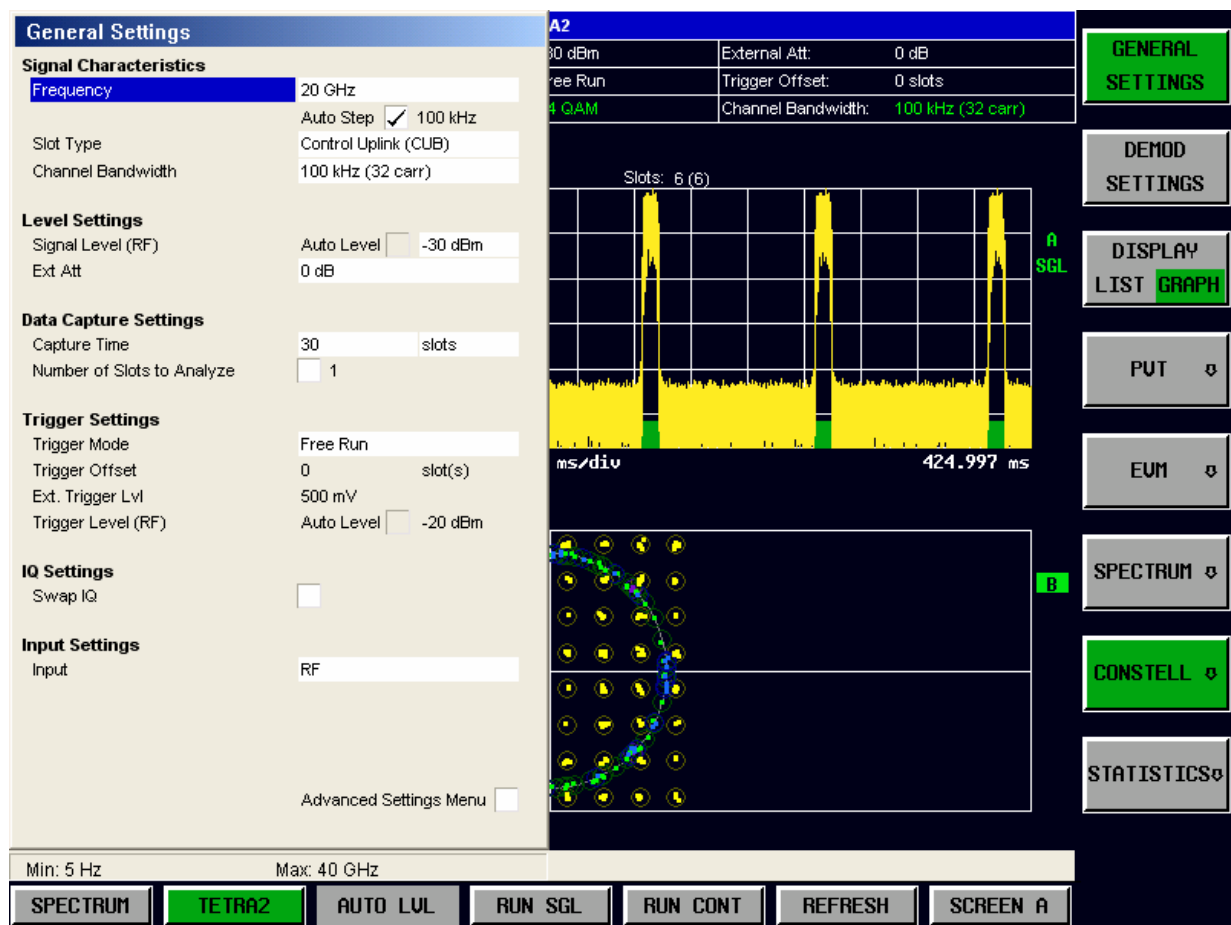
➢ Select the *Frequency* field and enter the desired channel center frequency to measure.

➢ Select the *Slot Type* for the input signal.

➢ Select the channel bandwidth for the input signal. The channel bandwidth will be either 25 kHz, 50 kHz, 100 kHz, or 150 kHz.

➢ Select the expected maximum value you expect as mean level during the strongest burst (in this case it is selected to be -30 dBm).

All other settings in this view are sufficient for this example.

➢ Press the *DEMOD SETTINGS* softkey to open the Demod Settings view

- Set the *Payload Modulation* to *64 QAM*.
- All other settings in this view are sufficient for this example.
- Close the Demod Settings by pressing the *TETRA2* hotkey.

Performing the main measurement

The set-up for the main measurement is performed using the steps below.

- Start the measurement by pressing the *RUN SGL* hotkey.
- During the measurement, the text "*Running...*" is displayed in the Status Bar at the bottom of the screen.

Measurement results are updated once the measurement has completed. The results are displayed in graphical form. The display can be toggled to a tabular list of measurement points by pressing the *DISPLAY* (*LIST/GRAPH*) Softkey.

Trouble-shooting guide

Find some hints that should help to make measurements run smoothly.

In case no slots or not all slots are found

- Correct slot type set?
  Check this in the dialog "Demod settings".

- Correct number of sub carriers set?
  Check using the measurement "Spectrum FFT" and in dialog "Demod settings".

- Signal level set much too high or much too low?
  Check using the measurement "Magnitude Capture Display": Peak power should be near to the "Reference Level" but not above.
  Check if the warnings "IFOVLD" or "OVLD" appears.

- Capture time too short?
  There must be one or more slots in the capture buffer and additionally there must be some extra time before and after a slot, otherwise it is not accepted!
  If not sure, increase the capture time.
  Check using the measurement "Magnitude Capture Display".

- Parameter "Swap IQ" set the same as in DUT?
  Toggle the parameter "Swap IQ" in dialog "Demod settings".

- Correct frequency set?
  Do the frequencies of DUT and FS-K110 application match? Check the signal's spectrum using the measurement "Spectrum FFT" or "ACP due to Modulation".

- Demodulator lock range too small?
  If the frequency error of the DUT is unknown or known to be rather high it is recommended to increase the parameter "Max Carrier Offset", page 79.
  Check the signals spectrum using the measurement "Spectrum FFT" or "ACP due to Modulation".

- In case you use the analog base band input of the instrument:
  - Only one cable connected?
  - Cables interchanged?
  - Balanced / unbalanced?
  - The low pass filter of the analog base band input (refer to page 76) must be switched on if the signal has high frequency components (above about 40 MHz). Otherwise aliasing occurs.

- In case you use the digital Baseband input of the instrument:
  - Cable is connected to the socket "IQ DATA IN" (not "IQ DATA OUT") of the analyzer and to the socket "BASEBAND DIGITAL OUT" (not "BASEBAND DIGITAL IN") of the R&S SMU (in case this vector signal generator is used)?
  - Same parameter "digital input sampling rate" set in receiver (analyzer) and transmitter?
  - If the R&S EX-IQ-Box is used to interface a customer specific digital Baseband format to the format needed at the digital Baseband input of the R&S analyzer: Is the R&S EX-IQ-Box configured in the correct way?
  - Remember that the center frequency is set to 0 Hz for digital Baseband input.
  - Remember that no trigger modes are supported for digital Baseband input.
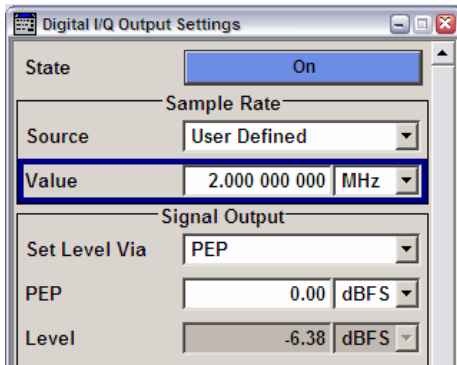
Hint for usage of digital Baseband inputs:

This R&S SMU screenshot shows one possible configuration for the scenario, that an R&S SMU vector signal generator (with digital Baseband output installed) is directly connected to an analyzer (with digital Baseband input installed) running the R&S FS-K110.

- Connect the devices using the digital Baseband cable and the correct sockets as described above.
- Switch digital Baseband output of R&S SMU *on* (in the overview diagram the block is labelled *AWGN/IMP)*.
- Switch R&S FS-K110 parameter *Input* to *IQ digital (*dialog *general settings)*.
- Set R&S SMU parameter *Source* to *User Defined*
- Set R&S FS-K110 parameter *Digital Input Sample Rate* to let's say 2 MHz (large enough for TEDS signals).
- Set R&S SMU parameter *Value* exactly the same as the R&S FS-K110 parameter *Digital Input Sampling Rate*.
- Press *Run Single* hotkey of R&S FS-K110.

In case that slots are found but the EVM is bad

- Correct payload symbol QAM type set?
  Check using the measurement "`Constellation vs. Symbols" and "Symbols to plot" set to "Data".

- Signal level set too high or much too low?
  Check using the measurement "Magnitude Capture Display": Peak power should be rather close to the "Reference Level" but never above it.
  Or check using the measurement "Result list": Enter the shown measurement value "Maximum of Burst power" minus 1 or 2 dB contingency reserve as parameter "Signal Level"

- Instrument calibrated?
  If red warning "UNCAL" appears switch back to the base system (softkey "SPECTRUM") and start a calibration (hard key "CAL").

- Does the transmitter send PRBS data?
  The demodulator needs pseudo-random data (data symbols) in all subcarriers. This means, a too regular bit pattern (on the physical layer, after channel coding in DUT) might cause the demodulator to fail or to be unstable.

- External Reference?
  If the instrument was told to use an external reference (hardkey SETUP in the base system) then make sure to supply in a valid reference signal with the correct frequency). Otherwise a red warning "EXTREF" will show up on the screen.

- Signal has high amplitude droop?
  If e.g. thermal effects in the power ramping stage cause an exponential amplitude decay or increase over the slot duration, then make sure to activate "Compensate Amplitude Droop", please refer to page 80.

- Fading?
  If the signal experiences multi-path effects, then make sure to activate "Pilot Tracking", please refer to page 80.

- Sync symbols according to the standard?
  Check using the measurement "Constellation vs. Symbols" and softkey "Symbols to plot".

Slot search details

This chapter gives some information how the application searches for TEDS slots.

- The slot search searches in the whole captured IQ data. The length is defined by parameter Capture Time, page 71.

- The slot search only accepts (and therefore the application only demodulates) slots which have the selected type (NDB / RAB / NUB / CB) and <u>at the same time</u> the selected number of carriers (8 / 16 / 32 / 48), please refer to parameters "Slot Type" on page 79 and "Channel Bandwidth" on page 67.

- Other slots are ignored, with one exception: 2 different slot types that use exactly the same sync and pilot symbols cannot be distinguished. This is the case for RAB slots with 8 subcarriers versus CB slots with 8 subcarriers.

- If the sync and pilot symbols of a certain slot are the same or similar as the sync and pilot symbols in the inner part of a wider slot, the slot search will also accept both kind of slots. This is the case for NDB with 8 subcarriers versus NDB with 16, 32 or 48 subcarriers.

- The payload symbol modulation type (4 QAM, 16 QAM, 64 QAM) is NOT a parameter that affects the slot search. It should nevertheless be set correctly because it affects the demodulation process and the measured results. Even measurements that use no demodulation (like "Spectrum FFT") might be affected indirectly, because they depend on getting a reliable slot start and slot end information from the demodulator.

- The time slots used can be as the standard [2] specifies, but they need not. This means the interval between 2 slots can be arbitrary.

- The slot search does not require an increase of the signal's amplitude during the slot duration. Slot search does not depend on power ramping.

- Slots at the very start and the very end of the capture buffer are always declined, because some measurements like ACP due to Transients need some time before and after the slot for measuring.

- Strong signals in adjacent channels can disturb the slot search if the parameter "Max Carrier Offset" on page 79 is set too high. It must then be decreased.

- A very low SNR, excessive noise, multipath or distortion can make the slot search unreliable.

- The slot search requires that the signal is as specified in standard [2], especially the sync and pilot symbols.

- The frequency offsets of the slots to measure must not be greater than the nominal center frequency plus or minus the demodulator lock range the user has selected (please refer to parameter "Max Carrier Offset" on page 79). Otherwise the slots will not be detected at all or at least not reliably.

Navigation

This section deals with navigation within the option. Navigation here is taken to mean all forms of interaction with the option except for remote control. The different methods of interacting with the option are:

- Hotkeys
- Softkeys
- Hardkeys
- Numeric Keypad
- Roll-key
- Cursor Keys
- External Keyboard
- Mouse

Hotkeys

Hotkeys are allocated to the seven keys at the bottom edge of the screen. On initial start-up of the R&S FS-K110 option, the hotkeys provided are shown in Fig. 1. These hotkeys are present at all times once the option has been started.

SPECTRUM	TETRA2	AUTO LVL	RUN SGL	RUN CONT	REFRESH	SCREEN B
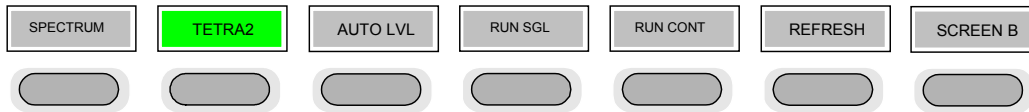
Fig. 1   Initial Hotkey menu

A keystroke activates the associated hotkey. An activated hotkey changes colour to green, as shown.
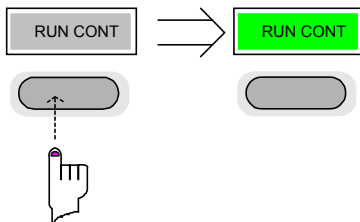
These hotkeys perform the following operations:

SPECTRUM

The *SPECTRUM* hotkey exits the R&S FS-K110 option & returns to the spectrum analyzer with most previous settings restored.
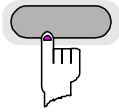
TETRA2

The *TETRA2* hotkey returns the user to the main measurement menu of R&S FS-K110, where measurement results can be seen. All settings views and pop-up dialogs are removed from the display, and the default softkey menu is displayed
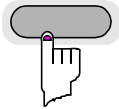
The *TETRA2* hotkey remains green whenever R&S FS-K110 is active

AUTO LVL

The *AUTO LVL* hotkey is c**urrently not available yet.**
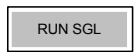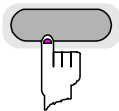
RUN SGL

The *RUN SGL* hotkey starts the selected measurement in single sweep mode. This means that the measurement will stop if either one capture buffer is processed or if the number of slots set by the parameter *Number of slots to analyze* (cf. dialog *Demod Settings*) is reached.
If another measurement (such as a continuous sweep measurement) is running while you press this hotkey, the running measurement will be completed and stopped.
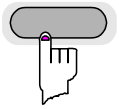
RUN CONT

The *RUN CONT* hotkey starts the selected measurement in continuous sweep mode. This means that the measurement will never stop. The parameter *Number of slots to analyze* (cf. dialog *Demod Settings*) will determine when MIN/MAX/AVG statistics of all measurements will be reset.
Pressing the *RUN CONT* hotkey while a continuous sweep measurement is running causes the measurement to be stopped (aborted).
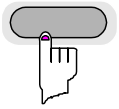
REFRESH

The *REFRESH* hotkey enables repeatedly recalculation using old IQ data and the currently set parameters (general settings/demod settings). It triggers no IQ data capturing.
Example: The user has done a RUN SGL measurement with certain settings. Afterwards he wants to try which results are calculated with exactly the same old IQ data but other settings. So the steps would be:
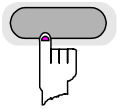
- RUN SGL, afterwards look at results.
- Cange some settings, press REFRESH, look at how results changed.
- Cange some settings, press REFRESH, look at how results changed and so on.

The *REFRESH* hotkey is only available after a RUN SGL.
Pressing the *REFRESH* hotkey disables the parameter *Number of slots to analyze* (cf. dialog *Demod Settings*) in case it was active.
REFRESH does of course not make sense after changing parameters that affect capturing of IQ data (center frequency, RF input vs digital or analog Baseband input, etc.)

SCREEN [A|B]

The *SCREEN [A|B]* hotkey selects the specified screen as the active screen. This is e.g. important to do before operating markers.
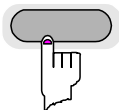
In full screen mode (cf. hotkey DISP) pressing the *SCREEN [A|B]* hotkey will display the specified screen.

After Pressing the *SCREEN [A|B]* hotkey the label displayed in the hotkey is changed e.g. after pressing the *SCREEN A* hotkey the label of the hotkey is changed to *SCREEN B.* The label indicates which screen will become the active screen after the hotkey is pressed.

Softkeys

Settings Softkeys

The softkeys are assigned to the nine keys on the right-hand side of the display. These enable quick access to all of the parameter settings and measurement screens of the R&S FS-K110 option. Each of the top two softkeys, when pressed, displays a settings view for a group of parameters. These softkeys are always available (except when using Save/Recall and Print manager or controlling markers) and are as follows:

General Settings
Signal Characteristics, Level Settings, Data Capture Settings, Trigger Settings, IQ Settings, Input Settings (and only if the necessary HW options are installed: Advanced Settings). Please refer to page 66.

Demod Settings
Demodulator Settings, EVM Settings, ACP Settings, Measurement Time Settings. Please refer to page 78.

Display List/Graph
Display a summary list of modulation errors or graphical traces.

PVT
Power versus Time Measurements

EVM
EVM versus Symbol, EVM versus Carrier, Magnitude Error and Phase Error Measurements.

Spectrum
Spectrum FFT, ACP Due to Modulation, ACP Due to Transients Measurements, Flatness

Constell
Constellation versus Symbol and Constellation versus Carrier Measurements

Statistics
Bit Stream Measurements

Fig. 2   Main Softkeys

Each of these groups of settings is described in detail in the Measurements & Settings section of this manual. Please also refer to for an overview of the whole softkey tree.

Other Softkeys

All other softkeys have different functions depending on the instrument state. Therefore, the labels (text) on the softkeys will vary to reflect their current function. The state of the softkeys is indicated by different appearances and colours, as follows:
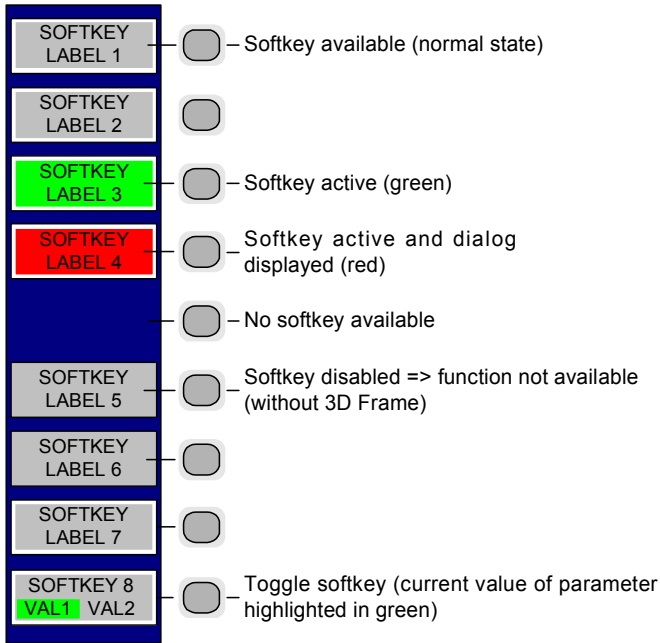
Fig. 3   Setup of the softkey area

A softkey in its normal state, where its function is available, is coloured grey with a 3D border.

A softkey that is disabled, because its function is <u>not</u> available, is coloured grey <u>without</u> a 3D border. Softkeys may become disabled because of the state of the instrument or because other settings disable the function associated with the softkey.

An active softkey (highlighted in green) is used when the softkey selects an item or view. For example, the *DEMOD SETTINGS* softkey will be highlighted green when the Demod Settings view is displayed.

A toggle softkey is used to change the value of a parameter that has only two states. Each press of the softkey toggles the value of the parameter. The current parameter value is highlighted in green in the lower half of the softkey label. For example, in the measurement results view, the *DISPLAY* softkey will have either *LIST* or *GRAPH* highlighted in green depending on whether the results are currently displayed as a list of measurement points or graphical trace(s).

When no function is assigned to a softkey then no softkey label will be shown.

Hardkeys

Hardkeys allow quick access to the desired parameter and various functions. The hardkeys supported by the R&S-FS-K110 option are as follows (other hardkeys do nothing):

FREQ	When the *FREQ* hardkey is pressed the General Settings view is displayed (if it is not already being displayed) and the *Frequency* parameter is selected.
SPAN	The *SPAN* hardkey is not available in present releases of the R&S FS-K110 application.
AMPT	When the *AMPT* hardkey is pressed the General Settings view is displayed (if it is not already being displayed) and the relevant *Signal Level* parameter for the selected signal input is selected.
MKR	When the *MKR* hardkey is pressed the main Marker softkey menu is displayed (if it is not already being displayed).
MKR->	When the *MKR->* hardkey is pressed the Marker extension softkey menu is displayed (if it is not already being displayed).
MKR FCTN	The *MKR FCTN* hardkey is not available in present releases of the R&S FS-K110 application.
SWEEP	When the SWEEP hardkey is pressed the General Settings view is displayed (if it is not already being displayed) and the *Capture Time* parameter is selected.
MEAS	When the *MEAS* hardkey is pressed the Main softkey menu is displayed (if it is not already being displayed).
TRIG	When the *TRIG* hardkey is pressed the General Settings view is displayed (if it is not already being displayed) and the *Trigger Mode* parameter is selected.
TRACE	When the *TRACE* hardkey is pressed the Show Trace pop-up dialog is displayed. If the pop-up dialog is already being displayed when the *TRACE* hardkey is pressed, the dialog is dismissed.
LINES	When the *LINES* hardkey is pressed the Limit Lines softkey menu is displayed (if it is not already being displayed) and the first limit in the current summary table (if there is one showing) is selected. Note this hardkey only functions when one of Results Summary, ACP Due to Modulation Summary, or ACP Due to Transients Summary table is active.
DISP	When the *DISP* hardkey is pressed the Display softkey menu is displayed (if it is not already being displayed).
FILE	When the *FILE* hardkey is pressed, the Save, Recall and File Manager softkey menu is displayed, allowing the save & recall of settings and/or measurement results of the R&S FS-K110 option.
PRESET	When the *PRESET* hardkey is pressed the R&S FSQ or R&S FSU-option is exited and a preset will be performed. Note that all options (including R&S FS-K110) shall also be preset. All user-set limits and parameters will be gone!
HCOPY	When the *HCOPY* hardkey is pressed the print manager softkey menu is displayed, allowing selection of the items to be printed.

External Keyboard

The external keyboard is optional. The keys on the external keyboard that can be used to interact with the R&S FS-K110 option are as follows:

Number keys 0 to 9

Decimal point (".")	Inserts a decimal point "." at the cursor position.
Minus key	Changes the sign of the mantissa or exponent of a numeric parameter. A "-" is inserted at the cursor position in the case of an alphanumeric parameter.
ESC key	Aborts the entry before it has been terminated. The previous value is restored. Closes the entry field after termination of input. Closes settings views and pop-up dialogs.
ENTER key	Terminates the input of dimension quantities. The new value is set. Invokes the input of parameters or immediately sets the new value. Selects the highlighted item in drop-down menus.
Left and Right Cursor Keys are used to:	Navigate between individual parameters within the setting views and some of the pop-up dialogs. Navigate between the individual items within drop-down menus. Move the cursor left & right inside the entry window to reach a particular position in the string during alphanumeric entry.
Up and Down Cursor keys are used to:	Navigate between individual parameters within the setting views and some of the pop-up dialogs. Navigate between the individual items within drop-down menus. Increment or decrement the value of a parameter during numeric entry.
CTRL keys	Used to activate hotkeys. Each of the seven hotkeys is allocated a different function (F) key. To access these hotkeys press CTRL and the corresponding F key together (see Fig. 4):

CTRL + F1	CTRL + F2	CTRL + F3	CTRL + F4	CTRL + F5	CTRL + F6	CTRL + F7
SPECTRUM	TETRA2	AUTO LVL	RUN SGL	RUN CONT	REFRESH	SCREEN B
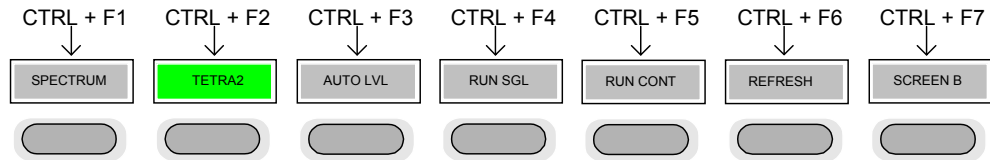
Fig. 4   Quick Access to Hotkeys

Function Keys	Used to activate softkeys. Each of the nine softkeys is allocated a different function (F) key. To access these softkeys the corresponding F key, as shown below:

F1 → SOFTKEY 1
F2 → SOFTKEY 2
F3 → SOFTKEY 3
F4 → SOFTKEY 4
F5 → SOFTKEY 5
F6 → SOFTKEY 6
F7 → SOFTKEY 7
F8 → SOFTKEY 8
F9 → SOFTKEY 9
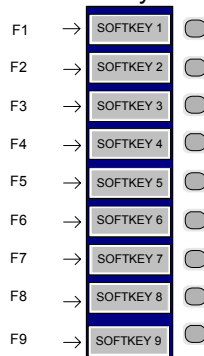
Fig. 5   Quick access to softkeys

Mouse

The mouse can be used to select individual parameters within the settings views or pop-up dialogs and to activate hotkeys and softkeys. It can also be used to select values from a drop-down list.

Selecting & Editing Parameters

Parameters are set either by numeric or alphanumeric entry or by simple selection from a list of possible values (a drop-down list is used to select an "enumerated" value) or by using checkboxes to turn a parameter setting on and off.

In all cases, the parameter has to be selected by placing focus on it and then editing has to be enabled before its value can be changed.

The rollkey and cursor keys on the front panel are provided for navigation and selection of parameters.

The numeric keypad, rollkey and cursor keys on the front panel and an external keyboard (optional) are provided for the entry of parameter values.

Numeric Keypad

The numeric keypad is provided for entry of numeric parameters. It contains the following keys:

- Number keys 0 to 9
  Starts editing of the selected parameter. This enables a new value to be entered for a parameter directly without having to press *ENTER* first. The digit will be displayed as the first digit of the newly entered value. Inserts a digit at the cursor position when editing an alphanumeric parameter.

- Decimal point
  Inserts a decimal point "." at the cursor position.

- Sign key ("-")
  Changes the sign of the mantissa or exponent of a numeric parameter. A "-" is inserted at the cursor position when editing an alphanumeric parameter.

- Unit keys (GHz/-dBm, MHz/dBm, kHz/dB and Hz/dB)

- Provides the numeric value entered with the selected unit and sets the parameter to that value.
  The unit keys are all assigned the value "1" for dimensionless quantities or for level entries (e.g. in dB). The unit keys thus assume the function of an *ENTER* key.

- *BACK* key
  Deletes the character to the left of the cursor with alphanumeric entry.

- ESC/CANCEL key
  Aborts the entry of a new parameter value. The previous value is restored. Closes settings views and pop-up dialogs.

- ENTER key
  Enables editing of the selected parameter (using numeric keys or rollkey). Finishes the editing of a parameter value. The new value is set. For an alphanumeric value, the new value is set to that displayed (using the current unit if applicable).
  In a drop-down menu, the parameter is set to the currently selected value in the list.

Rollkey
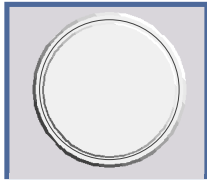
The rollkey has various functions:

- In a settings view, the rollkey can be used to navigate between individual parameters (the parameter selected being highlighted).

- In drop-down menus, the rollkey can be used to navigate between the individual values for the parameter.

- During numeric entry, the parameter is incremented (by turning clockwise) or decremented (by turning counter-clockwise) at a defined step size (depending on the parameter).

- In setting views and pop-up dialogs pressing the rollkey invokes the input of parameters or immediately sets the new value, i.e. pressing the rollkey is like pressing the *ENTER* key.

- In drop-down menus, pressing the rollkey selects the relevant item.

Cursor Keys
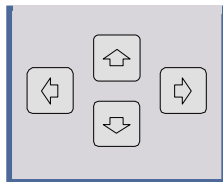
The keys ⬅ and ➡ are used to:

- Navigate between individual parameters within the setting views and some of the pop-up dialogs.

- Navigate between the individual values within drop-down menus.

- Move the cursor left & right inside the entry window to reach a particular position in the string during alphanumeric entry.

The keys ⬆ and ⬇ are used to:

- Navigate between individual parameters within the setting views and some of the pop-up dialogs.

- Navigate between the individual items within drop-down menus.

- Increment or decrement the value of a parameter during numeric entry.

Selection of a parameter within a settings view

Selection using rollkey
➢ Press GENERAL SETTINGS softkey for example (General settings view is displayed).

➢ Rotate the rollkey until reaching the required parameter.
Turning the rollkey clockwise selects parameters in the downward direction, turning it counter-clockwise selects parameters in the upward direction.

Example: Selecting *Signal Level* (General settings)
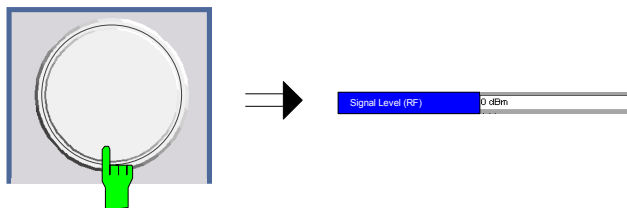
Note: *When the Signal Level parameter is selected its label is highlighted blue.*

When the desired parameter is reached press the rollkey to edit the parameter.

Selection using cursor keys
Cursor ⬆ , ⬇ , ⬅ or ➡ until obtaining the required parameter.
Within a list of parameters, the *Down* and *Right* both move to the next item (down) in the list and the *Up* and *Left* keys both move to the previous item (up) in the list.
Within a table of parameters, the cursor keys move the cursor in the direction indicated.

To start editing the parameter, either press the *ENTER* key on the numeric keypad, or press the rollkey.

Selection using mouse
➢ Use the mouse to move the cursor to the parameter and press the left mouse button to select the parameter.

➢ To start editing the parameter, either press the ENTER key on the numeric keypad, or press the rollkey.

For numeric parameters, editing can also be started by entering the new value directly from the numeric keypad without pressing the *ENTER* key first.

Selection using external keyboard
➢ Select parameter using the cursor keys (in the same way as using the cursor keys on the front panel).

➢ To start editing the parameter, either press the ENTER key on the numeric keypad, or press the rollkey.

For numeric parameters, editing can also be started by entering the new value directly from the numeric keypad without pressing the *ENTER* key first.

Entry of a numeric value

Once a parameter has been selected (see above), a new value for a numeric parameter can be entered in a number of ways. With the exception of entry via the number keys, to start editing the parameter, either press the *ENTER* key on the numeric keypad, or press the rollkey before following the instructions below.

If an error occurs, for example, the entered value is out of range, then the new value will not be accepted for the parameter setting.

Entry using number keys (numeric keypad)

> Enter required value using the number keys.

Example: To enter 200 MHz

| Frequency | 200 MHz |
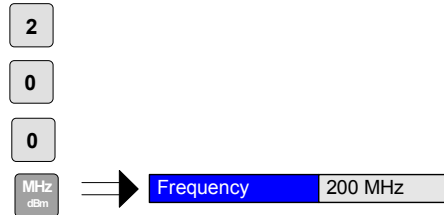
Note: *The parameter is not set to the new value until either one of the unit keys on the numeric keypad, the ENTER or the rollkey is pressed.*

If the new value is not valid, then a message box is displayed and the entered value will be replaced with a valid value. For example, when a value above the maximum allowed is entered, then the maximum value allowed will be shown in the entry box. The parameter will still be ready for editing so that another value can be entered if desired.

Entry using cursor keys

> Cursor ⬆ or ⬇ until obtaining the required value.

The application prevents the minimum and maximum values of the parameter from being exceeded and displays an "Out of range" message box if attempted.
Note: The cursor keys increment/decrement a parameter value in large steps.

Example: Cursor down to 100MHz
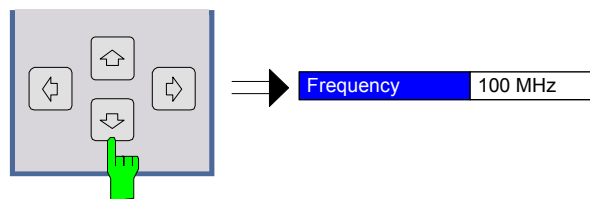
| Frequency | 100 MHz |

Note: *Each change of the parameter value takes place immediately. No other keys need to be pressed.*

Entry using rollkey	➢ Rotate the rollkey until reaching the required value. Turning the rollkey clockwise increases the value, turning it counter-clockwise decreases the value.

The application prevents the minimum and maximum values of the parameter from being exceeded and displays an "Out of range" message box if attempted.
Note: The rollkey increment/decrement a parameter value in small steps
Example: Rotate to 200 MHz
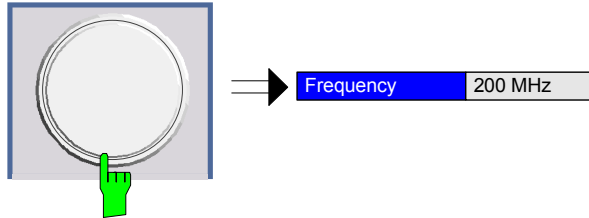
Frequency	200 MHz

Note: *Each change of the parameter value takes place immediately.*
          No other keys need to be pressed.

Entry using external keyboard	➢ Enter value using number keys 0 – 9 in the same way as for using the number keys on the numeric keypad (see above).
Terminating the entry	➢ Press one of the unit keys on the numeric keypad. The unit is entered in the parameter's edit box and the new parameter value is set immediately.
	➢ Press the *ENTER* key (on numeric keypad or external keyboard) or press the rollkey. The new parameter value is set immediately.

Note: *Pop-up dialogs, where used, do not close automatically. They*
          can be closed by pressing the ESC key.

In both cases, if the new value is not valid, then a message box is displayed and the entered value will be replaced with a valid value. For example, when a value above the maximum allowed is entered, then the maximum value allowed will be shown in the entry box. The parameter will still be ready for editing so that another value can be entered if desired.

Correcting the entry	➢ Position the cursor to the right of the digit which is to be deleted using the cursor keys ⬅ or ➡.
	➢ Press the BACK key. The digit to the left of the cursor is deleted.
	➢ Enter new digits. Each digit is inserted to the left of the cursor, the other digits are shifted right.
Aborting the entry	➢ Press the *ESC* key during parameter editing. The original parameter value is restored. The new entry is deleted.
	➢ If a pop-up dialog is displayed, press the *ESC* key again. The entry window is closed, the original value remains active.

Entry of an enumerated value

Once a parameter has been selected (see above), a new value for an enumerated parameter can be entered in a number of ways. To start editing the parameter, either press the *ENTER* key on the numeric keypad, press the rollkey or left click with the mouse on the drop down button before following the instructions below.

Note: *When the rollkey or ENTER is pressed, a drop-down menu is displayed, which contains all the available settings that may be selected for the parameter.*

Selection of setting using cursor keys	➢ Cursor ⬆ or ⬇ until obtaining the required setting.
	➢ Press *ENTER* on external keyboard or numeric keypad, or press rollkey to select the desired setting of parameter.
	Note: *Currently selected setting of the parameter is highlighted blue.*
	Pressing ENTER sets the new setting of the parameter immediately.
Selection of setting using rollkey	➢ Rotate the rollkey until reaching the required setting.
	➢ Press rollkey to select setting.
	Example: Select *Channel Bandwidth* parameter.
	Note: *Currently selected setting of the parameter is highlighted blue.*
	Pressing the rollkey sets the new setting of the parameter immediately.
Selection of setting using mouse	➢ When the parameter is selected and ready for editing, select a new setting using the mouse by left-clicking on the new setting from the drop-down list. The new setting of the parameter is set immediately.
Selection of setting using external keyboard	➢ Select setting using cursor keys.
	➢ Press *ENTER* to set the parameter to the new value.

Entry of a checkbox

A checkbox is used for parameter settings that are either On or Off (Boolean settings). A checkmark (✓) appears in the box when the setting is On; the checkbox is empty when the setting is Off.

Once a parameter has been selected (see above), a new value for a Boolean parameter can be entered in a number of ways. Because Boolean parameters are very simple, it is not necessary to press the *ENTER* key on the numeric keypad or to press the rollkey in order to edit them.

Toggle between the two states of a checkbox using rollkey	➢ Press the rollkey to toggle between the two states. **Example**: Turn *Auto Level* setting to Off
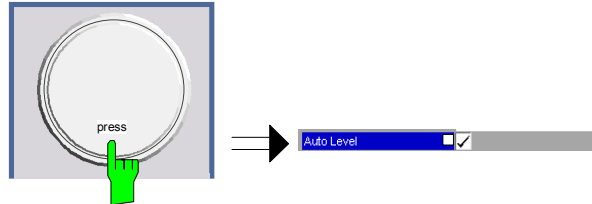
Note: *The checkbox is empty when the settings is Off*

Toggle between the two states of a checkbox using numeric keypad	➢ Press the *ENTER* key to toggle between the two states. **Example**: Turn *Auto Level* setting to On

Toggle between the two states of a checkbox using a mouse	➢ Left-click on the checkbox to toggle between the two states.

Toggle between the two states of a checkbox using external keyboard	➢ Press *ENTER* to toggle between the two states.

Status Bar & Title Bar

Title Bar

The title bar is visible at the very top of the display when R&S FS-K110 is active and there are no settings views currently being displayed.

Fig. 6   Title Bar

The center of the title bar shows TETRA2.

Status Bar

The main status bar is displayed at the bottom of the display, just above the hotkeys.

When a parameter in a settings view or pop-up dialog is selected, the status bar will display the minimum and maximum settings allowed for the selected parameter (see Fig. 7).

Fig. 7   Status Bar

When a parameter whose value is enumerated or Boolean in type is selected in any dialog, the status bar will show "N/A" displayed for the minimum and maximum, since the minimum and maximum values are "Not Applicable."

At other times, the status bar shows the current measurement status along with detailed information about the progress through any running measurement.

The status bar is also used to display warning and error messages to the user. In order to highlight these messages, warning messages are displayed with a blue background and error messages with a red background. Refer to Section 7 for a list of warning and error messages.

Save/Recall

This section of the user manual describes the Save/Recall facility of the option.
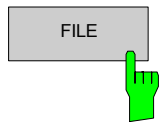
The *FILE* hardkey opens the Save/Recall softkey menu. Any open settings views or pop-up dialogs will be closed.
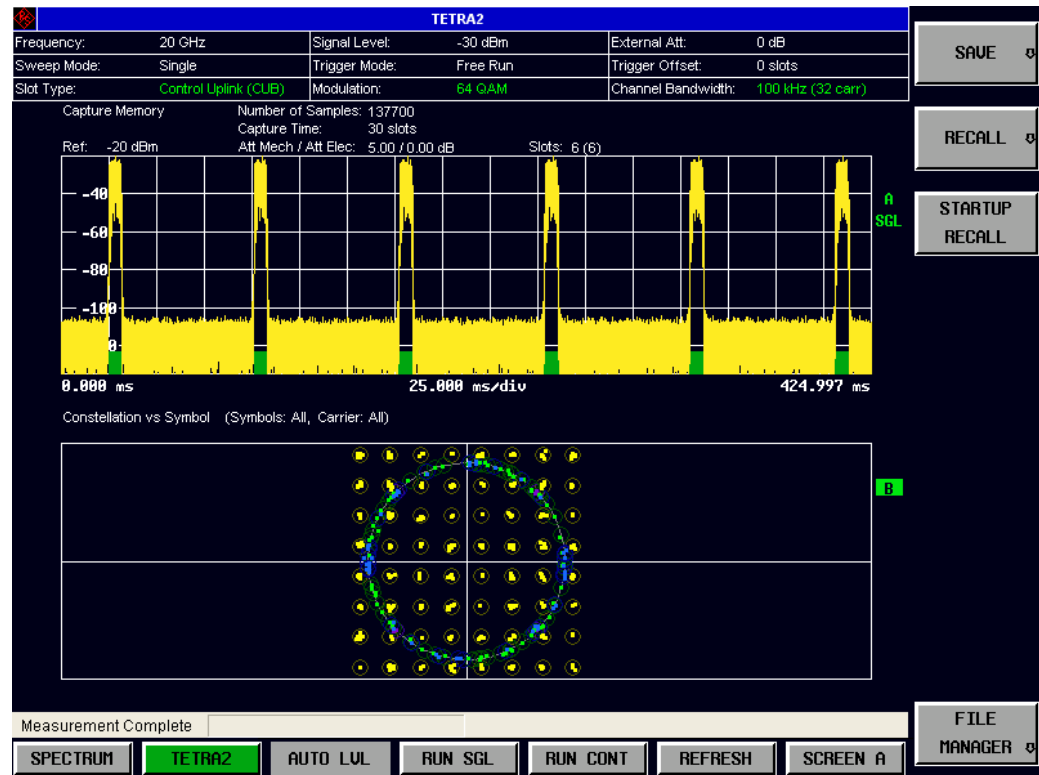
Fig. 8   Save/Recall softkey menu

The save/recall facility provided by R&S FS-K110 is exactly the same as that provided by the host analyzer. Refer to the user manual of the spectrum analyzer for details of the save/recall operation.

The save/recall facility in R&S FS-K110 provides the following items that can be saved and/or recalled:

- Current Settings   All user settings provided by R&S FS-K110
- TETRA2 Results   All current trace and table results
- User Limits   All table limit values.
- IQ Data   Allows the raw IQ data to be stored. When recalled the data is reprocessed to generate results
- All Traces   The current on-screen traces

To close the save/recall softkey menu and return to the main R&S FS-K110 softkey menu, press the *TETRA2* hotkey.

Printing

This section of the user manual describes print facility of the option
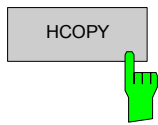
HCOPY

The *HCOPY* hardkey opens the print softkey menu. Any open settings views or pop-up dialogs will be closed.
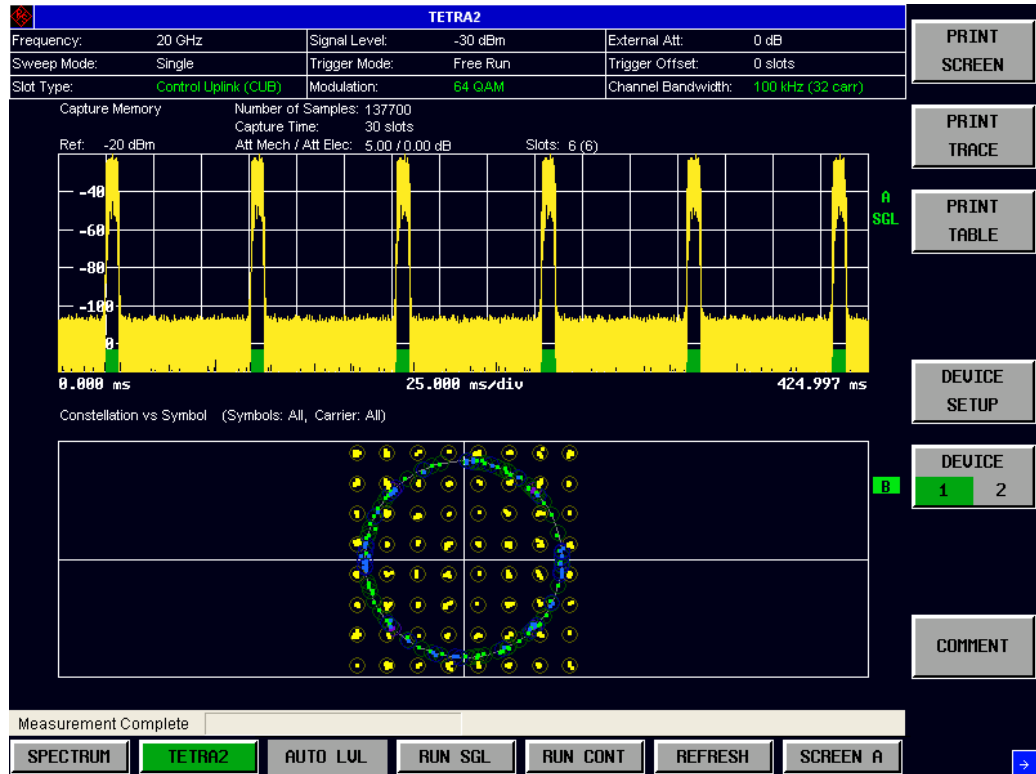
Fig. 9   Print softkey menu
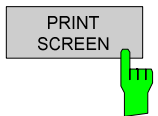
PRINT SCREEN

The *PRINT SCREEN* softkey prints the top header and the displayed measurement tables and traces.
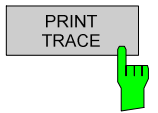
PRINT TRACE

The *PRINT TRACE* softkey prints the displayed measurement traces only.
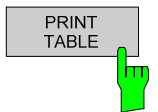
PRINT TABLE

The *PRINT TABLE* softkey prints the displayed measurement tables only.

The print facility provided by R&S FS-K110 is exactly the same as that provided by the host analyzer. Refer to the user manual for the spectrum analyzer for details of the print facility operation.

The default directory for the print output files is D:\R_S\INSTR\TEMP.

To close the print softkey menu and return to the main R&S FS-K110 softkey menu, press the *TETRA2* hotkey.

2 Measurements & Settings

This section contains a detailed description of all measurement modes, settings & results. It covers the following subjects:

- Measurement modes

- Running measurements

- Measurement results

- General settings

- Demodulation settings

- Marker settings

- General hints about measurements

Running measurements

To start a measurement, press the *RUN SGL* hotkey (single) or *RUN CONT* hotkey (continuous).

A single measurement (*RUN SGL*) will complete once the requested number of bursts have been obtained (parameter is active) or a single sweep (i.e. one capture buffer) has been completed.
When a measurement is completed in continuous mode (*RUN CONT*) then a new measurement will be started.

Note that if the *RUN SGL* hotkey is pressed while a current measurement is running, that measurement will be aborted, and the Status Bar will display, "*Measurement Aborted*".

During a measurement, the text "*Running...*" is displayed in the Status Bar at the bottom of the screen. After successful completion of a single measurement, the Status Bar will display "*Measurement Complete*"

Measurement settings summary

The tabular section below the title bar shows the overall measurement settings used to obtain the current measurement results.

TETRA2					
Frequency:	390.05 MHz	Signal Level:	-40 dBm	External Att:	0 dB
Sweep Mode:	Single	Trigger Mode:	Power	Trigger Offset:	0 slots
Slot Type:	Normal Downlink (NDB)	Modulation:	64 QAM	Channel Bandwidth:	50 kHz (16 carr)

Fig. 10   Overall measurement settings summary

The settings summary includes the following information:

Setting	Description
Frequency	The nominal center frequency of the input signal (or channel).
Sweep Mode	Shows "Single" for a single measurement (hotkey RUN SGL) and "Continuous" for a continuous measurement (hotkey RUN CONT) .
Slot Type	The type of slot/burst being analyzed / being searched for.
Signal Level	The highest expected mean signal level for the input signal.
Trigger Mode	The trigger source used to start the measurement sweep.
Modulation	The type of modulation used for the payload (data) symbols of the slots.
External Att	The setting for any external attenuation or pre-amplification
Trigger Offset	The trigger delay (positive value) or pre-trigger time (negative value) applied to the trigger.
Channel Bandwidth	The nominal (channel) bandwidth of the expected input signal in kHz.

R&S FS-K110 Measurement Results

In this section we describe the measurements available on the R&S FS-K110 application.

Measurement Menus

A summary of the measurement menus is shown in the figure below.
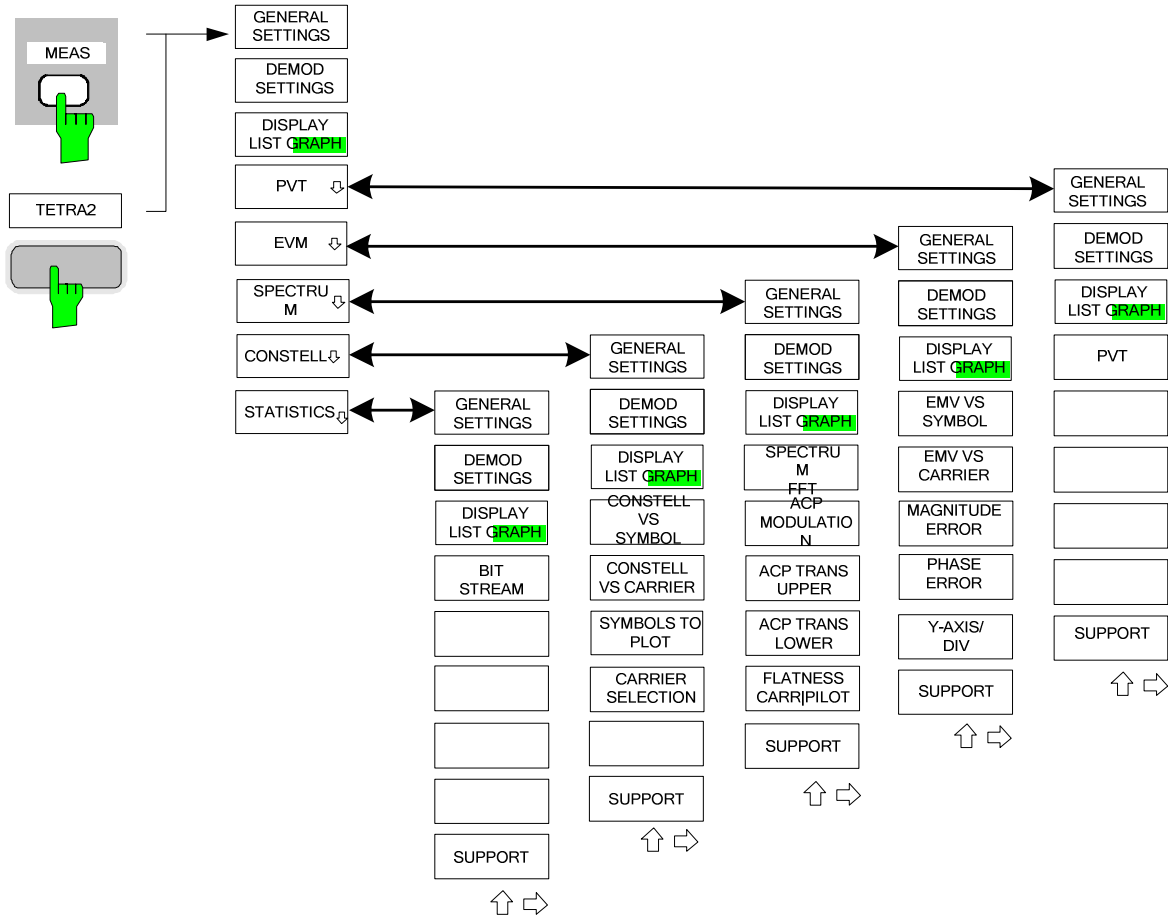
Fig. 11   R&S FS-K110 measurement menus

Magnitude Capture Display (Available From Multiple Measurements)

The Magnitude Capture Display is special in that it is mostly not used as an independent measurement. Instead it is mostly part of the following measurements:

- EVM vs Symbol

- EVM vs Carrier

- Magnitude Error

- Phase Error

- Spectrum FFT

- Constellation vs Symbol

- Constellation vs Carrier

- Bit Stream

Normally (split screen mode) any of these measurements shows Magnitude Capture Display in the upper half of the screen.

But by using the hotkey SCREEN [A|B] and hardkey DISP the magnitude capture display can as well be shown in full screen mode (as shown below) or it can be put into the background and is not visible any more.
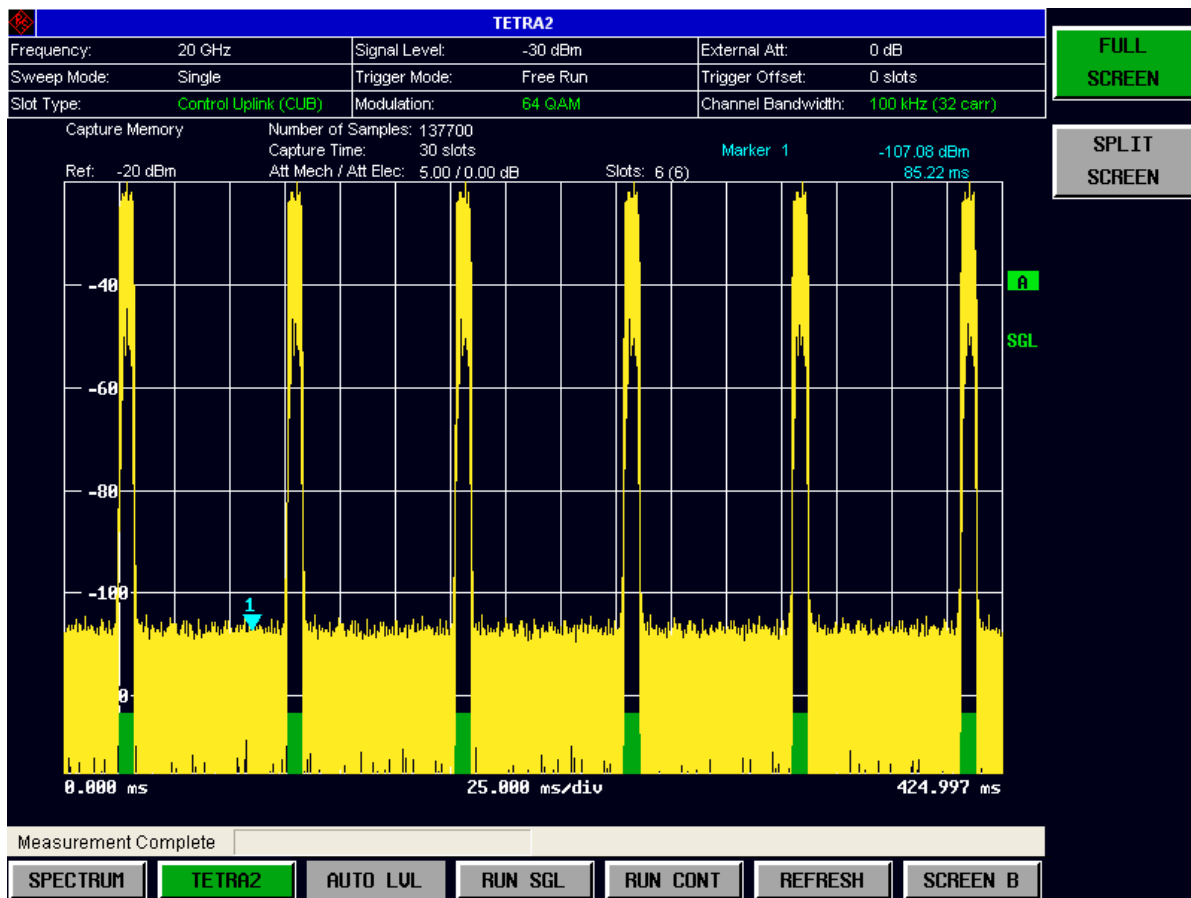
Fig. 12   Magnitude Capture Display Results

The Magnitude Capture Display shows the complete range of captured data for the current sweep. All analyzed bursts are identified with a green bar at the bottom of the Magnitude Capture Display. Information

about which slots are found or declined can be found in chapter "Slot search details" on page 16.
Please note that slots at the very start and end of the buffer are declined, because the internal signal processing needs some additional symbols before and after a slot.

Note that the R&S FS-K110 captures IQ data with a bandwidth much larger than the nominal set channel bandwidth. As a consequence the Magnitude Capture display will show not only the power in the TX channel, but also in the neighboring channels (which should ideally be inactive).

Measurements can be run in split screen mode (allowing both the Magnitude Capture Display and the selected IQ measurement results to be displayed simultaneously) or in full screen mode (with either the Magnitude Capture display or the selected IQ measurement results displayed).

The horizontal top line of the Capture Display marks that level which is called Reference Level. In the above example it is -20dBm. All input levels above this level may cause distortion, clipping and warnings like "IFOVLD" or "OVLD" on the screen. Avoid these situations by setting the parameter

- Signal Level (RF) (refer to page 68) for RF input or

- Signal Level (Baseband) (refer to page 69) for analog Baseband input

correctly.

Exception: For digital Baseband input there is no risk of overloading the analyzer's hardware. The horizontal top line of Capture display marks the maximum input level the digital Baseband input can have.

Measurements may be performed for RF or analog Baseband or digital Baseband input. Please refer to parameter Input Settings on page 74. The unit of the parameter Reference Level (horizontal top line of the Magnitude Capture Display) will change between "dBm" (RF input operation) and "Volt" (analog or digital Baseband input operation).
In case of analog or digital Baseband input operation the Magnitude Capture Display trace shows the relation (in decibel) of the input signal to the Reference Level's voltage. But the marker and the trace delivered in SCPI operation have the measurement unit "Volt" (no logarithm).

The Magnitude Capture Display measurement is good for checking:

- Is there a signal at all?

- Has the signal the correct power? The maximum power should be near to the Reference Level, but never above! Too low levels increase the SNR.

- Have the bursts the assumed length?

- Does the slot search algorithm of the R&S FS-K110 accept all slots?

- Are there single burst or consecutive ones?

- Does triggering work as excepted (cf. Trigger Settings on page 72)

- How many burst are there in the Capture Buffer (cf. parameter Capture Time on page 71)

Power vs Time (PVT)

PVT 👆
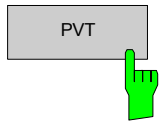
The PVT measurement results are selected by pressing the PVT softkey in the main measurement softkey menu.

Remote: `CONF:BURS PVT:IMM`

Fig. 13   PVT Result

This measurement is designed for single bursts (gaps before and after each slot) and therefore makes no sense for NDB slots. Nevertheless the measurement allows NDB slots.

For detailed information about the results please refer to chapter "

Results of Power versus Time" on page 118.

The signal around every found slot (slot or sub-slot duration plus 6 symbol durations before and after) is first compensated for its frequency error and then filtered by a quasi-rectangular low pass filter with a bandwidth of 25 KHz / 50 KHz / 100 KHz / 150 KHz depending on the set channel bandwidth.
The filter's output can be exactly aligned to the slot's timing, because the application knows the symbol instants after demodulation.

The lower half of the diagram shows the power versus time traces. The vertical lines show the symbol instants S1 (x axis is 0 there) and S14 (or S31 or S34), i.e. the first and last symbols.

Other vertical lines show T1 and T3, times that are defined in figure 6.4 of [2].
A green bar shows the slot or subslot duration.

The table in the upper half shows

- Reference Power as defined in [2], i.e. the mean power of the RRC filtered sync and pilot symbols.

- Slot Power: The mean power of the PVT signal during the slot or subslot duration.

- The mean power before the burst (i.e. before T1), absolute and relative to the Reference Power of the same slot.

- The mean power after the burst (i.e. after T3), absolute and relative to the Reference Power of the same slot.

- Trigger to Sync: The time from the event that triggered the start of the IQ data capturing to the first symbol instant of the first found slot in the current capture buffer. The result "Trigger to Sync" is most useful if an external trigger (cf. Trigger Mode on page 72) is used. Please refer to Fig. 54 for detailed information about this result.

EVM vs Symbol
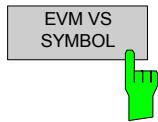
EVM VS
SYMBOL

The EVM vs Symbol measurement results are selected by pressing the EVM softkey in the main measurement softkey menu followed by the EVM VS SYMBOL Softkey.

Remote: `CONF:BURS:EVM:ESYM:IMM`

Fig. 14   EVM vs Symbol

The EVM vs Symbol display shows the RMS EVM measured for the first until the last symbol instant defined for the currently selected slot type (cf. parameter Slot Type, page 79). The results are displayed on a per-symbol basis, with dots indicating the value at each symbol. Note that EVM can be displayed in percent or dB, per the selection in the Y-AXIS/DIV pop-up dialog (page 42).

The EVM at a certain symbol instant is calculated as the RMS average of the momentary EVM in all subcarriers. For detailed information please refer to Formula 15 and Formula 16.

Note that the parameter "Show 2nd EVM based on" (page 80) has no influence here, i.e. all kind of symbols are used.

The parameters (cf. Demod Settings, page 78)

- Pilot Tracking

- Compensate Amplitude Droop

- Compensate IQ Offset

- and especially Payload Modulation

do have an effect.

The measurement EVM vs Symbol is useful

- as an overall figure of merit including all modulation errors

- to see if there are problems at the start or end of a burst due to power ramping

- to see whether certain symbol types cause high EVM (e.g. the first 2 symbol instants represent mostly sync symbols)

Note that due to the Inter-Carrier-Interference a perfect TEDS signal will never show an EVM as low as a perfect single-carrier or OFDM QAM signal.
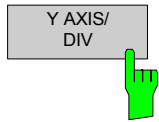
Y AXIS/
DIV

Pressing *Y AXIS/ DIV* softkey displays a pop-up dialog which allows the settings of the Y-Axis to be controlled. The center and the span/range of the Y-Axis can be adjusted to allow the user to zoom in on the measurement results.
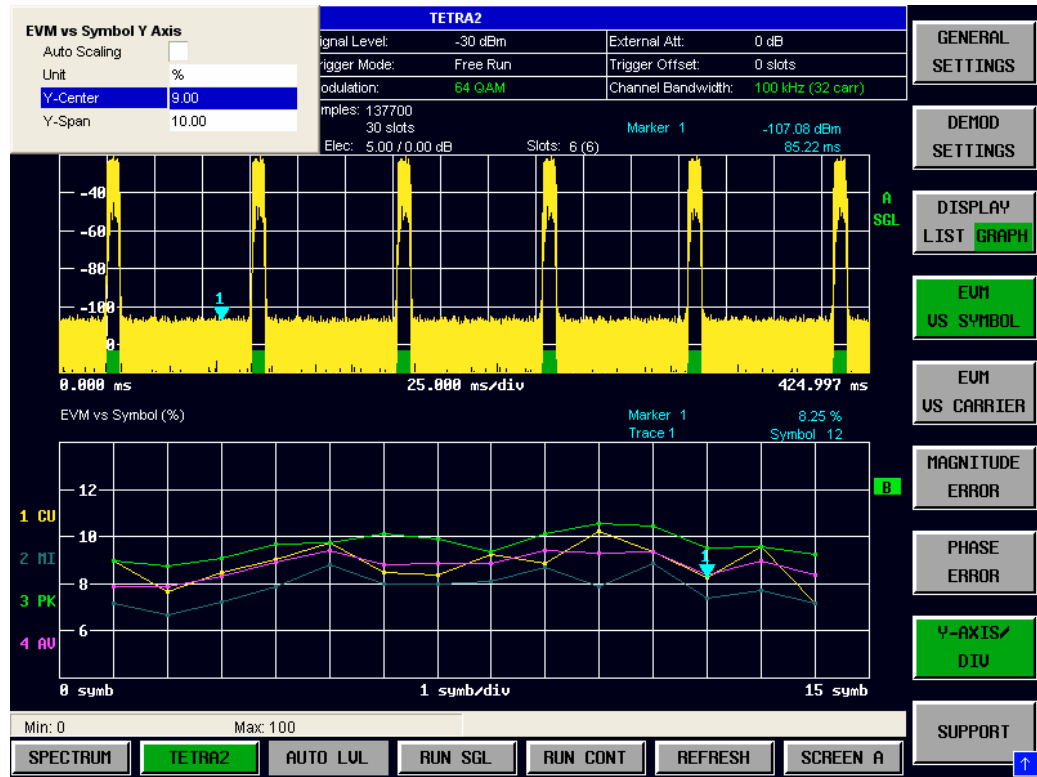
Fig. 15   EVM vs Symbol - Y-Axis Scaling

EVM vs Symbol Y Axis

The y axes of the measurements EVM vs Symbol and EVM vs Carrier can be configured with the same kind of dialog. But since both measurement store individual settings the descriptions are kept separately in this manual.
First for EVM vs Symbol:

Auto Scaling
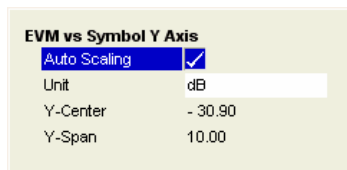
Auto Scaling specifies whether the Y-Axis scale should be set manually or calculated automatically.

When the *Auto Scaling* parameter is switched OFF then the setting of the *Y-Center* and *Y-Span* settings are used to calculate the Y-Axis scale.

Remote: `DISP:WIND2:TRAC:Y:SCAL:ESYM:AUTO`

Unit
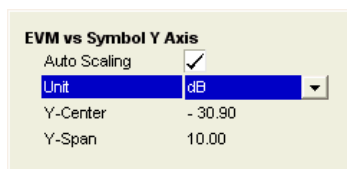
Unit specifies whether the EVM results will displayed in dB or percent.

Remote: `DISP:WIND2:TRAC:Y:SCAL:ESYM:UNIT`

Y-Center

Y-Center specifies the center/mid-range of the Y-Axis when *Auto Scaling* is switched OFF.

Remote: `DISP:WIND2:TRAC:Y:SCAL:ESYM:CENT`

Y-Span

Y-Span specifies the span/range of the Y-Axis when *Auto Scaling* is switched OFF.

Remote: `DISP:WIND2:TRAC:Y:SCAL:ESYM:SPAN`

EVM vs Carrier
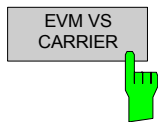
The EVM vs Carrier measurement results are selected by pressing the *EVM* softkey in the main measurement softkey menu followed by the *EVM vs CARRIER* softkey.

Remote: `CONF:BURS:EVM:ECAR:IMM`

Fig. 16   EVM vs Carrier Results

The EVM vs Carrier display shows the RMS EVM measured for all subcarriers defined for the currently selected channel bandwidth (cf. parameter Channel Bandwidth, page 67). The results are displayed on a per-subcarrier basis, with dots indicating the value at each subcarrier. Note that EVM can be displayed in percent or dB, per the selection in the Y-AXIS/DIV pop-up dialog.

The RMS EVM at a certain symbol instant is calculated as the RMS average of the EVM

of all symbols in the subcarrier.
For detailed information please refer to Formula 15 and Formula 16 (page 103).
Note that the parameter "Show 2nd EVM based on" (page 80) has no influence here, i.e. all kind of symbols are used.

The parameters (cf., page 78)

- Pilot Tracking

- Compensate Amplitude Droop

- Compensate IQ Offset

- and especially Payload Modulation

do have an effect.

The measurement EVM vs Symbol is useful

- as an overall figure of merit including all modulation errors

- to see if there are problems (e.g. a CW interferer) at certain subcarriers

- to see whether certain symbol type cause high EVM (e.g. the header symbols are located in certain subcarriers only)

Note that due to the Inter-Carrier-Interference a perfect TEDS signal will never show an EVM as low as a perfect single-carrier or OFDM QAM signal.
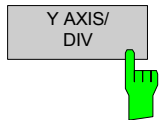
Y AXIS/ DIV

Pressing *Y AXIS/ DIV* softkey displays a pop-up dialog which allows the settings of the Y-Axis to be controlled. The settings provided are similar to that provided for the EVM vs Symbol measurement screen (please refer to chapter "EVM vs Symbol Y Axis" on page 42).

Remote: `DISP:WIND2:TRAC:Y:SCAL:ECAR:AUTO`
`DISP:WIND2:TRAC:Y:SCAL:ECAR:UNIT`
`DISP:WIND2:TRAC:Y:SCAL:ECAR:CENT`
`DISP:WIND2:TRAC:Y:SCAL:ECAR:SPAN`

Magnitude Error

MAGNITUDE
ERROR

The Magnitude Error results are selected by pressing the *EVM* softkey in the main measurement softkey menu followed by the *MAGNITUDE ERROR* softkey.

Remote: `CONF:BURS:MAGN:IMM`

Fig. 17   Magnitude Error Results

The Magnitude Error display shows the RMS Magnitude Error measured for the first until the last symbol instant defined for the currently selected slot type (cf. parameter Slot Type, page 79). The results are displayed on a per-symbol basis, with dots indicating the value at each symbol.

The RMS Magnitude Error at a certain symbol instant is calculated as the RMS average of the momentary Magnitude Error in all subcarriers. For detailed information please refer to Formula 10, page 102.
Note that the RMS Magnitude Error does not distinguish whether the measured signal's amplitude was smaller or larger than the ideal signal's amplitude.

Note that the parameter "Show 2nd EVM based on" (page 80) has no influence here, i.e. all kind of symbols are used.

The parameters (cf. Demod Settings, page 78)

- Pilot Tracking

- Compensate Amplitude Droop

- Compensate IQ Offset

- and especially Payload Modulation

do have an effect.

The measurement Magnitude Error versus Symbols is useful

- to see if the scaling of the measured symbols is correct

- to see if there are problems at certain symbol instants

- to see whether certain symbol types cause a high Magnitude Error (e.g. the first 2 symbol instants represent mostly sync symbols)

Note that due to the Inter-Carrier-Interference a perfect TEDS signal will never show a Magnitude Error as low as a perfect single-carrier or OFDM QAM signal.
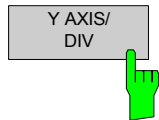
Y AXIS/ DIV

Pressing *Y AXIS/ DIV* softkey displays a pop-up dialog which allows the settings of the Y-Axis to be controlled. The settings provided are similar to the EVM vs Symbol measurement screen (please refer to chapter "EVM vs Symbol Y Axis" on page 42).

Remote: `DISP:WIND2:TRAC:Y:SCAL:MAGN:AUTO`
`DISP:WIND2:TRAC:Y:SCAL:MAGN:CENT`
`DISP:WIND2:TRAC:Y:SCAL:MAGN:SPAN`

Phase Error
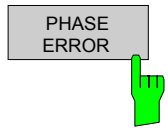
PHASE ERROR

The Phase Error results are selected by pressing the *EVM* softkey in the main measurement softkey menu followed by the *PHASE ERROR* softkey.
Remote: `CONF:BURS:PHAS:IMM`

Fig. 18   Phase Error Results

The Phase Error display shows the RMS Phase Error measured for the first until the last symbol instant defined for the currently selected slot type (cf. parameter Slot Type, page 79). The results are displayed on a per-symbol basis, with dots indicating the value at each symbol.

The RMS Phase Error at a certain symbol instant is calculated as the RMS average of the momentary Phase Error in all subcarriers. For detailed information please refer to Formula 5, page 101.
Note that the RMS Phase Error does not distinguish whether the measured signal's phase was smaller or larger than the ideal signal's phase.

Note that the parameter "Show 2nd EVM based on" (page 80) has no influence here, i.e. all kind of symbols are used.
The parameters (cf. Demod Settings, page 78)

- Pilot Tracking

- Compensate Amplitude Droop

- Compensate IQ Offset

- and especially Payload Modulation

do have an effect.

The measurement Phase Error versus Symbols is useful

- to see if the phase of the measured symbols is correct

- to see if there are problems at certain symbol instants

- to see whether certain symbol types cause a high Phase Error (e.g. the first 2 symbol instants represent mostly sync symbols)

Note that due to the Inter-Carrier-Interference a perfect TEDS signal will never show a Phase Error as low as a perfect single-carrier or OFDM QAM signal.
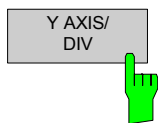
Y AXIS/
DIV

Pressing Y AXIS/ DIV softkey displays a pop-up dialog which allows the settings of the Y-Axis to be controlled. The settings provided are similar to the EVM vs Symbol measurement screen (please refer to chapter "EVM vs Symbol Y Axis" on page 42).

Remote: `DISP:WIND2:TRAC:Y:SCAL:PHAS:AUTO`
              `DISP:WIND2:TRAC:Y:SCAL:PHAS:CENT`
              `DISP:WIND2:TRAC:Y:SCAL:PHAS:SPAN`

Spectrum FFT
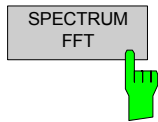
SPECTRUM
FFT

The Spectrum FFT measurement results are selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *SPECTRUM FFT* softkey.

Remote: `CONF:BURS:SPEC:FFT:IMM`

Fig. 19   Spectrum FFT Results (example)

Two cases must be distinguished:

1. At least one slot is found in the currently used IQ data:

    The signal around every found slot (slot or sub-slot duration plus 6 symbol durations before and after) is multiplied with a window function and processed by an FFT ("Welch method"). All these single FFT results contribute to the total Min/Max/AVG result statistic of the measurement. At the end of the measurement a Min/Max/Avg and a current (i.e. last found slot) trace will be shown.

2. No slot at all is found in the currently used IQ data:

    The same FFT processing as described before is done, but on the whole currently captured IQ data. The FFT result is show as "current trace", but it does NOT contribute to Min/Max/Avg result traces. This trace should just give an overview.

The FFT span depends on the selected channel bandwidth (cf. parameter Channel Bandwidth, page 67). Note that measurement "ACP Modulation" (page 51) does show exactly the same FFT result, but a wider span.
The Resolution Bandwidth (RBW) is in any case equal to 300 Hz.
The x axis frequencies are relative to the nominal set center frequency (cf. parameter Frequency, page 67).
For details about the signal processing please refer to Fig. 44 on page 96.

The measurement Spectrum FFT is useful

- to check if the signal has the expected bandwidth
- check the shape of the signal's spectrum
- to check if there are interferers in the signal
- to check if there are active adjacent channels.
- to detect disturbances (spurs, spectral regrowth and clipping effects).
- to roughly estimate the SNR

ACP Modulation
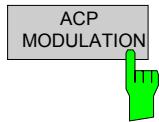
ACP
MODULATION

The ACP due to modulation measurement results are selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *ACP MODULATION* softkey.

Remote: `:CONF:BURS:SPEC:ACPR:MOD`

Fig. 20   ACP Due to Modulation Results (example)

Every time a slot in the TX channel is found, the raw input signal around this slot is filtered with a RRC filter at different offset frequencies.
The RRC filter is as defined in [2]:

- Roll-off: 0.35

- Design symbol rate: 18 KHz

- Filter's frequency offset relative to the TX channel's nominal center frequency depends on the set signal bandwidth and the offset channel index.

The automatically set ACP parameters can be checked in the upper half of Fig. 20 or in chapter "ACP (Modulation+Transients) Settings" on page 81. There is the TX channel and 3 offset channels above and 3 below.

The application is able to exactly cut out the useful part (i.e. first to last symbol instant) from the RRC-filters' outputs, because a demodulation took place. The application calculates the mean power during the useful part of each slot found in the TX channel.

For each offset channel the maximum measured absolute mean power during the useful part is drawn as a green bar in the lower part of the diagram (cf. Fig. 20).
Exception: For the TX channel the bar represents the maximum "Reference Power" measured in it (cf. Formula 50).

The Summary Table in the upper half of the diagram shows the absolute and relative powers in all 6 offset channels, where "relative" means that a power in the adjacent channel is related to the Reference Power (cf. Formula 50) measured in the TX-channel by the demodulator for the same slot.

For more details about the trace please refer to Formula 67 on page 117.
For more details about the result table please refer to Fig. 20 on page 51.

Please note that the switch ACP Display, page 82, selects if the "Current" & "Max" or the "Average"and "Max" results are shown in the table.

The FFT trace shown in the lower half of the diagram is the same as the one of measurement Spectrum FFT (page 49), except that the span is wider. The FFT trace serves only as a signal overview, no measurement results are derived from it! The FFT trace is therefore even drawn if no slots are found. A potential frequency offset or a wrong signal bandwidth can be identified with its help.

A potential frequency offset is not compensated for this measurement, so it should be checked that it is low.

The limits to check the results against can be set by using the LINES hardkey.
Each signal bandwidth (cf. parameter Channel Bandwidth, page 67) stores its own set of limits. All limits are automatically set to the ones defined in [2] when a PRESET is performed. Afterwards the user can change them.

The measurement "ACP Due to Modulation" is useful

- for checking if the requirements defined in [2] and [1] are met.

- for checking if the transmitter disturbs adjacent channels.

- for checking on spurs and interferers by means of the FFT trace.

For this measurement it is of course required that the offset channels are inactive.

ACP Transients Upper
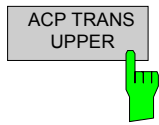
ACP TRANS
UPPER

The "ACP due to Transients - Upper" result display is selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *ACP TRANS UPPER* softkey.

Remote: `CONF:BURS:SPEC:ACPR:TUPP:IMM`
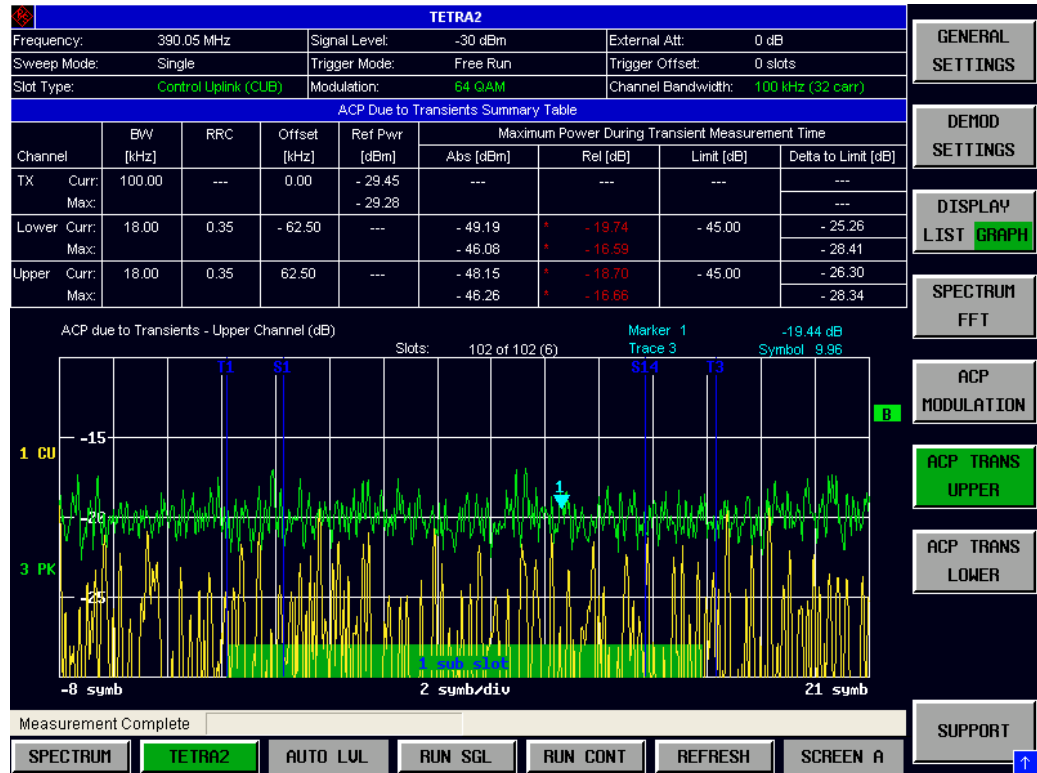
Fig. 21   ACP Due to Transients – Upper Channel (example)

Every time a slot in the TX channel is found, the raw IQ signal around this slot is filtered with an RRC filter (refer to Fig. 48).
The RRC filter is as defined in [2] and [1]:

- Roll-off: 0.35

- Design symbol rate: 18 KHz

- Filter's frequency offset relative to the TX channel's nominal center frequency depends on the set signal bandwidth. For the measurement "ACP due to Transients - Upper" the ACP measurement's frequency is higher than the center frequency.

The automatically set ACP parameters can be seen in the upper half of Fig. 21 on page 53 or in chapter "ACP (Modulation+Transients) Settings" on page 81.

The standard [2] demands that the measurement range is not too short. The R&S FS-K110 measures in the slot or subslot duration plus 6 symbol times before and after that. The vertical lines show the symbol instants S1 (x axis is 0 there) and S14 (or S31 or S34), i.e. the first and last symbols.
Other vertical lines show T1 and T3, times that are defined in figure 6.4 of [2].
A green bar shows the slot or subslot duration.

The application is able to exactly align the RRC-filter's output to the slot's timing because a demodulation took place.

The upper half of the diagram shows the absolute and relative powers in the upper adjacent channel. In the table"relative" means that the maximum power in the adjacent channel is related to the Reference Power (cf. Formula 50) measured in the TX-channel by the demodulator for the same slot.

For more details about the trace please refer to Formula 63 on page 115 (respectively Formula 66 for the lower adjacent channel).
For more details about the result table please refer to Fig. 51 on page 115.

Please note that the switch ACP Display, page 82, selects if the "Current" & "Max" or the "Average"and "Max" results are shown in the table.

A potential frequency offset is not compensated for this measurement, so it should be checked before (refer to Fig. 28).

The limits to check the results against can be set by using the LINES hardkey.
Each signal bandwidth (cf. parameter Channel Bandwidth, page 67) stores its own set of limits. All limits are automatically set to the ones defined in [2] when a PRESET is performed. Afterwards the user can change them.

The measurements "ACP Due to Transients – Upper / Lower" are useful

- for checking if the requirements defined in [2] and [1] are met.

- for checking if the transmitter disturbs adjacent channels.

For these measurements it is of course required that the adjacents channels are inactive.

ACP Transients Lower
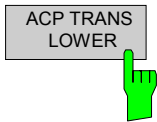
ACP TRANS
LOWER

The "ACP due to Transients – Lower" result display is selected by pressing the *SPECTRUM* softkey in the main measurement softkey menu followed by the *ACP TRANS LOWER* softkey.

Remote: `CONF:BURS:SPEC:ACPR:TLOW:IMM`
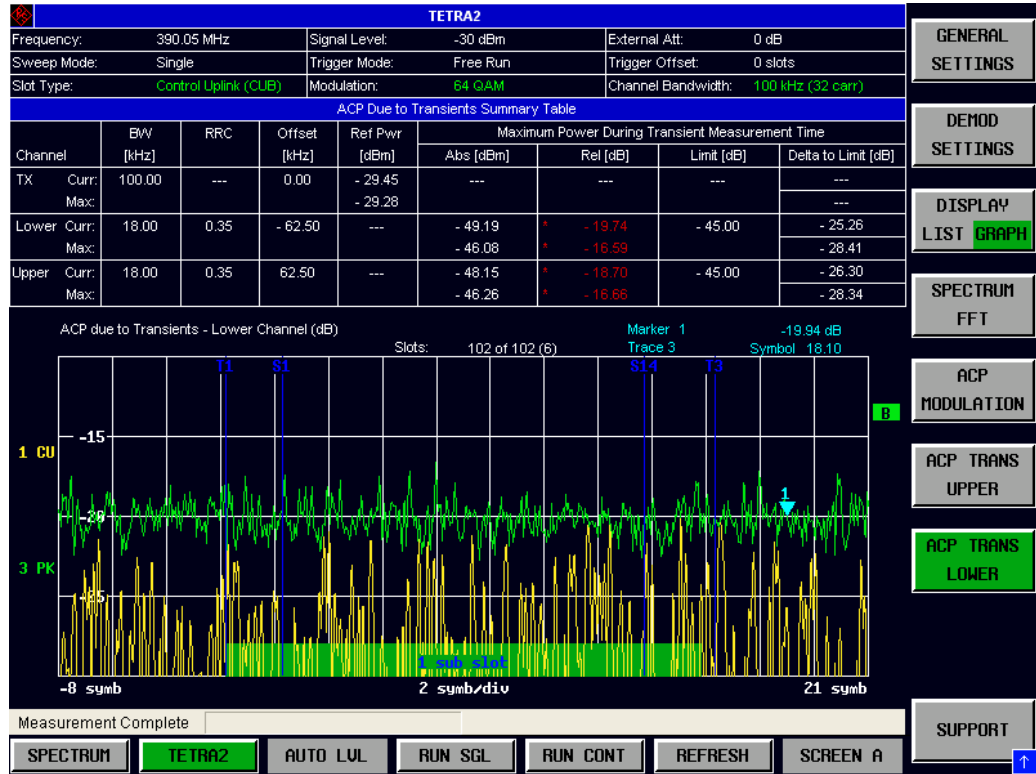
Fig. 22   ACP Due to Transients – Lower Channel (example)

The upper half of the display is identical to that of measurement ACP Transients Upper, page 53.

The lower part of the display is also identical to the measurement ACP Transients Upper, page 53, except that not the upper adjacent channel, but the lower one is measured.

Flatness

| Flatness CARR| PILOT |
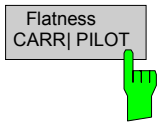
The "Flatness Carrier" respectively "Flatness Pilot" result display is selected by pressing the SPECTRUM softkey in the main measurement softkey menu followed by the FLATNESS CARR|PILOT softkey. . Pressing this softkey again toggles between these two measurements.

Remote: `CONF:BURS:SPEC:FLAT:SEL CARR`
         `CONF:BURS:SPEC:FLAT:SEL PIL`

Fig. 23   Flatness measurement (example): Subcarrier Power Deviation

TETRA2					
Frequency:	1 GHz	Signal Level (RF):	-30 dBm	External Att:	0 dB
Sweep Mode:	Single	Trigger Mode:	Free Run	Trigger Offset:	0 slots
Slot Type:	Control Uplink (CUB)	Modulation:	4 QAM	Channel Bandwidth:	25 kHz (8 carr)

Flatness of SubCarrier Reference Powers and Pilot Symbol Powers

	Min	Avg	StdDev	Max	Limit	Unit
Total Reference Power (Slot)	- 26.39	- 26.30	- 48.13	- 26.23	---	dBm
Avg Subcarrier Reference Power	- 35.47	- 35.38	- 57.34	- 35.32	---	dBm
Reference Power Deviation	* - 1.52	0.00	0.56	0.97	± 1.00	dB
@ Carrier	+3	---	---	-2	---	---
Pilot Power Deviation	* - 2.03	0.30	0.79	* 1.35	± 1.00	dB
@ Carrier/symbol	-4/14	---	---	-4/10	---	---

GENERAL SETTINGS

DEMOD SETTINGS

DISPLAY LIST GRAPH

SPECTRUM FFT

ACP MODULATION

ACP TRANS UPPER

ACP TRANS LOWER

FLATNESS CARR PILOT

SUPPORT

Pilot Power Deviation (dB)   Slots: 200 of 200 (32)

1 MI   2 PK   3 AV   4 RM

upper   lower

-5 carr   1 carr/div   5 carr

Measurement Complete

SPECTRUM | TETRA2 | AUTO LVL | RUN SGL | RUN CONT | REFRESH | SCREEN A

Fig. 24   Flatness measurement (example): Pilot Symbol Power Deviation

This measurement checks the power deviation of the subcarriers and the pilot symbols.

- For "Flatness Carriers" this is in detail:
  Deviation of the measured "Reference Power" of each subcarrier from the slot's "Average Subcarrier Reference Power".
  The "Reference Power" of each subcarrier is the average power of all its pilot and sync symbols (please refer to Formula 45).
  And the slot's "Average Subcarrier Reference Power" is the measured total "Reference Power" of the whole slot (mean power of ALL sync and pilot symbols, please refer to Formula 49), divided by the number of subcarriers.
  The final result is a vector, one value per subcarrier. It is displayed (trace results) or condensed to scalar results (result table) by mathematical operations.

- For "Flatness Pilots" this is in detail:
  Deviation of the measured power of any pilot symbol in each subcarrier from the corresponding subcarrier's "Reference Power" (please refer to Formula 45).
  The final result is a kind of matrix with the size: number of subcarriers times number of symbol positions in the slot. But because not all subcarriers and not all symbol positions contain a pilot symbol the result matrix is a sparse matrix. It is condensed to a vector (trace results) or even more to scalar results (result table) by mathematical operations.

The table in the upper part of the result display shows numeric results (for details please refer to page 110):

- As first result the Total Reference Power of the whole slot, i.e. the mean power of all pilot and sync symbols in the whole slot.
- As second result the Average Subcarrier Reference Power, i.e. the first result divided by the number of carriers.
- As third result the deviation of the Average Subcarrier Reference Power (second result) from the Reference Powers measured separately for each subcarrier (mean power of pilot and sync symbols in that subcarrier). Additionally it shows in which subcarrier the maximum and minimum (unit "dB")

deviation occurred.

- As fourth result the deviation of the power of any pilot symbol in a subcarrier from that subcarrier's measured Reference Power. Additionally it shows in which subcarrier and at which symbol position the maximum and minimum (unit "dB") deviation occurred.

The lower part of the result display shows the result traces versus subcarrier index.
Note:

- Pilot Symbol Flatness can only be measured and displayed for subcarriers that contain at least one pilot symbol.
- Subcarrier Reference Power Flatness is measured for all subcarriers.

- For "Flatness Carrier" measurement:
  Maximum, minimum, average and standard deviation (== RMS) results for the subcarrier the marker resides on.
- For "Flatness Pilot" measurement:
  Maximum, minimum, average and "dB"-standard deviation (== linear-scale RMS) results for all the pilot symbols in the subcarrier the marker resides on.

Note: Both the result table in the upper half and the traces in the lower half distinguish two kinds of averaged results:

- "AVG":
  For all absolute powers (shown in unit "dBm"): Arithmetic averaging of powers (unit Watt) is done.
  For power deviation results (shown in "dB"): Arithmetic averaging of the deviations in linear scale is done.
  If the power deviations vary around 0 dB, their average will tend towards 0 dB, they compensate eachother.
- "StdDev":
  For all absolute powers "Total Reference Power (Slot)" and "Average SubCarrier Reference Power":
  This column displays the straight-forward standard deviation of the powers, calculated in unit "Watt".
  For the power deviations (unit "dB"):
  This column displays the standard deviations of the "dB" values. But they are calculated internally by averaging the squares of the deviations in linear scale (RMS averaging). This prevents that deviations in different directions compensate eachother. After converting them to unit "dB" the results are always positive. Because of the RMS averaging done internally the corresponding trace in the lower half is labelled "RMS", which is shorter than "StdDev".

The measurements "Flatness Carrier" and "Flatness Pilot" are useful

- for checking if "Transmitter output power" requirements of [2] and [1] are met

- for checking if there is a remarkable channel amplitude response

- for checking if the transmitter adjusts all subcarrier powers equally.

- for checking if the transmitter adjusts all pilot symbol powers equally.

Constellation vs Symbol
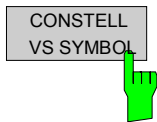
CONSTELL
VS SYMBOL

The Constellation versus Symbol diagram is selected by pressing the *CONSTELL* softkey in the main measurement softkey menu, followed by the *CONSTELL VS SYMBOL* softkey.

Remote: `CONF:BURS:CONS:CSYM:IMM`
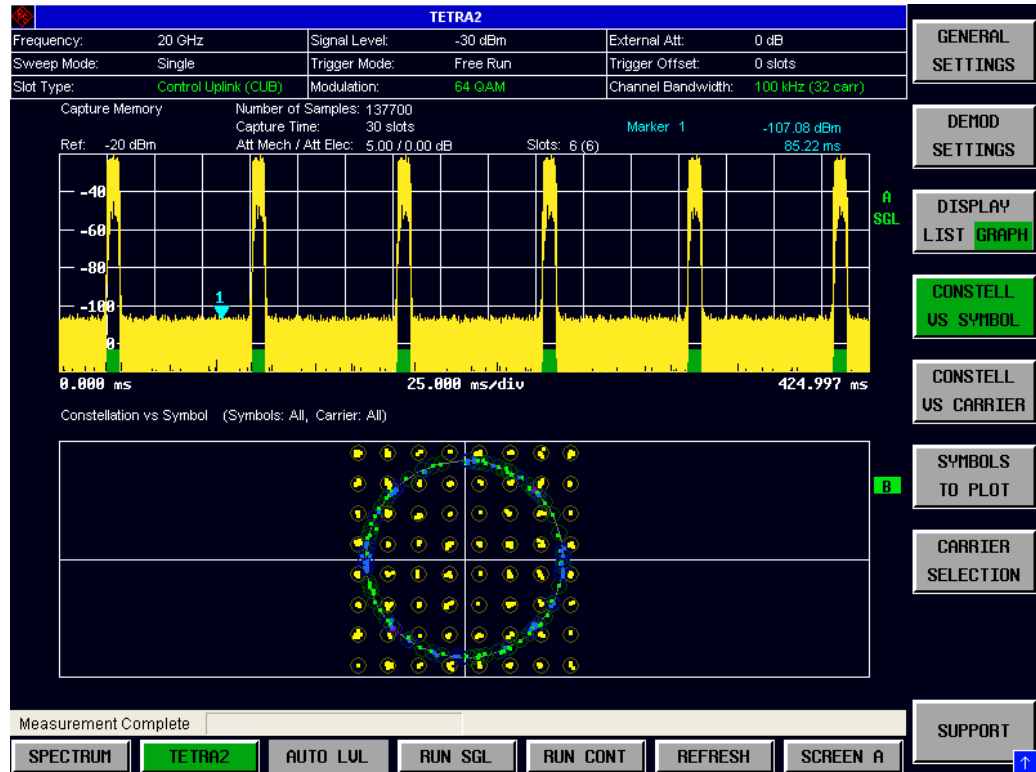
Fig. 25   Constellation vs Symbol Results (example)

The Constellation versus Symbols display shows the measured (refer to signal $IQ_{meas}(m,k)$ in Fig. 45) IQ symbols.

- The symbol instants to plot are always: From the first until the last symbol instant defined for the currently selected slot type (cf. parameter Slot Type, page 79).
- The subcarriers to plot can be set by the *CARRIER SELECTION* softkey.
- The kind of symbols to plot can be set by the *SYMBOLS TO PLOT* softkey.
- Only the last slot found in the current capture buffer is plotted.

The ideal points are displayed as circles in the display.
The title of the lower part of the measurement tells what is plotted.
Colors help to distinguish the different symbol types.

The measurement "Constellation vs Symbol" is useful

- for checking how stable the demodulation is.
- for checking if the correct payload modulation is set.
- for checking if certain symbol types have a wrong phase or scaling
- for checking if symbols in certain subcarriers have a wrong phase or scaling
- because most modulation errors can be identified visually in the constellation diagram

Note that due to the Inter-Carrier-Interference even a perfect TEDS signal will not show a perfect constellation diagram.

Symbols To Plot
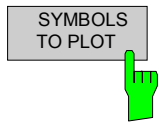
SYMBOLS TO PLOT

Pressing *SYMBOLS TO PLOT* softkey displays a pop-up dialog which allows the selection of which symbols to plot on the Constellation vs Symbol and Constellation vs Carrier display.

The choices of symbols to plot are: All, Data, Header, Sync, or Pilot.

Be aware that certain combinations of Carrier Selection and Symbols To Plot will result in an empty result display, namely if the selected type of slot does not contain any symbol of this type in the selected subcarrier(s).

Remote: `CONF:BURS:CONS:SYMB:SEL`

Carrier Selection
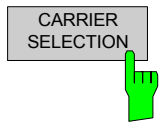
CARRIER SELECTION

Pressing the *CARRIER SELECTION* softkey displays a pop-up dialog which allows the selection of which subcarriers to plot on the constellation display. Either a specific carrier number or all carriers can be selected.

This softkey is only allowed for display Constellation vs Symbol but not for display Constellation vs Carrier.

Remote: `CONF:BURSt:CONS:CARR:SEL`

Constellation vs Carrier
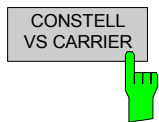
CONSTELL VS CARRIER

The Constellation vs Carrier measurement results are selected by pressing the *CONSTELL* softkey in the main measurement softkey menu followed by the *CONSTELL VS CARRIER* softkey,

Remote: `CONF:BURS:CONS:CCAR:IMM`
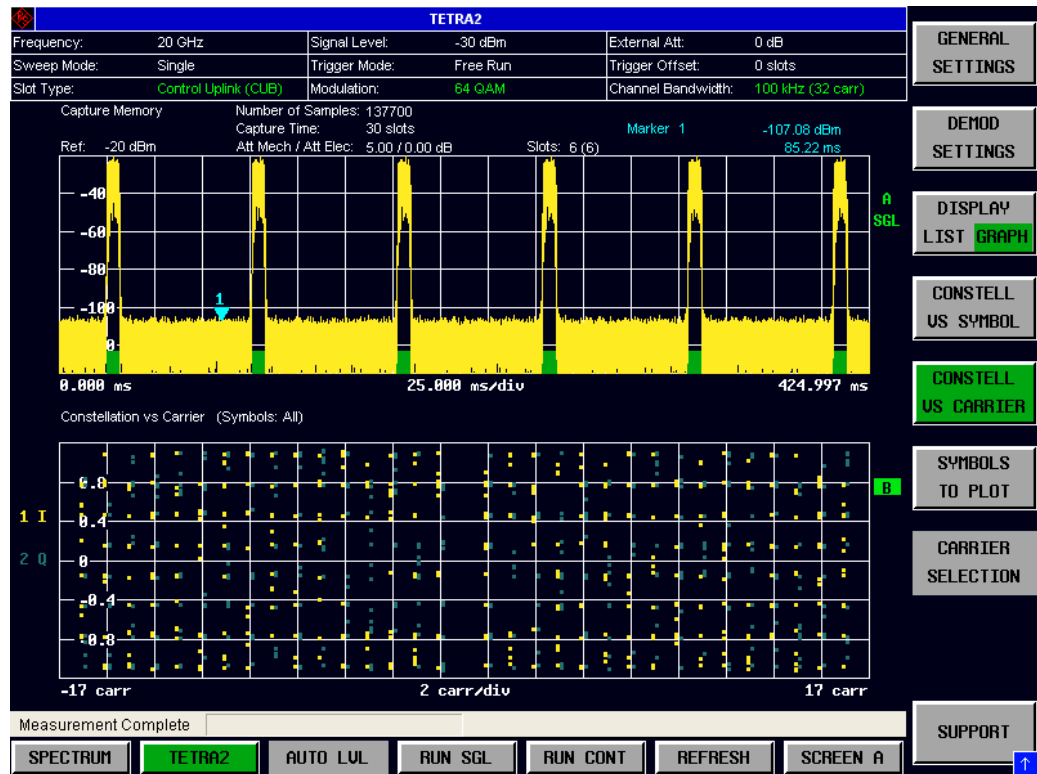
Fig. 26   Constellation vs Carrier Results

The Constellation versus Carrier display shows the measured (refer to signal $IQ_{meas}(m,k)$ in Fig. 45) IQ symbols.

- The symbol instants to plot are always: From the first until the last symbol instant defined for the currently selected slot type (cf. parameter Slot Type, page 79).

- All subcarriers are plotted. The *CARRIER SELECTION* softkey has no effect.

- The kind of symbols to plot can be set by the *SYMBOLS TO PLOT* softkey.

- Only the last slot found in the current capture buffer is plotted.

The main difference to the Constellation versus Symbols display is that the I and the Q part are NOT drawn in the complex plane here. Instead the I axis of each constellation diagram (each subcarrier) is rotated 90 degrees. So I and Q are plotted on the same vertical axis, I a little bit left of it in yellow color, Q a little bit right of it in blue color.

The ideal points are not displayed, in contrast to the Constellation versus Symbols display.
The title of the lower part of the measurement tells what is plotted.
Colors help to distinguish the different symbol types.

The measurement "Constellation vs Carriers" is useful

- for checking how stable the demodulation is.

- for checking if certain symbol types have a wrong phase or scaling

- for checking if symbols in certain subcarriers have a wrong phase or scaling

- for checking on interferers that only affect certain subcarriers

- for a quick overview which symbol types are allocated to certain subcarriers

Note that due to the Inter-Carrier-Interference even a perfect TEDS signal will not show a perfect constellation diagram.

Bit Stream

| BIT |
| STREAM |
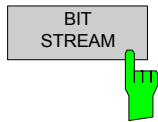
The Bit Stream measurement results are selected by pressing the *STATISTICS* softkey in the main measurement softkey menu followed by the *BIT STREAM* softkey.

Remote: `CONF:BURS:STAT:BSTR:IMM`
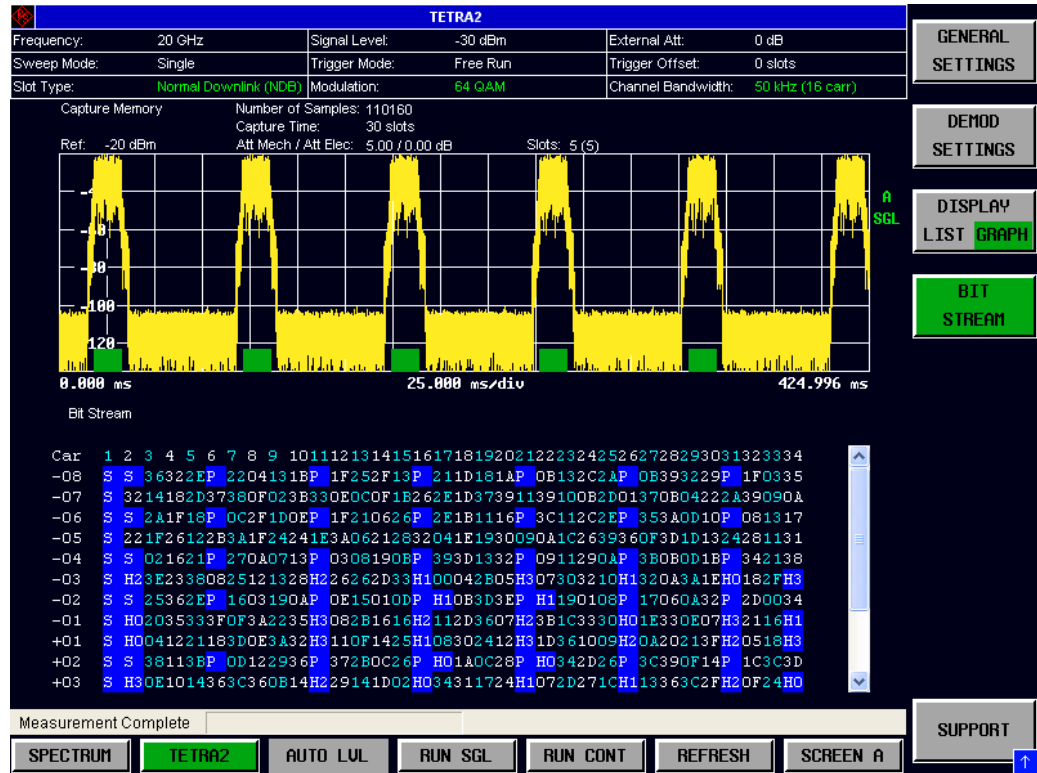
Fig. 27   Bit Stream Results

The bit stream results display shows the demodulated data stream of the last found slot in the current capture buffer.
The list has the same style used in [2] Annex P:

- The symbol instants are counted 1,2,3,4, …SN_{max}

- The subcarriers are sorted the same way as in [2] Annex P, but the R&S FS-K110 uses a symmetric way to count them, e.g. -8,-7,….,-2,-1, +1,+2, … , +7,+8.

The result list can be scrolled through using the cursor keys, a marker or the rollkey.

Colors show the different symbol types.
In the list:

- "P" means "Pilot symbol". No demodulated symbol data available.

- "S" means "Sync symbol". No demodulated symbol data available.

- "H" means "Header symbol". A symbol value of just 1 digit is enough, because header symbols are always 4-QAM.

- 2 hexadecimal digits mean "Data symbol". 2 digits are used, because even 64-QAM can be used.

The process of converting received IQ points to bits uses the symbol mapping described in chapter 5.13 of [2]. Be aware that no kind of channel coding is done in the R&S FS-K110, so these are the bits received on the physical layer.

Results Summary

The Summary Table is displayed when the display mode is set to LIST (softkey DISPLAY LIST / GRAPH). This table shows the overall modulation errors and provides limit checking for result values in accordance with user-set limits.

Remote: `CONF:BURS:SUMT:IMM`

		Min	Mean	Limit	Max	Limit	Unit
EVM All Symbols	A	2.06	2.06	10.00	2.06	10.00	%
	B	- 33.72	- 33.72	- 20.00 *	- 33.72	- 40.00	dB
Data+Sync+Pilot	C	2.06	2.06	10.00	2.06	10.00	%
	D	- 33.71	- 33.71	- 20.00 *	- 33.71	- 40.00	dB
IQ Offset	E	- 46.86	- 46.86	- 25.00	- 46.86	- 25.00	dB
Gain Imbalance	F	1.04	1.04		1.04		%
	G	- 0.09	- 0.09		- 0.09		dB
Quadrature Error	H	0.69	0.69		0.69		deg
Amplitude Droop	I	- 2	- 2		- 2		mdB/sym
Center Freq Error	J	0.12	0.12	± 100	0.12	± 100	Hz
Phase Error	K	1.19	1.19	5.00	1.19	5.00	deg
Magnitude Error	L	1.49	1.49	10.00	1.49	10.00	%
Burst Power	M	- 28.73	- 28.73		- 28.73		dBm
Crest Factor	N	8.66	8.66		8.66		dB

Fig. 28   Results of the Summary Table

Result values which are within the limit as specified by the user are displayed in green. Result values which are outside of the limits specified by the user are displayed in red with a '*' to the left. Results which have no limits specified by the user are displayed in white. Limit values are displayed in white (not bold).

Table 2 gives a very short description about the base result that is calculated for each row. But these base results are not output! Instead the application calculates the Min/Mean/Max statistic (in a way that can vary for different results) for the N results, where N is the number of slots found and demodulated so far (in Fig. 28 N would be 56).

Table 2   Short description of the base results of the "Result Summary" table

X	The number of slots measured so far. If the user specified a number of slots to measure in total (please refer to parameter "Number of Slots to Analyze" on page 71) this number is additionally shown as e.g. "56 of 200".
A	Average EVM of a single slot. All symbols in the slot are used. Unit is "%". Please refer to Formula 21.
B	Same as A, but after all calculations the unit is converted to"dB". Please refer to Formula 22.
C	Average EVM of a single slot. But the parameter "Show 2nd EVM based on" (page 80) determines which symbol types are used to calculate the EVM. Unit is "%". Please refer to Formula 24.
D	Same as C, but after all calculations the unit is converted to "dB". Please refer to Formula 25.
E	The average of the IQ offsets measured in M subcarriers of a single slot. Unit is "dB". Please refer to Formula 39.
F	The average of the Gain Imbalance measured in M subcarriers of a single slot. Unit is "%". Please refer to Formula 35.
G	Same as F, but after all calculations the unit is converted to "dB". Please refer to Formula 36.
H	Average of the Quadrature Errors measured in M subcarriers of a single slot. Unit is "%". Please refer to Formula 42.
I	Average of the Amplitude Droops measured in M subcarriers of a single slot. Unit is "mdBm/sym". Please refer to Formula 30.
J	Average of the carrier frequency offsets measured in M subcarriers of a single slot. Unit is "Hz". Please refer to Formula 27.
K	Average Phase Error of a single slot. All kinds of symbols are used. Unit is "degree". Please refer to Formula 7.
L	Average Magnitude Error of a single slot. All kinds of symbols are used. Unit is "%". Please refer to Formula 12.
M	Mean power of all symbols of a single slot. Do not confuse with the "Reference Power" shown in several other measurements. Unit is "dBm". Please refer to Formula 48.
N	Relation of the maximum and the mean power during the useful part of a single slot. Unit is "dB". Please refer to Formula 32.

For more detailed information about the individual results and how the statistic is calculated for each of them please refer to the formulas specified.

The Min/Mean/Max results displayed in this table take in account all slots measured so far. In Fig. 28 this would be 56 slots..
If the user has specified a number of slots to measure in total (parameter "Number of Slots to Analyze" on page 71) and this number requires capturing more than one buffer of IQ data, then each update of the screen at the end of each sweep shows the results so far.

The limit values in the table of results can be modified.
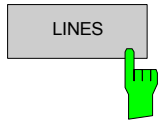
LINES

Pressing the *LINES* hardkey allows limits to be selected and modified

TETRA2						
Frequency: 20 GHz		Signal Level: -30 dBm		External Att: 0 dB		
Sweep Mode: Single		Trigger Mode: Free Run		Trigger Offset: 0 slots		
Slot Type: Control Uplink (CUB)		Modulation: 64 QAM		Channel Bandwidth: 100 kHz (32 carr)		

Measurement Results Summary Table

Number of Slots	56					
	Min	Mean	Limit	Max	Limit	Unit
EVM All Symbols	2.06	2.06	10.00	2.06	10.00	%
	- 33.72	- 33.72	- 20.00 *	- 33.72	- 40.00	dB
Data+Sync+Pilot	2.06	2.06	10.00	2.06	10.00	%
	- 33.71	- 33.71	- 20.00 *	- 33.71	- 40.00	dB
IQ Offset	- 46.86	- 46.86	- 25.00	- 46.86	- 25.00	dB
Gain Imbalance	1.04	1.04		1.04		%
	- 0.09	- 0.09		- 0.09		dB
Quadrature Error	0.69	0.69		0.69		deg
Amplitude Droop	- 2	- 2		- 2		mdB/sym
Center Freq Error	0.12	0.12	± 100	0.12	± 100	Hz
Phase Error	1.19	1.19	5.00	1.19	5.00	deg
Magnitude Error	1.49	1.49	10.00	1.49	10.00	%
Burst Power	- 28.73	- 28.73		- 28.73		dBm
Crest Factor	8.66	8.66		8.66		dB

Measurement Complete

SPECTRUM | TETRA2 | AUTO LVL | RUN SGL | RUN CONT | REFRESH | SCREEN A

RESTORE DEFAULTS

Fig. 29   Editing Limit Values

For the EVM selection (see below), separate limits are kept for each type of EVM selection (All, Data+Sync+Pilot, Data+Header, Data, Sync+Pilot).
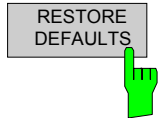
RESTORE
DEFAULTS

Pressing the *RESTORE DEFAULTS* softey resets all limits that are currently active (which might depend on the set channel bandwidth or other parameters) to default values. For reset of all limits please use the PRESET hardkey.

General Settings

This section describes the General Settings view where all settings related to the overall measurement can be modified.
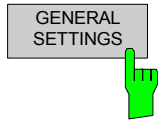
GENERAL
SETTINGS

The *GENERAL SETTINGS* softkey displays the General Settings view.
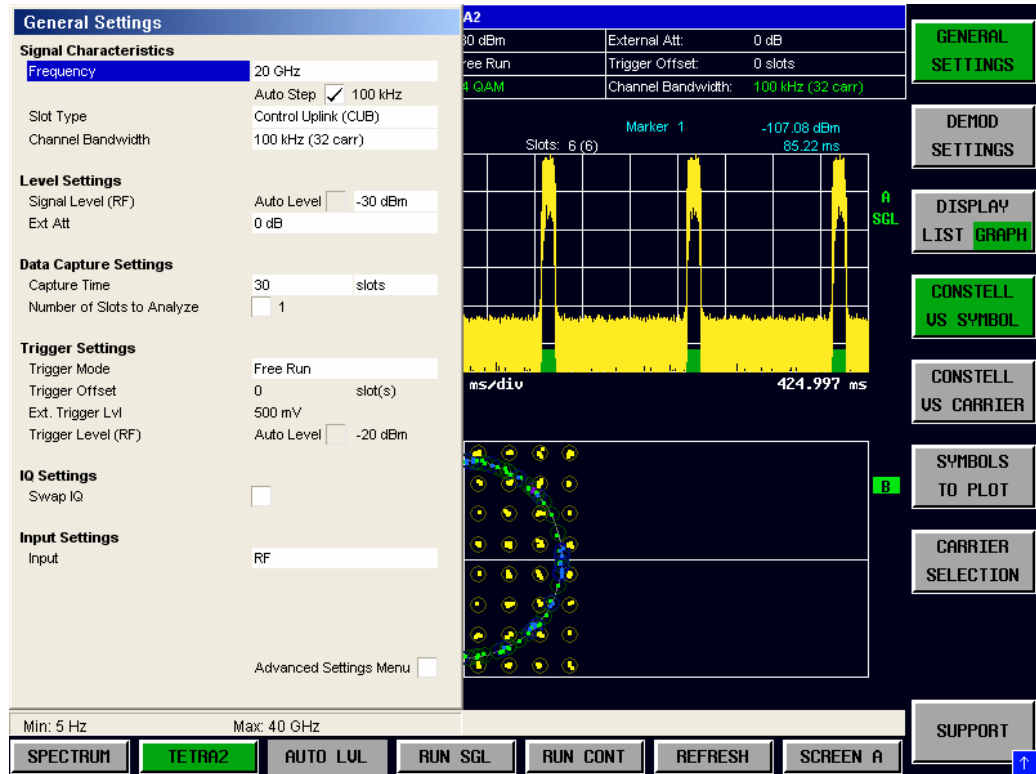
Fig. 30   General Settings view.

The parameters within the General Settings view are logically grouped together into:

- Signal Characteristics

- Level Settings

- Data Capture Settings

- Trigger Settings

- IQ Settings

- Input Settings

- Advanced Settings (depends on HW options installed)

Any parameters that are not available for editing will have a grey background. This usually occurs when one parameter setting makes another parameter invalid, for example if the *Trigger Mode* is Free Run then none of the parameters below this (*Trigger Offset, Power Level* and *Auto Power Trigger Level*) have any meaning, so these parameters are greyed out.

When a particular parameter is selected within the General Settings view the status bar changes to display information about the valid settings for the selected parameter.

Signal Characteristics

The Signal Characteristics settings are the general settings concerning the physical attributes of the signal to be measured.

Frequency

Frequency specifies the nominal Center Frequency of the signal to be measured.

Also note the *Auto Step* and frequency step fields below the *Frequency* field. The frequency step sets the step size for adjusting the frequency using the Rollkey. When the *Auto Step* box is selected the frequency step size is set equal to the channel bandwidth.

The *Frequency* parameter is also editable when analog Baseband input is selected, however the frequency range is then limited according to the setting of the "IQ Path" parameter (refer to page 75) as follows:

IQ Path = I Only	Range = 0 to 35 MHz
IQ Path = Q Only	Range = 0 to 35 MHz
IQ Path = I + j*Q	Range = -35 to 35 MHz

I.e. negative frequencies only make sense for complex valued signals. Real valued signals (fed into the analyzer using only one cable) only allow positive frequencies.

When measuring with the digital Baseband input, the frequency parameter is fixed to 0 Hz and cannot be edited.

Remote: SENS:FREQ:CENT

Slot Type

Slot Type specifies the type of slot/burst to search for and to analyze. The possible slot types are:

- Normal Downlink Burst (NDB)
- Normal Uplink Burst (NUB)
- Control Uplink Burst (CB)
- Random Access Burst (RAB)

Setting a value not matching the input signal type will in most cases cause the application to demodulate nothing at all! For more details please refer to chapter "Slot search details" on page 16.

Remote: SENS:DEM:FORM:BAN:BTYP

Channel Bandwidth

Channel Bandwidth specifies the channel bandwidth (i.e. the number of subcarriers) of the signals to search for and analyze. Setting a value not matching the input signal type will in most cases cause the application to demodulate nothing at all! For more details please refer to chapter "Slot search details" on page 16.

Remote: SENS:DEM:FORM:BAN:BAND

Level Settings

The level settings are the general settings concerning the level and attenuation of the signal to be measured.

Auto Level

Level Settings		
Signal Level (RF)	Auto Level	-40 dBm
Ext Att	0 dB	

Auto Level is not available in present releases of the R&S FS-K110 application.

Signal Level (RF)

Level Settings		
Signal Level (RF)	Auto Level	-40 dBm
Ext Att	0 dB	

Signal Level (RF) specifies the expected mean level of the strongest burst or slot in the RF input signal. The R&S FS-K110 application automatically adds an assumed constant Crest Factor of 10 dB to the input *Signal Level (RF)* to get and set the *Reference Level* of the instrument. This *Reference Level* sets the instrument's HW (attenuator, amplifiers).

Therefore setting *Signal Level (RF)* too low may cause compression in the instrument. Setting it too high degrades the SNR.
The top of the y axis of diagram Magnitude Capture Display represents the instrument's *Reference Level.* So it is recommended to check there that the peak of the trace comes close to *Reference Level*, but never above.

Note that the constant assumed Crest Factor of 10 dB is a compromise. A signal with 8 carriers will have a lower maximum Crest Factor in the long run than one with 48 carriers . For 48 carriers a (very small) percentage of slots will even have a crest factor higher than 10 dB. So setting the Signal Level 1-2 dB higher or lower can gain 1-2 dB of SNR, depending on the measurement situation.

Also note that the constant assumed Crest Factor of 10 dB also assumes that there is only one TEDS signal present at the input. The application captures IQ data with a bandwidth much larger than the nominal set channel bandwidth, so some neighbor channels are also "seen" by the instrument and must be taken into be increasing the parameter *Signal Level (RF).*

The *Signal Level (RF)* parameter is not editable when analog or digital Baseband input is selected (refer to parameter "IQ Input" on page 75).

Remote: `CONF:POW:EXP:RF`
          `DISP:WIND1:TRAC:Y:SCAL:RLEV:RF`

Signal Level (Baseband)

Level Settings
Signal Level (Baseband)   Auto Level   1 V
Ext Att   0 dB
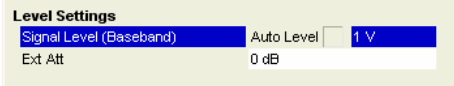
Signal Level (Baseband) has the same meaning as Signal Level (RF), but for the analog Baseband input (refer to parameter "IQ Input" on page 75).
The application does not offer this setting if the corresponding analog Baseband option is not installed!

When using analog Baseband inputs it is even more important to set the Signal Level not too low. Clipping in the ADC could occur, which is even worse than rather "soft" compression in the mixer of the RF input.

Note that the analog Baseband input's Reference Level is not continuously adjustable, in contrast to that of the RF input. Changing the parameter *Signal Level (Baseband)* has therefore only a real effect if a threshold for switching the input attenuator was reached (relais clicks, "Att" reading on display changes, trace of measurement Magnitude Capture Display changes).

Remote: `CONF:POW:EXP:IQ`
`DISP:WIND1:TRAC:Y:SCAL:RLEV:IQ`

Full Scale Level

IQ Digital
Full Scale Level   Auto ✓   1 V
Digital Input Sampling Rate   Auto ✓   2 MHz

When using the RF or the analog Baseband input the analyzer uses the parameter *Signal Level* to adjust its hardware in a way, that the mixer is not overloaded and no clipping occurs in the ADC.

But when using the digital Baseband input, the analyzer uses the parameter *Full Scale Level* instead. Parameter *Signal Level* is ignored, because there is no physical signal that has to be processed and digitized. Instead the digital Baseband input gets a stream of IQ data that has been digitized (or has been generated by means of SW) outside the analyzer. The analyzer can therefore not know the voltage that originally corresponded to a certain IQ sample magnitude.

The parameter *Full Scale Level* tells the analyzer which voltage corresponds to the maximum I or Q value that can be fed into the digital Baseband input (0x7FFFF as integer or as fixed point about 1.0 +j*0.0 or 0.0 +j*1.0).

The application does not offer this setting if the digital Baseband option FSQ-B17 is not installed or the digital Baseband input is not used as signal path!

Remote: `INP:DIQ:RANG`

Auto checkbox:
If not checked, the correct *Full Scale Level* value must be entered manually.
If checked, the *Full Scale Level* value cannot be entered manually. Instead the R&S FS-K110 expects that the device-under-test sends the correct *Full Scale Level* value via the LVDS connection. Only certain R&S test transmitters will support this feature.
It is recommended to not check this checkbox right now.

Remote: `INP:DIQ:RANG AUTO OFF`

Ext Att

Level Settings
Signal Level (Baseband)   Auto Level ☐   1 V
Ext Att   0 dB

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

Set this value if the signal is attenuated or amplified before it is fed into the instrument and the application should nevertheless show correct power results.

All displayed power level results will be shifted by this value. Exception: The *Reference Level* and *Signal Level* ignore the external attenuation value. It is important to know the actual power level the instrument's HW must bear.

When using the digital Baseband input, the *Ext Att* parameter is disabled and ignored. The parameter *Full Scale Level* can be used to describe the scaling of the signal.

Remote: `CONF:EXT:ATT`
                 `DISP:WIND:TRAC:Y:RLEV:OFFS`

Data Capture Settings

The Data Capture settings specify how much data is to be captured.

Capture Time

Capture Time specifies the time (and therefore the amount of data) to be captured in each capture buffer.
The *Capture Time* can be specified in TEDS full time-slots or seconds.

Note that the Magnitude Capture Display shows this time duration and the slot search algorithm searches slots in it.
Use the Magnitude Capture Display to check if there are at least some slots present in every sweep.

Increase the *Capture Time* if no slots are found at all or slots are not found in any sweep.
Possible reason: The slot search algorithm needs some extra time before and after a slot to accept it. So for <u>very</u> short *Capture Times* it is
- unlikely that a slot is in the buffer
- AND additionally in the middle of the short buffer.

A maximum of 108 full TEDS slots equal to 1.53 seconds can be specified for the capture time.

When using the digital Baseband input: For a parameter *Digital Input Sampling Rate* much higher than needed for capturing a TEDS signal (larger than 10 MHz, depends on channel BW) the analyzer might automatically reduce the maximum *Capture Time* that can be used.

Remote: `SENS:SWE:TIME`
                `SENS:SWE:SLOT`

Number of Slots to Analyze

Number of Slots to Analyze specifies the number of slots to be measured. A maximum of 100000 can be specified.

If the number of slots found in a single capture buffer is less then required then the application will continue capturing IQ data and measuring until the requested number of slots has been reached.
A RUN SGL measurement will then stop. A RUN CONT measurement will then reset all results and start again.

Note: The parameter *Number of Slots to Analyze* is not editable AND has no effect at all when the corresponding checkbox is set to OFF.

Remote: `SENS:BURS:COUN?`
                `SENS:BURS:COUN:STAT`

Trigger Settings

The Trigger settings group contains all the settings related to the triggering of a measurement.

Trigger Mode

Trigger Mode is the source of the trigger for starting capturing of IQ data.

The possible values for the *Trigger Mode* are:

Free Run – the capturing starts immediately after the previous measurement is done.

External - the capturing starts when the external trigger signal meets or exceeds the specified external trigger level at the input connector *EXT TRIGGER/GATE* on the rear panel.

Power - the capturing starts when the signal power at the active input (refer to parameter "Input" on page 74) meets or exceeds the specified power trigger level.

In case the digital Baseband input is used:
The only allowed trigger mode is *Free Run.*

Remote: `TRIG:SEQ:MODE`

Trigger Offset

Trigger Offset specifies the time offset between the trigger event and the start of the IQ data capturing. A negative value indicates a pre-trigger (i.e. data capturing starts earlier than the trigger event).

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

Remote: `TRIG:SEQ:HOLD`
`TRIG:SEQ:HOLD:SLOT`

External Trigger Level

External Trigger Level specifies the level the external trigger signal must meet or exceed to trigger capturing of IQ data.

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

Remote: `TRIG:SEQ:LEV:EXT`

Auto Power Trigger Level

Feature *Auto Power Trigger Level* is currently not yet available and therefore the corresponding checkbox is not editable.

Trigger Level (RF)

Trigger Level (RF) specifies the level the signal at the RF input must reach to trigger capturing of IQ data.

The *Trigger Level* parameter is editable only when *Trigger Mode* is set to Power.

The *Trigger Level (RF)* parameter is only editable and has only an effect when parameter "Input" on page 74 is set to "RF".

Remote: `TRIG:SEQ:LEV:POW`

Trigger Level (Baseband)

Trigger Level (Baseband) specifies the level the signal at the analog Baseband input must reach to trigger capturing of IQ data.
The application does not offer this setting if the corresponding analog Baseband HW option B71 is not installed!

The *Trigger Level* parameter is editable only when *Trigger Mode* is set to Power.

The *Trigger Level (Baseband)* parameter is only editable and has only an effect when parameter "Input" on page 74 is set to "Baseband analog"

Remote: `TRIG:SEQ:LEV:IQ`

Ext.Trigger Lvl

Ext. Trigger Lvl specifies the level the signal at the external trigger input (rear of instrument) must reach to trigger capturing of IQ data.

The *Ext. Trigger Level* parameter is only editable and has only an effect when *Trigger Mode* is set to External.

Remote: `TRIG:SEQ:LEV:EXT`

IQ Settings

The IQ settings contains settings related the Inphase and Quadrature component of the input signal.

Swap IQ

IQ Settings	
Swap IQ	☐

Swap IQ can tell the application to interchange the I an Q parts of the captured IQ data. This can reverse an IQ swap that was done in the DUT by intention or by mistake.
If the IQ swap settings in the DUT and the R&S FS-K110 do not match, no slots will be found and analyzed (except the carrier frequency error is very small).

The settings for this parameter are:
* OFF: Do not interchange I and Q parts.
* ON: I and Q parts of the IQ data are interchanged.

Please note, that the application will first mix (if necessary) the input signal (which can be real valued) to the complex Baseband (signal is now complex valued) and then interchange I and Q.
As a consequence:
* Feature *Swap IQ* is only identical to interchanging the I and Q cable of the analog Baseband input if the center frequency is exactly zero.
* Feature *Swap IQ* is even allowed for analog Baseband operation using only one cable ("low IF" operation).

Remote: `SENS:SWAP`

Input Settings

The Input settings group contains settings related to the input source of the signal to be measured. Note that this group is only available when the B71 (analog Baseband input) HW option and / or the FSQ-B17 (digital Baseband input) HW option is installed.

Input

Input Settings	
Input	RF ▾

Input allows the selection between RF and analog Baseband inputs and digital Baseband input.

The application does not offer this setting if the instrument does only offer an RF input.

The analyzer indicates the currently active signal path to the right of the upper half of the display (not for all measurements) in green color:
* *BDI*: digital Baseband input
* *B50*: analog Baseband input, 50 Ω impedance
* *B1K*: analog Baseband input, 1 KΩ impedance
* *B1M*: analog Baseband input, 1 MΩ impedance
* For RF input there is no indicator.

Remote: `INP:SEL`

Advanced Settings

The Advanced Settings contains settings which control details of how the instrument operates and how measurements are performed.

The advanced settings are displayed on the right hand side of the General Settings view, and are only displayed when the Advanced Settings checkbox is checked.

Note that this part of the dialog might not be visible depending on the HW options installed in the instrument.
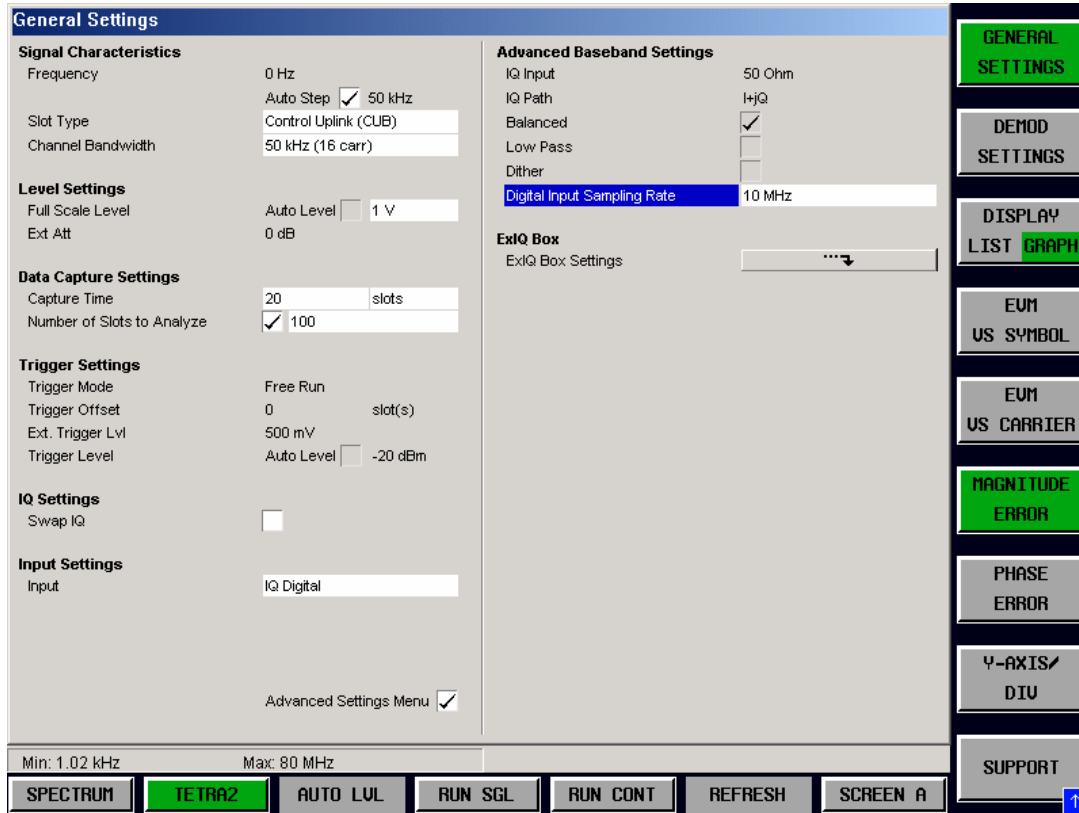
Fig. 31   Advanced Settings view

IQ Input
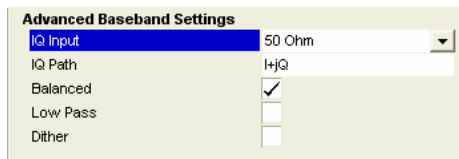
IQ Input allows the selection of the impedance of the analog Baseband inputs. The values that can be selected are 50 Ω and 1 kΩ/1 MΩ (depending on the instrument configuration).
The *IQ Input* parameter is editable only and has an effect only when analog Baseband input is selected by means of parameter "Input", page 74.

Remote: `INP:IQ:IMP`

IQ Path
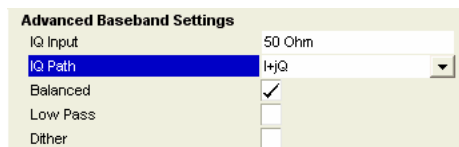
IQ Path allows the selection of the input path for analog Baseband inputs.
Either

* a single input (I or Q) may be used (i.e. the signal is real valued "low IF" signal modulated on a carrier of for example

10 MHz). The other input is internally set to zero.

- or both inputs may be used (complex baseband signal, I+j*Q).

The *IQ Path* parameter is editable only when analog Baseband input is selected by means of parameter "Input", page 74.

Remote: `INP:IQ:TYPE`

Balanced

Balanced switches the analog Baseband inputs between symmetrically (balanced) and asymmetrical (unbalanced).
The *Balanced* parameter is editable only and has an effect only when analog Baseband input is selected means of parameter "Input", page 74.

Remote: `INP:IQ:BAL`

Low Pass

When switched on the *Low Pass* parameter specifies that an analog anti-aliasing filter is internally applied to all the IQ inputs.
The filter must be turned on if there might be frequency components (harmonics) above about 40 MHz.
The amplitude and phase equalized single sided bandwidth of the analog Baseband inputs is for

- Low pass On: 30 MHz
- Low pass Off: 36 MHz

The *Low Pass* parameter is editable only and has an effect only when analog Baseband input is selected means of parameter "Input", page 74.

Remote: `SENS:IQ:LPAS`

Dither

When switched on the *Dither* parameter specifies that a 2 MHz wide noise signal at 42.67 MHz is injected into the signal path of the analog Baseband input. It appears in the spectrum at 38.92 MHz.
The dither signal distinctly improves the linearity of the A/D converter at very low signal levels (low drive level at the A/D converter) and thus the accuracy of the level displayed.

The *Dither* parameter is editable only and has an effect only when analog Baseband input is selected.

Remote: `SENS:IQ:DITH`

Digital Input Sampling Rate

Specifies which sample rate the IQ signal has which is fed into the analyzer's digital Baseband input.
Do not confuse with the transmission speed of the digital Baseband input, which can be totally different (e.g. if IQ data was stored in a memory)!

Auto checkbox:
If not checked, the correct Digital Input Sampling Rate value must be entered manually.
If checked, the Digital Input Sampling Rate value cannot be entered manually. Instead the R&S FS-K110 expects that the device-under-test sends the correct Digital Input Sampling Rate value via the LVDS connection. Only certain R&S test transmitters support this feature.
It is recommended to only check this checkbox when using a suitable R&S test transmitter.

Remote: `INP:DIQ:SRAT AUTO ON`

Setting a too low *Digital Input Sampling Rate* will cause a warning, because the IQ signal's bandwidth might become too low for running all measurements reliably (especially ACP measurements). The instrument will continue measuring, because most measurements do not need such high sampling rates as the ACP measurements. Of course results can not be guaranteed in this operation mode.

Channel BW:	Minimum sampling rate without warning:
25 KHz	259.2 KHz
50 KHz	259.2 KHz
100 KHz	324.0 KHz
150 KHz	388.8 KHz

Digital Input Sampling Rates much higher than needed for capturing TEDS signals (greater than 10 MHz, depends on channel bandwidth) might cause the analyzer to automatically reduce the maximum *capture time* that can be used.

The *Digital Input Sampling Rate* parameter is editable only and has an effect only when digital Baseband input is selected.
The application does not offer this setting if the digital Baseband option FSQ-B17 is not installed!

Remote: `INP:DIQ:SRAT`

ExIQ Box Settings

Digital Input Sampling Rate	10 MHz
ExIQ Box Settings	···↴

This button invokes a tool for the configuration of the R&S ExIQ Box. The R&S ExIQ Box must be connected to the analyzer's USB socket (USB cable).

First scenario:
The digital baseband inputs / outputs of R&S signal generators and R&S signal analyzers can be connected directly to each other (without an R&S ExIQ Box) because they use the same digital interface format. The invoked tool will recognize that no R&S ExIQ Box is present to configure.

Second scenario:
If the device under test uses a different digital interface format, the R&S ExIQ Box can serve as a versatile digital interface adapter between the device under test and the signal analyzer. The invoked tool allows setting the parameters of the R&S ExIQ Box.

Demod Settings

This section of the user manual describes the Demod (short for Demodulation) Settings view, where the settings associated with the signal modulation can be modified.
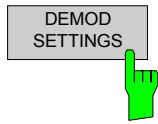
The *DEMOD SETTINGS* softkey displays the Demod Settings view.

Fig. 32   Demod Settings view

The Demod settings are logically grouped together into:

- Demodulator Settings

- EVM Settings

- ACP Settings (currently not yet available)

- Measurement Time Settings (currently not yet available)

When a particular parameter is selected within the Demod Settings view the status bar changes to display information about the valid settings for the selected parameter. The parameters available in the Demod Settings view are dependent on the currently selected standard.

Demodulator Settings

The demodulator settings specify the characteristics of the slots to be considered in the measurement results and how the demodulator should work.

Slot Type

Slot Type specifies the type of slot/burst to analyze. This a repeat of the *Slot Type* parameter given in the General Settings view.

Setting this parameter not correctly will in most cases cause the slot search algorithm to decline all slots and no slots at all will be demodulated. For details refer to chapter "Slot search details" on page 16.

Remote: `SENS:DEM:FORM:BAN:BTYP`

Payload Modulation

Payload Modulation specifies the type of modulation used for the data symbols of the slots.

Setting this parameter to the wrong value will not affect the slot search (i.e. which slots are found and demodulated) but will make the demodulation worse and cause measuring of wrong modulation errors.

The choices of modulation are: 4 QAM, 16 QAM, or 64 QAM.

For Random Access Burst only 4 QAM is allowed.

Remote: `SENS:DEM:FORM:BAN:MOD`

Demod RRC Roll-off

Demod RRC Roll-off is currently not yet available.
This is the RRC filters' Roll-off factors the application uses for demodulation (not ACP!). It is fixed to 0.2.

Max Carrier Offset

Max Carrier Offset specifies the maximum carrier frequency error a input signal is allowed to have, so that all slots contained in it will still be reliably found (assuming that the slot type and the number of carriers are set correctly, the pilot and syncs are according to standard [2] and there are not excessive noise and distortion).

Specify ±1 kHz if the signal is known to be within +/- 1 kHz of the nominal carrier frequency. This setting will result in faster demodulation times and improves the applications performance in case of strong signals in adjacent channels.

Otherwise (especially if the slot search algorithm fails or the DUT's frequency error is known to be large), specify ±10 kHz.

Remote: `SENS:DEM:FORM:BAN:MCAR`

EVM Settings

The EVM settings specify the type of calculations and normalizations that will be performed on the demodulator's output.

Show 2nd EVM based on

Show 2nd EVM based on specifies the symbols that will be used in the calculation of the slots' EVM in the Summary Table measurement, <u>second</u> row.

The <u>top</u> row is always the RMS EVM of <u>all</u> symbols in one slot. But for the <u>second</u> row the choices are:

- All
- Data+Sync+Pilot
- Data+Header,
- Data
- Sync+Pilot.

Please also refer to Table 2 on page 64.

Changing this parameter does (in contrast to the other parameters in this dialog) not require restarting the measurement. Instead the measurement "Summary Table" is updated immediately with the correct results.

Remote: `FETC:BURS:SUMT:EVM:ALL`
`FETC:BURS:SUMT:EVM:DATA`
`FETC:BURS:SUMT:EVM:DHE`
`FETC:BURS:SUMT:EVM:DSP`
`FETC:BURS:SUMT:EVM:SPIL`

Pilot Tracking

Pilot Tracking specifies whether or not the measurement engine will try to track the amplitude and phase changes during the burst by means of the known sync and pilot symbols and compensate those changes. At a certain symbol instant the same complex compensation value is applied in all subcarriers. Please refer to Fig. 44 and its descriptions.

Remote: `SENS:DEM:FORM:BAN:PTR`

Compensate Amplitude Droop

Compensate Amplitude Droop specifies whether or not the measurement engine will compensate subcarrier-wise for the estimated Amplitude Droop (exponential amplitude decay or rise).

Please refer to Fig. 44 and to Formula 28..

Remote: `SENS:DEM:FORM:BAN:CAD`

Compensate IQ Offset

Compensate IQ Offset specifies whether or not the measurement engine will compensate subcarrier-wise for the estimated IQ offset.

Remote: `SENS:DEM:FORM:BAN:CIQ`

ACP (Modulation+Transients) Settings

The ACP (Modulation + Transients) Settings specify the offset frequencies, bandwidths, and root-raised cosine roll-off parameters for both ACP measurements.

ACP Auto

ACP (Modulation+Transients)				
ACP Auto	✓			
+/- Offset Freq [kHz]	0	25	50	75
Bandwidth [kHz]	25	18	18	18
ACP RRC Roll-off	0	0.35	0.35	0.35
Measure ACP Transients		✓	☐	☐
ACP Display	ACP Avg			

The setting *"ACP Auto"* is currently not yet available. This means all ACP parameters are automatically set according to standard [2] and [1], dependent on the set channel bandwidth.

+/- Offset Freq

ACP (Modulation+Transients)				
ACP Auto	✓			
+/- Offset Freq [kHz]	0	25	50	75
Bandwidth [kHz]	25	18	18	18
ACP RRC Roll-off	0	0.35	0.35	0.35
Measure ACP Transients		✓	☐	☐
ACP Display	ACP Avg			

The setting *"+/- Offset Freq"* is currently not yet available. These are the frequency offsets (relative to the nominal center frequency) where to measure the ACP channels.

Bandwidth

ACP (Modulation+Transients)				
ACP Auto	✓			
+/- Offset Freq [kHz]	0	25	50	75
Bandwidth [kHz]	25	18	18	18
ACP RRC Roll-off	0	0.35	0.35	0.35
Measure ACP Transients		✓	☐	☐
ACP Display	ACP Avg			

The setting *"Bandwidth"* is currently not yet available.. These are the symbol rates to design the ACP RRC filters with. This means the values specified in standard [1] or [2] are used automatically

ACP RRC Roll-off

ACP (Modulation+Transients)				
ACP Auto	✓			
+/- Offset Freq [kHz]	0	25	50	75
Bandwidth [kHz]	25	18	18	18
ACP RRC Roll-off	0	0.35	0.35	0.35
Measure ACP Transients		✓	☐	☐
ACP Display	ACP Avg			

The setting *"ACP RRC Roll-off"* is currently not yet available.. These are the Roll-off factors to design the ACP RRC filters with. This means the values specified in standard [1] or [2] are used automatically.

Measure ACP Transients

ACP (Modulation+Transients)				
ACP Auto	✓			
+/- Offset Freq [kHz]	0	25	50	75
Bandwidth [kHz]	25	18	18	18
ACP RRC Roll-off	0	0.35	0.35	0.35
Measure ACP Transients		✓	☐	☐
ACP Display	ACP Avg			

Checkboxes *"Measure ACP transients"* are currently not yet available. This means, the measurement *ACP due to Transients* is always performed in the offset channels +1 and -1, not in other channels.

ACP Display

ACP (Modulation+Transients)				
ACP Auto	✓			
+/- Offset Freq [kHz]	0	25	50	75
Bandwidth [kHz]	25	18	18	18
ACP RRC Roll-off	0	0.35	0.35	0.35
Measure ACP Transients		✓	☐	☐
ACP Display	ACP Avg			

Drop-down menu *"ACP Display"* selects which <u>numeric</u> ACP results are shown simultaneously in the two ACP measurements:

- "Current" & "Max" or
- "Average" & "Max

This switch has no influence on

- which results are calculated internally. I.e. you can toggle this switch after a measurement of 1000 slots has stopped and you will immediately see the desired result. You do not have to restart the measurement with the changed settings.
- which traces are calculated internally or shown. I.e. the number of traces shown in the *ACP due to Transients* measurement is independent of this switch.

Measurement Time Settings

Many measurements of the R&S FS-K110 application rely on IQ data that was exactly cut out of the raw IQ data around every found slot. The exact slot timing is known for each slot, because each slot was demodulated.

The *Measurement Time* settings specify these periods to cut out for the various measurements, i.e. the "gating" settings.

Auto

Measurement Time	
Auto	✓
ACP due to Transients	6 sym + (sub)slot + 6 sym
PVT	6 sym + (sub)slot + 6 sym
Spectrum FFT	6 sym + (sub)slot + 6 sym

The setting *"Auto"* is currently not yet available. This means all times are set to reasonable values or as standard [1] or [2] specify.

ACP due to Transients

Measurement Time	
Auto	✓
ACP due to Transients	6 sym + (sub)slot + 6 sym
PVT	6 sym + (sub)slot + 6 sym
Spectrum FFT	6 sym + (sub)slot + 6 sym

Setting the Measurement time for *ACP due to Transients* is currently not yet available. This means the time duration of the trace is fixed to the slot or subslot duration plus 6 symbol durations before and after that.

PVT

Measurement Time	
Auto	✓
ACP due to Transients	6 sym + (sub)slot + 6 sym
PVT	6 sym + (sub)slot + 6 sym
Spectrum FFT	6 sym + (sub)slot + 6 sym

Setting the Measurement time for *PVT* is currently not yet available. This means the time duration of the PVT trace is fixed to the slot or subslot duration plus 6 symbol durations before and after that.

Spectrum FFT

Measurement Time	
Auto	✓
ACP due to Transients	6 sym + (sub)slot + 6 sym
PVT	6 sym + (sub)slot + 6 sym
Spectrum FFT	6 sym + (sub)slot + 6 sym

Setting the Measurement time for *Spectrum FFT* is currently not yet available. This means the gating time for cutting out the FFT input data is fixed to the slot or subslot duration plus 6 symbol durations before and after that.

Exception: If no slot at all is found in the capture buffer, the whole capture buffer is processed by the FFT to give a trouble-shooting help. The statistic of the Spectrum FFT measurement (average trace) ignores this special kind of result.

File Manager

This section of the user manual describes the File Manager, which provides the possibility to save and recall R&S FS-K110 settings during a measurement session, as well as providing some general file management support.

The File Manager display is shown below (only the softkeys on the very right side are relevant).
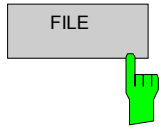
FILE

The *FILE* hardkey the File Manager softkey menu.
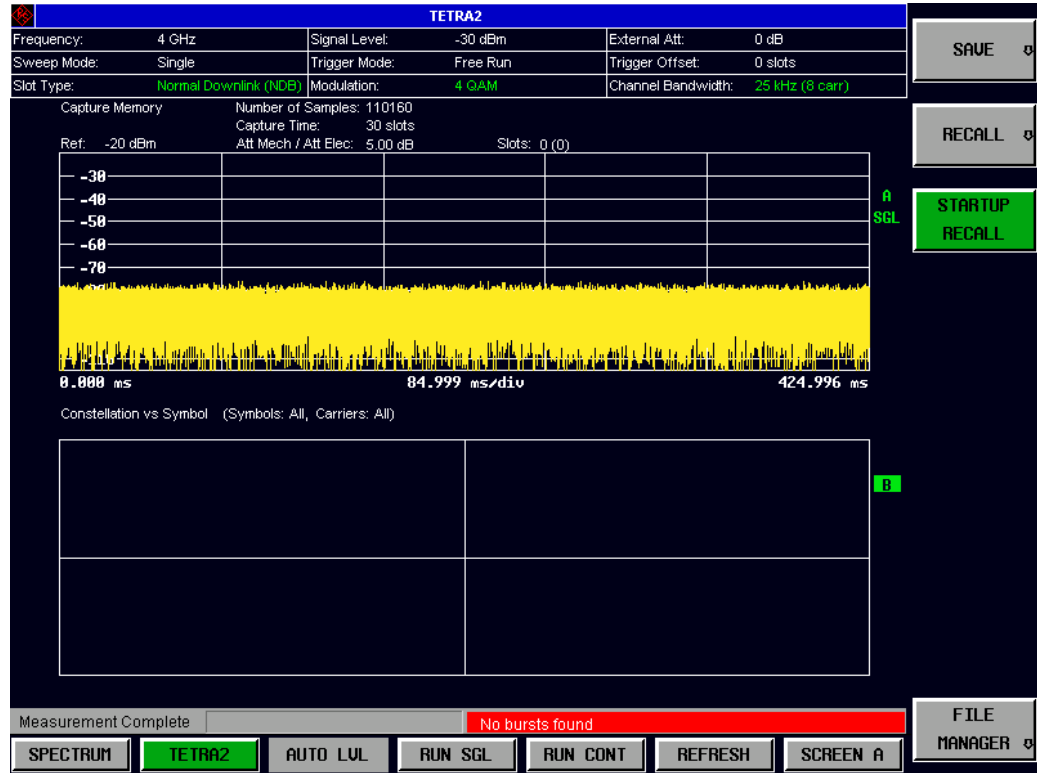
Fig. 33   File Manager menu

From the File Manager menu, settings can be saved, recalled, and set as startup recall. These options are discussed below.

SAVE

The *SAVE* softkey allows the user to save the current measurement settings and/or results.
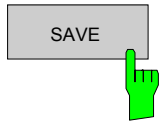
SAVE

The *SAVE* softkey Save dialog.
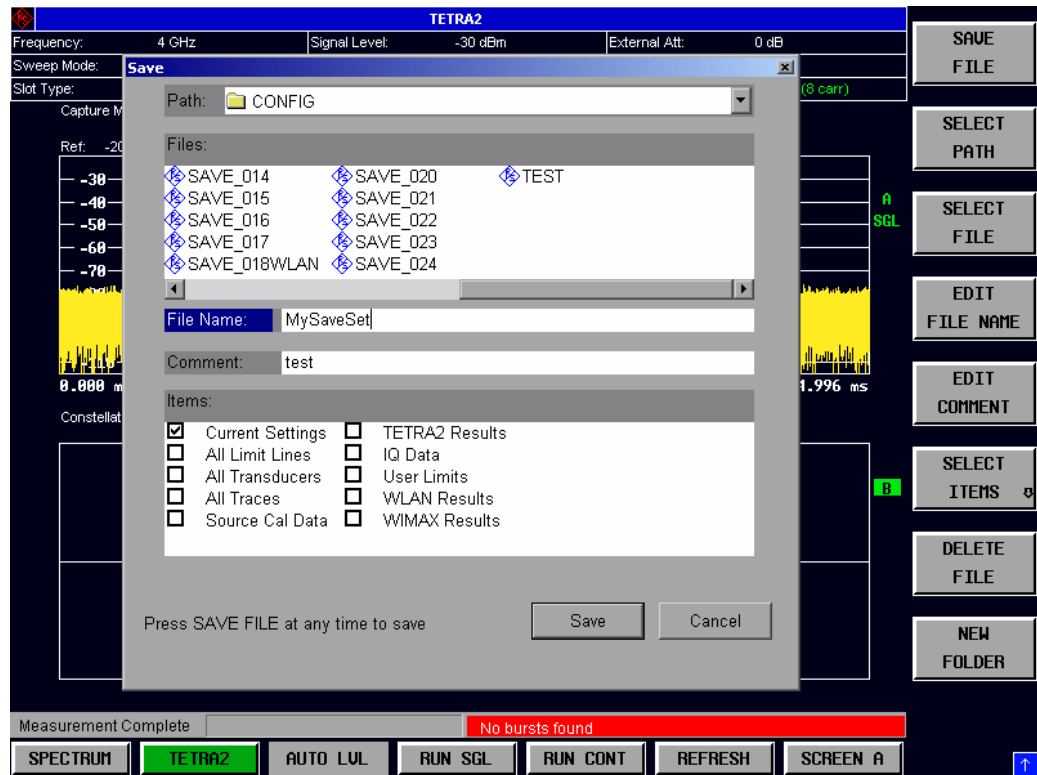
Fig. 34   Save file dialog

From this panel, the name of the file to be saved can be specified. In addition, the types of settings and measurement results can be specified.

RECALL

The *RECALL* softkey allows the user to recall previously saved measurement settings and/or results.
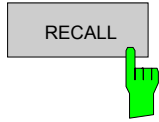
RECALL

The *RECALL* softkey displays the Recall dialog.
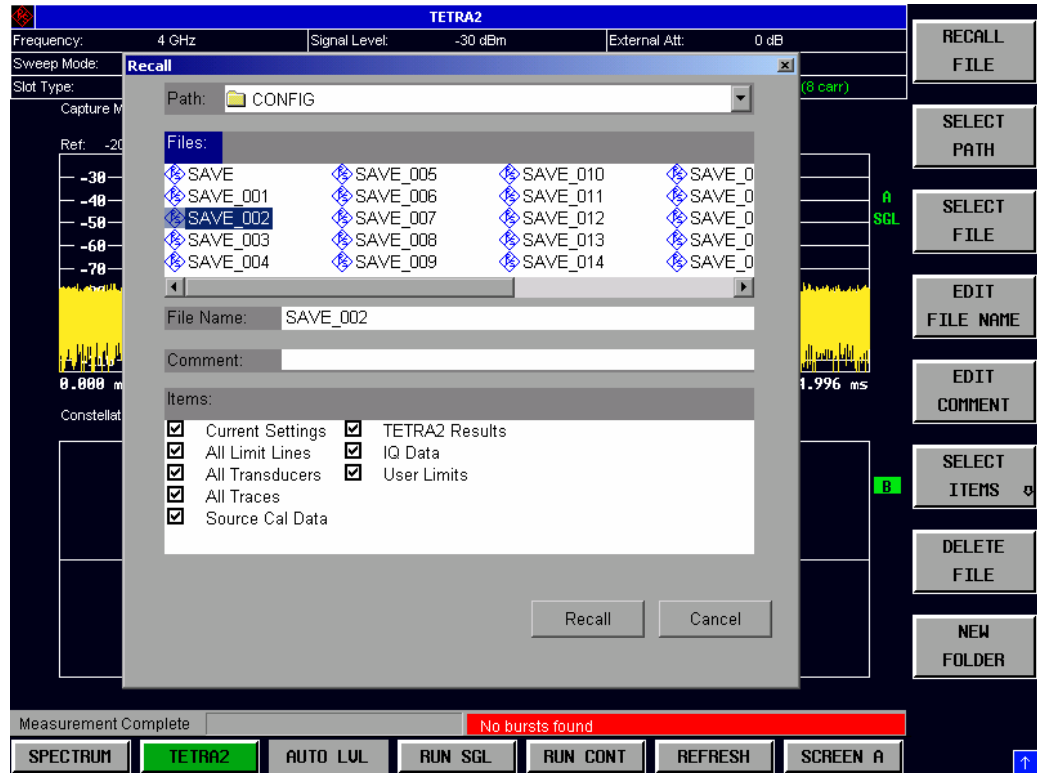
Fig. 35   Recall file dialog

From this panel, the name of the file to be recalled can be specified. The settings or results that are available in the recall file are shown, along with check boxes to indicate whether or not these parameters should be recalled.

STARTUP RECALL

The *STARTUP RECALL* softkey specifies a file with settings and/or results that should be recalled at each start up of the application.
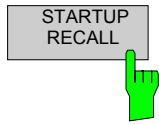
| STARTUP RECALL | The *STARTUP RECALL* softkey displays the Startup Recall dialog. |
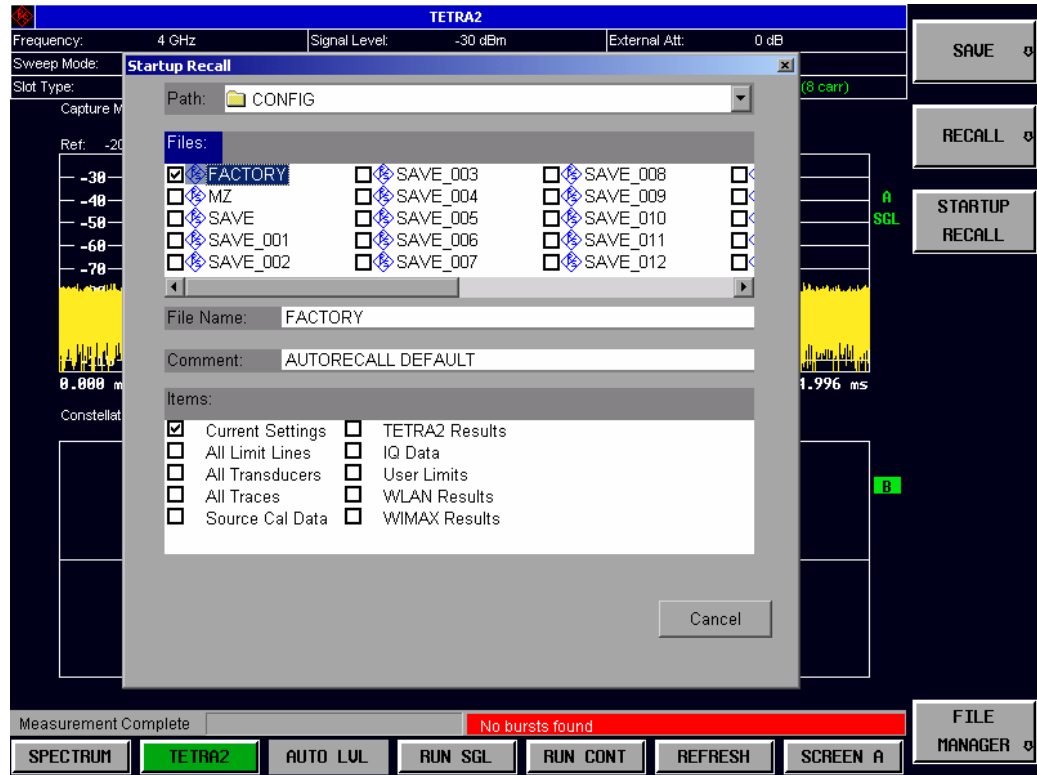
Fig. 36   Startup Recall file dialog

From this panel, the name of the file to be recalled can be specified. The settings or results that are available in the recall file are shown, along with check boxes to indicate whether or not these parameters should be recalled.

FILE MANAGER

The *FILE MANAGER* softkey allows the user to manage files on the FSQ hard drive
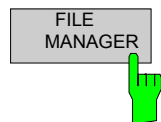
FILE MANAGER	The *FILE MANAGER* softkey displays the File Explorer dialog.
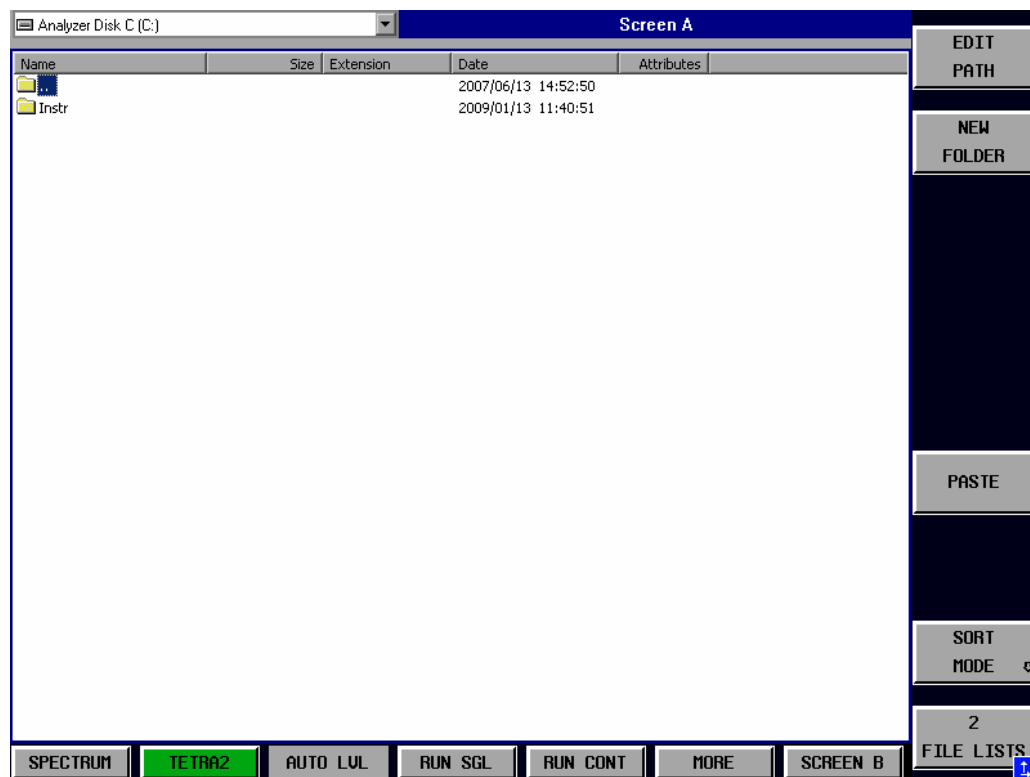
Fig. 37   File Explorer dialog

From this panel, files and folders can be modified on the instrument's hard drive.

Trace Selection

For a number of measurement displays, the R&S FS-K110 application software allows the user to specify which traces to display. The measurement displays that have this trace selection capability include:

- PVT

- EVM vs Symbol

- EVM vs Carrier

- Magnitude Error vs Symbol

- Phase Error vs Symbol

- Spectrum FFT

- ACP Due to Modulation

- ACP Due to Transients

Note that at least one trace must be left active.
Note that the display to activate or deactivate a trace can be selected first by means of hotkey *SCREEN A/B* first.

The "Show Trace" pop-up dialog is activated by pressing the *TRACE* hardkey. This pop-up dialog is shown exemplary for the measurement Power vs Time in the figure below.

The *TRACE* hard key allows individual traces to be switched on or off.

Show Trace: Power vs Time	
1 - Current	✓
2 - Minimum	✓
3 - Peak	✓
4 - Average	✓
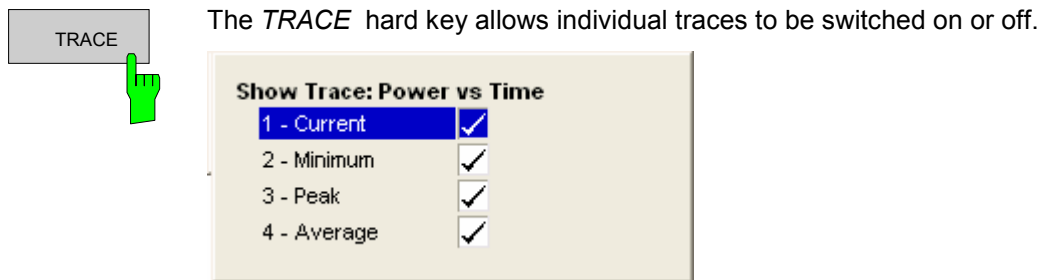
Fig. 38   Trace Selection pop-up dialog

Remote: DISP:WIND2:TRAC1:STAT
         DISP:WIND2:TRAC2:STAT
         DISP:WIND2:TRAC3:STAT
         DISP:WIND2:TRAC4:STAT

Markers

This section of the user manual describes the Marker facility of the option.

| MKR |
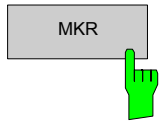
The *MKR* hardkey the marker softkey menu. Any settings views or pop-up dialogs on display when the marker softkey menu is displayed will be closed.

Fig. 39   Marker Menu

From the marker menu it is possible to adjust the marker position and switch the marker display off.

Note that the display to activate or deactivate a marker can be selected first by means of hotkey *SCREEN A/B* first.

Adjusting Markers

After having activated (please refer to previous chapter) a marker can be adjusted by pressing the marker softkey in the marker softkey menu.
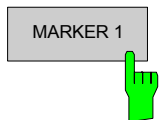
| MARKER 1 |

The *MARKER 1* softkey displays the Marker pop-up dialog. The contents of the marker pop-up depend on the type of graph to which the marker being adjusted belongs.
As soon as a field in the marker pop-up dialog is adjusted then the marker position in the trace will update, along with the results displayed for the marker.

Remote: CALC<1|2>:MARK<1>:XCAR
         CALC<1|2>:MARK<1>:XFRE
         CALC<1|2>:MARK<1>:XSYM
         CALC<1|2>:MARK<1>:XTIM

Toggle Marker Display

Markers can be toggled by pressing the Marker softkey as follows:
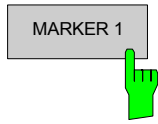
Pressing the *MARKER 1* softkey when the marker is not displayed (softkey has grey background) causes the Marker pop-up to be displayed and the marker to be switched on.

Remote: `CALC1:MARK:STAT ON`

Pressing the *MARKER 1* softkey when the Marker pop-up is displayed (softkey has red background) causes the marker to be switched off and the dialog to be hidden.

Remote: `CALC1:MARK:STAT OFF`
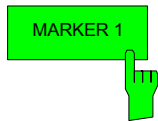
Pressing the *MARKER 1* softkey when the Marker is displayed but the Marker pop-up is not displayed (softkey has green background) causes the Marker pop-up to be displayed.

Remote: `CALC1:MARK:STAT ON`

All markers in the active screen can be switched off by pressing the *MARKER OFF* softkey.

Assigning Markers to Traces

Pressing the *MKR→* hardkey opens a submenu that allows setting markers from one trace to another one or searching for the minimum or maximum of the trace the marker is currently on.
Note that the display to manipulate a marker in can be selected first by means of hotkey *SCREEN A/B*.
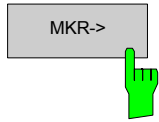
MKR->	Pressing the *MKR->* hardkey displays the Marker Extension softkey menu.
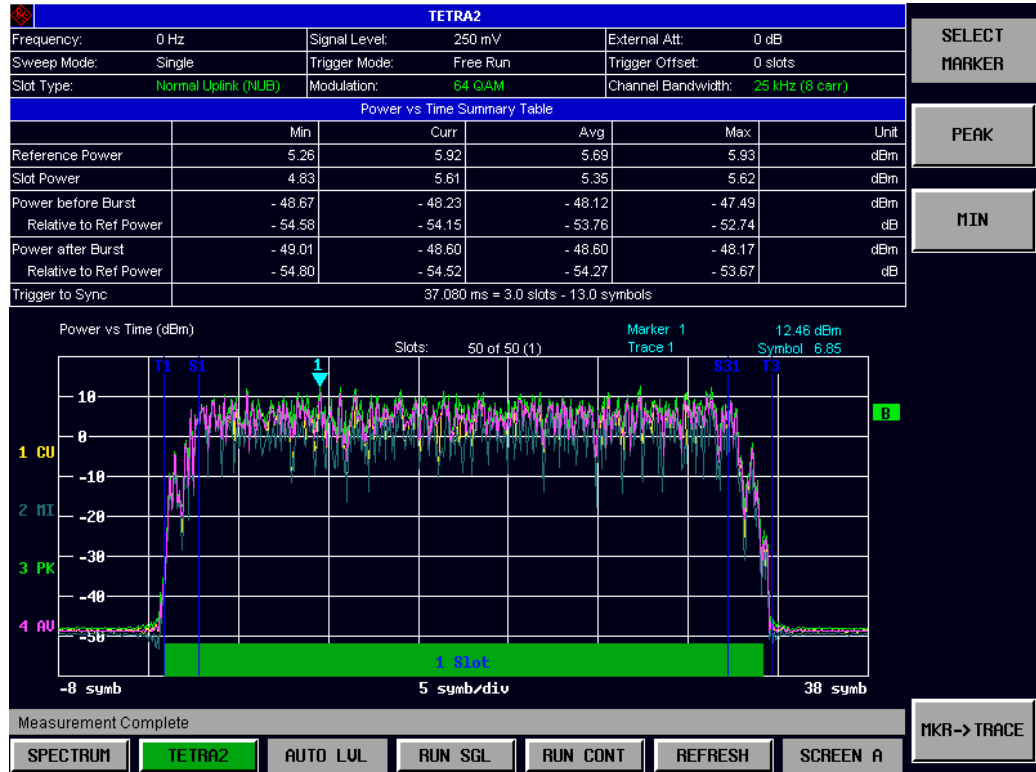
Fig. 40   Marker Extension Softkey Menu
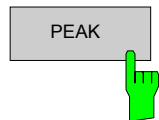
PEAK	Pressing the *PEAK* softkey moves the marker to the peak value of the selected trace. Remote Control: Currently not yet available.
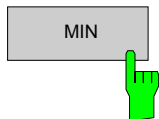
MIN	Pressing the *MIN* softkey moves the marker to the minimum value of the current trace. Remote Control: Currently not yet available.
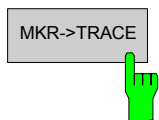
MKR->TRACE	In result graphs which have more than one trace (e.g. PVT) the marker can be assigned to any of the displayed traces. Pressing the *MKR->TRACE* displays the Select Trace pop-up dialog. The marker can now be moved from e.g. the trace showing the minimum results to the trace showing the maximum results, or vice versa. .
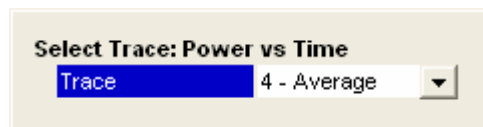
Fig. 41   Select Trace Pop-up Dialog

Remote: `CALC2:MARK:TRAC`

Display Settings

The layout of the display can be controlled using the display menu.
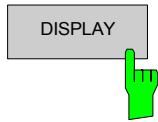
The *DISPLAY* hardkey brings to view the display softkey menu. Any settings views or pop-up dialogs on display will be closed.
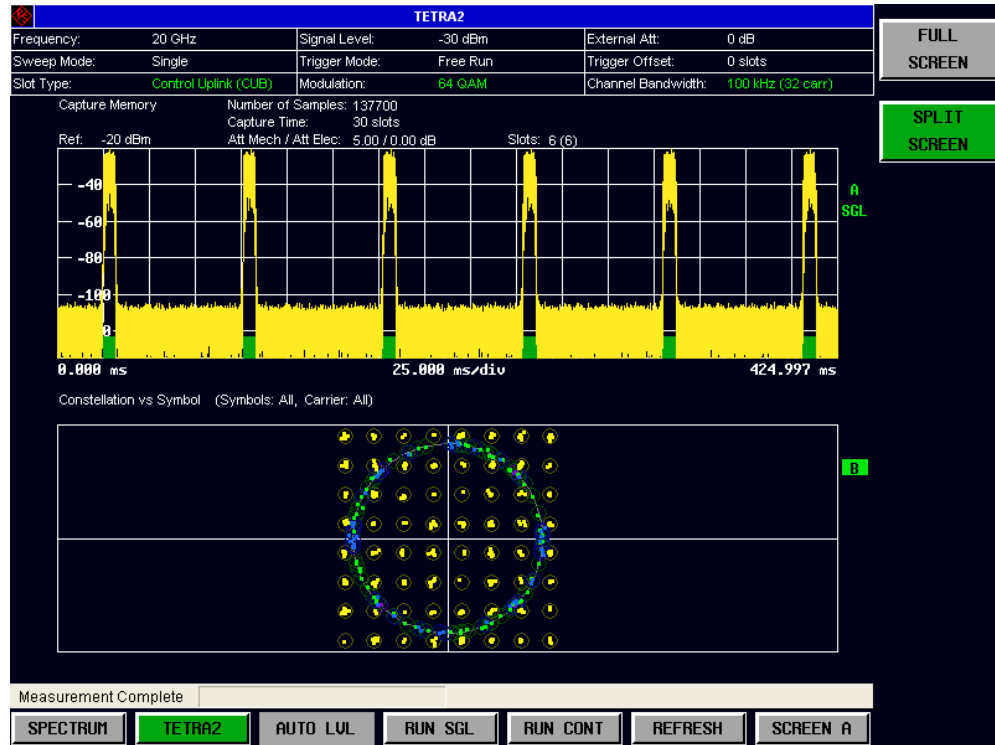
Fig. 42   Display Menu

The display menu allows the display to be changed between split and full screen display.

The active screen can be selected by pressing the *SCREEN A/SCREEN B* hotkey.
Example of use: A screen needs to be made active in order to control the markers it displays.

In full screen mode the *SCREEN A/SCREEN B* hotkey also toggles which screen is displayed.

Remote: `DISP:FORM`

Support

This section of the user manual describes the Support function, which stores necessary data files to be sent to Rohde & Schwarz support center.

The softkey to create and store the support files is located in each of the measurement softkey menus (please refer to Fig. 43).

Note: *The Support softkey is only available if no measurement is performed, i.e. RUN CONT must not be activated. Rather press RUN SGL, wait until the measurement is done and then press the Support softkey.*

Fig. 43   Measurement submenu offering a SUPPORT softkey

On pressing the *Support* softkey a popup dialog box is displayed and the following data is stored on the instrument's hard disk, path "D:\USER\SUPPORT\TETRA2*.*".

- *.bin file   option settings

- *.iqw file   IQ-data

- *.txt file   option and version list

- *.bmp screenshot

Note: *Attach all the files under D:\USER\SUPPORT\TETRA2*.* to an email and send to:* info@rohde-schwarz.com*.*

3 Measurements in Detail

This section provides a more detailed explanation of the measurements provided by the R&S FS-K110 and provides help for using R&S FS-K110 to measure the characteristics of specific types of DUT.

Signal Processing

Abbreviations

$\Delta a(m)$	decision-directed estimated scaling error for subcarrier m
$\Delta f(m)$	decision-directed estimated frequency error for subcarrier m
Δf_{mean}	estimated mean frequency error of the whole slot
$\Delta phi(m)$	decision-directed estimated phase error for subcarrier m
$\Delta t(m)$	decision-directed estimated time delay for subcarrier m
$ACP_n(t)$	ACP trace in offset channel n at time t. OV >> 1
$d(m)$	decision-directed estimated exponential amplitude decay for subcarrier m
f_n	offset frequency for ACP channel with index n in Hz
f_c	nominal absolute RF carrier frequency in Hz
$f_{sc}(m)$	nominal frequency offset of subcarrier m in Hz
$g(m)$	decision-directed estimate for Gain Imbalance for subcarrier m
k	symbol instant index. S1 up to SN_{max}
M	total number of subcarriers. 8,16,32 or 48
m	subcarrier index. 0,1,2, …, M-1.
n	ACP offset channel indices. -3,-2,-1,+1,+2,+3.
$IQ_{ACP}(t)$	IQ signal used for the ACP measurements. OV >> 1.
$IQ_{Err}(m,k)$	IQ error signal at subcarrier m and symbol instant k. OV = 1.
$IQ_{Meas}(m,k)$	measured IQ signal at subcarrier m and symbol instant k. OV =1.
$IQ_{Ref}(m,k)$	ideal IQ signal at subcarrier m and symbol instant k. OV = 1.
$IQ_{PVT}(t)$	IQ signal used for the PVT measurement. OV >> 1.
$IQ_{Sub}(m,k)$	RRC filtered Q signal of subcarrier m used for demodulation. OV = 1.
$IQ_{Raw}(t)$	captured raw IQ signal. OV >> 1
OV	oversampling factor of a signal. Sampling rate = OV * 2400 Hz.
$q(m)$	decision-directed estimated Quadrature Error for subcarrier m
RRC	Root Raised Cosine filter.
$S(m,k)$	Decided symbol value at subcarrier m and symbol instant k. OV =1.
SN_{max}	Number of symbol instants in slot. Either 14, 31 or 34.
t	time index (seconds)
T_{sym}	Symbol duration. T_{sym} = 1/2400 s.
W(k)	Complex compensation value for symbol instant k (pilot tracking).

All signals with high oversampling factors (OV >> 1) are considered quasi time-continuous here although they are sampled of course.

Slot based signal processing

Fig. 44 shows the signal processing that deals with the whole slot (all subcarriers together):
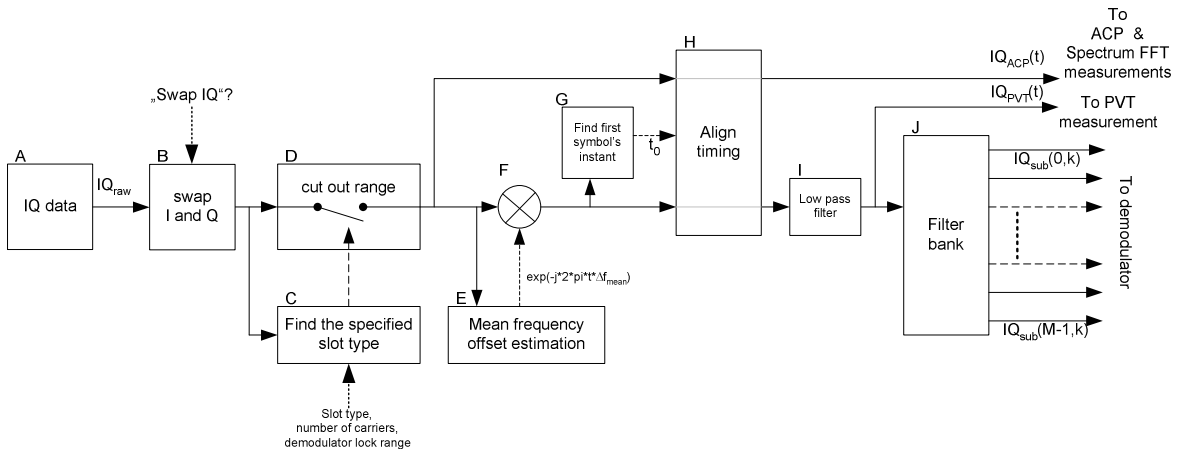
Fig. 44   Slot based signal processing overview

Block A: In the first step the application has to capture IQ data with a sample rate and a bandwidth that fits for all measurements.
That the RF input is used: The signal at the RF input around the set center frequency f_c is downconverted to the complex baseband.
If the analog Baseband input (HW option B71) is used: Either only the I-input or only the Q-input or both (I +j*Q) are fed to a complex digital mixer that downconverts the signal around the set center frequency f_c to the complex baseband. If the center frequency is already 0 Hz no downconversion takes place of course.
If the digital Baseband input (HW option FSQ-B17) is used: The IQ data is not downconverted, only resampled to a suitable sample rate and scaled.
The IQ data is stored in an internal RAM. The length of the data is determined by the user parameter "Capture Time" , please see page 71.
At least some slots should have been captured in the "Capture Time".

Block B: Optional swapping of the I and Q part of the signal. Please refer to the user parameter "Swap IQ" on page 74. This is useful if the I and Q parts were also interchanged in the DUT.

Block C: From the start to the end of the IQ data, the application will find only that type of slots the user has specified. Other types are not accepted.
For details about the slot search, please refer to chapter "Slot search details" on page 16.

Block D: Every time a slot it detected and accepted, it is cut out of the IQ data and fed into the subsequent DSP algorithms. A few additional symbols before and after the slot's (or sub slot's) duration are automatically included because some measurements like "ACP due to Transients" require this.

Block E: The mean frequency offset Δf_{mean} of the whole slot is estimated.

Block F: The estimated mean frequency offset Δf_{mean} of the whole slot is compensated.

Block G: The position t_0 of the first symbol's instant is estimated, using all subcarriers.

Block H: All measurements working on the signals $IQ_{ACP}(t)$ and $IQ_{ACP}(t)$ need to start and stop measuring at exact times relative to the slot's start or the first symbol. The demodulator must also exactly know where the symbol instants are.
Therefore the signals are timing compensated and the important time instants are stored internally.

Block I: A low pass filter rejects adjacent channels. Only the TX channel can pass.
The output signal $IQ_{PVT}(t)$ is fed into the PVT measurement and into the filter bank.

Block J: A filter bank separates the N subcarriers the signal consists of.
Each subcarrier is filtered with a Root Raised Cosine filter with a roll-off of 0.2. This removes the Inter-Symbol-Interference between the symbols in the same subcarrier. But as the RRC transmit and receive filters are wider than the subcarrier spacing, the filter bank cannot completely remove Inter-Carrier-Interference.
The signal is down-sampled at the symbol instants.
All subcarrier signals $IQ_{Sub}(m,k)$ are fed to the demodulator.

Subcarrier based signal processing

Fig. 45 shows that part of the application's signal processing specific for a single subcarrier. The application has M identical paths like this, one for each subcarrier.
For the input signal $IQ_{sub}(m,k)$ please refer to Fig. 44.
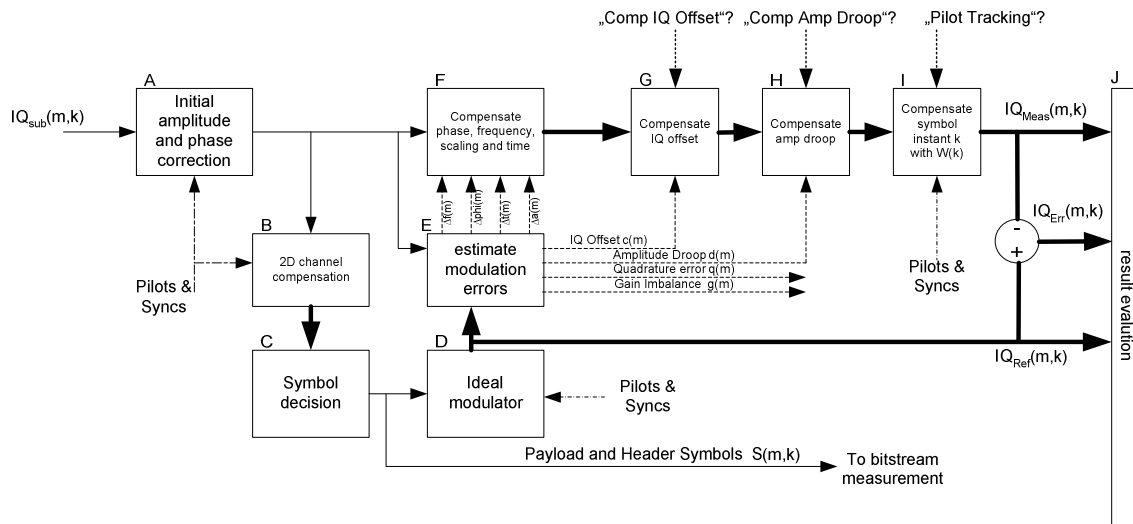
Fig. 45   Subcarrier based signal processing (demodulator)

Block A: All IQ symbols in the subcarrier k are multiplied with the same complex valued constant C_k.
C_k is calculated as the best fit after comparing the received sync and pilot symbols and their ideal positions. This is a coarse phase and magnitude compensation.
Please refer to the standard [2].

Block B: Only in the path leading to the symbol decision a 2 dimensional channel estimation and compensation is done to avoid wrong symbol decisions.
All sync and pilot symbols in <u>all</u> subcarriers are used for the 2 dimensional channel estimation.

Block C: Symbol decision of all payload and header symbols in this subcarrier. The symbol values are delivered to the bitstream measurement and the ideal modulator (block D).
For a proper working of the demodulator the signal should be good enough that the percentage of wrong decisions is low.
Note: No kind of channel coding is done in the application.

Block D: The ideal IQ signal for this subcarrier is generated. This is possible because:

- The ideal sync and pilot symbols are known a-priori.

- The ideal payload and header symbols can be built using the decided bitstream (assuming there were no wrong decisions).

The output only consists of the symbol instants of this subcarrier from the first to the last

Block E: symbol defined in the slot.
Block E: Decision-directed estimation of the modulation errors for this subcarrier using all the symbol instants defined in the selected type of slot. Criterion is to minimize the Mean squared EVM of this subcarrier.

Block F: Compensate the errors estimated by Block E for this subcarrier.

1. Timing error: $\Delta t(m)$
2. Frequency error: $\Delta f(m)$
3. Scaling error: $\Delta a(m)$
4. Phase error: $\Delta phi(m)$

All of these errors are small since they were already compensated in earlier signal processing blocks.

Block G: Optional compensation of the IQ offset estimated by Block E for this subcarrier.
The complex IQ offset value is subtracted from this subcarrier's IQ signal.
Please refer to parameter "Compensate IQ Offset" on page 80.

Block H: Optional compensation of the amplitude droop estimated by Block E for this subcarrier.
The subcarrier's IQ signal is multiplied with an opposed exponential function. The subcarrier's measured power should afterwards be as similar as possible to the ideal signal's power during the slot's useful part.
Please refer to parameter "Compensate Amplitude Droop" on page 80.

Block I: Optional pilot tracking, calculated using <u>all</u> subcarriers.
The amplitudes and phases of the sync and pilot symbols in all subcarriers are compared against their ideal values. The application calculates (best fit) some complex valued compensation values $W_{SP}(k_{SP})$ for all the symbol instants k_{SP} where the slot either holds sync or pilot symbols.
The final values $W(k)$ at all the symbol instants k in the slot are calculated by extrapolating and interpolating the few values $W_{SP}(k_{SP})$.
The IQ symbol at symbol instant k in each subcarrier is multiplied with the same corresponding complex value $W(k)$.

Please refer to the standard [2] and to parameter "Pilot Tracking" on page 80.

Note that the pilot tracking can take care of arbitrary time-varying amplitude and phase changes that were not compensated by earlier stages. Block A and F in Fig. 45 only compensate a constant (over time) amplitude and phase error. Block H in Fig. 45 only compensates an amplitude change that is exponential over time.

Block J: The evaluation algorithms requires

- All the estimates of the slot based signal processing (please refer to Fig. 44). Not drawn in Fig. 45.
- All the estimates of the subcarrier based signal processing (please refer to Fig. 45).
- The signal $IQ_{meas}(m,k)$, i.e. the measured signal of subcarrier m at the symbol instants k.
- The signal $IQ_{ref}(m,k)$, i.e. the ideal signal of subcarrier m at the symbol instants k.
- The signal $IQ_{err}(m,k)$, i.e. the difference between $IQ_{ref}(m,k)$ and $IQ_{meas}(m,k)$.
- Parameters the user has set.

Transmitter distortion model

Fig. 46 shows the transmitter and distortion model assumed by the measurement demodulator of the R&S FS-K110. The error parameters and signals are described in Table 3 below.
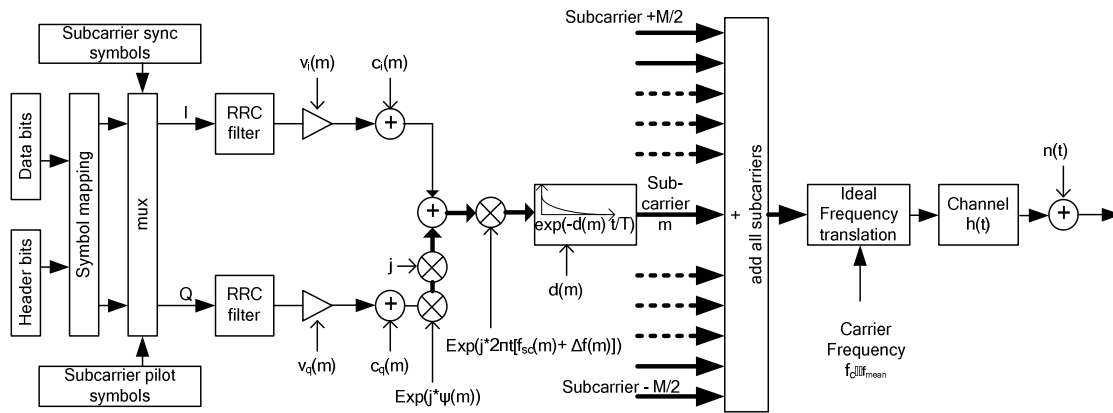
Fig. 46   Transmitter distortion model for one subcarrier m

Table 3   Distortion parameters of transmitter

Parameter	Ideal Value	Description
$v_i(m)$, $v_q(m)$	$v_i(m) = v_q(m)$	Gains of I and Q path of subcarrier m
$c_i(m)$, $c_q(m)$	$c_i(m) = c_q(m) = 0$	Carrier leakage in I and Q path of subcarrier m
$\psi(m)$	$\psi(m) = 0$	Quadrature error of subcarrier m
$d(m)$	$d(m) = 0$	Exponential amplitude droop of subcarrier m. Can vary from subcarrier to subcarrier in the case of a channel varying over time.
$\Delta f(m)$	$\Delta f(m) = 0$	small frequency error of subcarrier m relative to its nominal subcarrier offset frequency.
Δf_{mean}	$\Delta f_{mean} = 0$	Frequency error of the whole signal relative to the nominal carrier frequency f_c
$n(t)$	$n(t) = 0$	Thermal noise. Systematic errors not covered by the model are also considered as noise by the demodulation routines.

Instead of directly displaying the parameters from the table above, derived parameters are displayed in the "Summary Table" measurement.

ACP signal processing

A diagram of the signal processing dealing with the measurements

- "ACP due to Modulation" and
- "ACP due to Transients"

is shown in Fig. 47. For the input signal $IQ_{ACP}(t)$ please refer to Fig. 44.
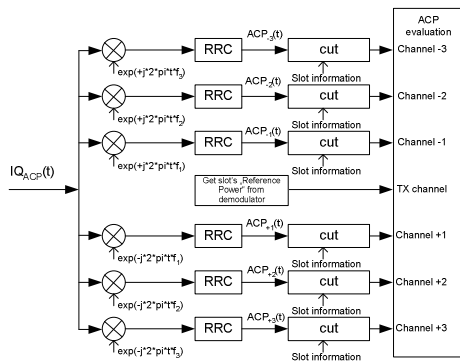
Fig. 47   ACP signal processing

The application chooses the offset frequencies f_n automatically according to the standard [2].

A Root-Raised Cosine filter is applied to each of these offset frequencies. The symbol rate and the roll-off factor to design the RRC filters are also automatically chosen by the application.

The filters' output are then cut and aligned to the found slots' positions.

No special signal processing is done for the TX channel. Instead the "Reference power" (please refer to Formula 50) is fetched from the demodulator.

The ACP measurements use sample rates much higher than the symbol rate of 2400 Hz, therefore the input signal is considered quasi time-continuous for some formulas although it is sampled of course.

Please refer to chapter "Results of ACP due to Transients" on page 114 or "Results of ACP due to Modulation" on page 117 for details about the ACP results.

PVT signal processing

Fig. 48 shows the signal processing specific to measurement "Power Versus Time". For the input signal $IQ_{PVT}(t)$ please refer to Fig. 44.
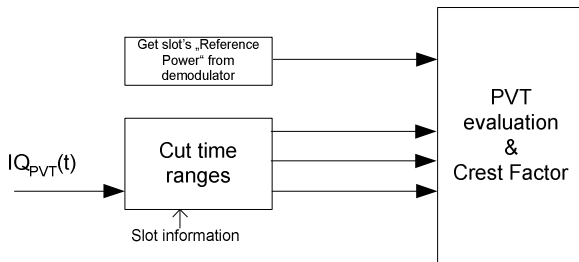
Fig. 48   PVT signal processing

The input signal $IQ_{PVT}(t)$ is already low pass filtered and frequency compensated.

The measurement only needs to cut out the necessary time periods (relative to the found slot) and to feed them into the PVT evaluation block.

The "Reference Power" is fetched from the demodulator (please refer to Formula 50).

The PVT measurement uses sample rates much higher than the symbol rate of 2400 Hz. Therefore the input signal is considered quasi time-continuous for some formulas although it is sampled of course.

Please refer to chapter "

Results of Power versus Time" on page 118 for details about the PVT results.

The signal $IQ_{PVT}(t)$ is also used to calculate the Crest Factor (cf. Formula 31).

Result descriptions

Normalization constants

The expectation value for the mean power of all ideal symbol instants of a whole slot is 1:

$$C_{pow} = E(\frac{1}{M \cdot SN_{max}} \sum_{m=0}^{M-1} \sum_{k=1}^{SN_{max}} \left| IQ_{Ref}(m,k) \right|^2) = 1 \qquad \text{Formula 1}$$

Using Formula 1 the expectation value for the magnitude of all ideal symbol instants of the whole slot is also 1.0:

$$C_{Mag} = \sqrt{C_{pow}} = 1 \qquad \text{Formula 2}$$

Both C_{Mag} and C_{pow} do not depend on the payload modulation type, number of subcarriers or slot type. But a pseudo-random equal distribution of the payload and header symbols is assumed for any slot, i.e. no constant pattern should be sent.

Phase Error

The Phase Error in rad at the symbol instant k in subcarrier m is the difference of the phase of the measured and the phase of the ideal symbol:

$$PhaseError(m,k) = arg\left(IQ_{Meas}(m,k) \cdot IQ_{Ref}{}^{*}(m,k) \right) \qquad \text{Formula 3}$$

Note that this is not equal to the phase of $EVM(m,k)$, Formula 13.

Using Formula 3 the RMS Phase Error at a certain symbol instant k, averaged over all M subcarriers is:

$$PhaseError_{symbol}(k) = \sqrt{\frac{1}{M} \cdot \sum_{m=0}^{M-1} \left| PhaseError(m,k) \right|^2} \qquad \text{Formula 4}$$

The „Min/Max/Avg/Current" - statistic for $PhaseError_{symbol}(k)$ is done according to chapter "RMS averaging" on page 122.

All statistics of $PhaseError_{symbol}(k)$ can be converted to unit 'degree:

$$PhaseError_{symbol,\,degree}(k) = \frac{360°}{2 \cdot \pi} \cdot PhaseError_{symbol}(k) \qquad \text{Formula 5}$$

Different statistics of $PhaseError_{symbol,degree}(k)$ are shown as:

- Traces of measurement "Phase Error vs Symbol".
- SCPI: `CONF:BURS:MAGN:IMM`, then fetch some traces

The RMS Phase Error of the whole slot is (using Formula 4):

$$PhaseError_{Slot} = \sqrt{\frac{1}{SN_{max}} \cdot \sum_{k=1}^{SN_{max}} \left| PhaseError_{symbol}(k) \right|^2} \qquad \text{Formula 6}$$

The „Min/Max/Avg/Current" - statistic for $PhaseError_{Slot}$ is done according to chapter "RMS averaging" on page 122.

All statistics of $PhaseError_{Slot}$ can be converted to unit 'degree':

$$PhaseError_{slot,\,degree} = \frac{360°}{2 \cdot \pi} \cdot PhaseError_{slot} \qquad \text{Formula 7}$$

Different statistics of $PhaseError_{Slot,degree}$ are shown as:

- The row called "Phase Error" in the "Summary Table" measurement.
- SCPI: `FETCh:BURSt:SUMTable:PHASeerror`

Magnitude Error

The Magnitude Error at the symbol position k in subcarrier m is:

$$MagError(m,k) = \frac{\left| IQ_{Meas}(m,k) \right| - \left| IQ_{Ref}(m,k) \right|}{C_{Mag}} \qquad \text{Formula 8}$$

Note that this is not equal to the magnitude of $EVM(m,k)$, Formula 13.

The RMS Magnitude Error at a certain symbol instant k, averaged over all M subcarriers is (using Formula 8):

$$MagError_{symbol}(k) = \sqrt{\frac{1}{M} \cdot \sum_{m=0}^{M-1} \left| MagError(m,k) \right|^2} \qquad \text{Formula 9}$$

The „Min/Max/Avg/Current" - statistic for $MagError_{symbol}(k)$ is done according to chapter "RMS averaging" on page 122.

All statistics of $MagError_{symbol}(k)$ can be converted to unit 'percent':

$$MagError_{symbol,percent}(k) = 100\% \cdot MagError_{symbol}(k) \qquad \text{Formula 10}$$

Different statistics of $MagError_{symbol,percent}(k)$ are shown as:

- Traces of measurement "Magnitude Error vs Symbol".
- SCPI: `CONF:BURS:MAGN:IMM` , then fetch some traces

The RMS Magnitude Error of the whole slot is (using Formula 9):

$$MagError_{Slot} = \sqrt{\frac{1}{SN_{max}} \cdot \sum_{k=1}^{SN_{max}} \left| MagError_{symbol}(k) \right|^2} \qquad \text{Formula 11}$$

The „Min/Max/Avg/Current" - statistic for $MagError_{Slot}$ is done according to chapter "RMS averaging" on page 122.

All statistics of $MagError_{Slot}$ can be converted to unit 'percent':

$$MagError_{slot,percent} = 100\% \cdot MagError_{slot} \qquad \text{Formula 12}$$

Different statistics of $MagError_{slot,percent}$ are shown as:

- The row called "Magnitude Error" in the "Summary Table" measurement.
- SCPI: `FETC:BURS:SUMT:MAG`

Error Vector Magnitude

The Error Vector Magnitude at a certain symbol position k in subcarrier m is:

$$EVM(m,k) = \frac{\left| IQ_{Ref}(m,k) - IQ_{Meas}(m,k) \right|}{C_{Mag}} = \frac{\left| IQ_{Err}(m,k) \right|}{C_{Mag}}$$

Formula 13

The RMS Error Vector Magnitude at a certain symbol instant k, averaged over all M subcarriers is (using Formula 13):

$$EVM_{symbol}(k) = \sqrt{\frac{1}{M} \cdot \sum_{m=0}^{M-1} \left| EVM(m,k) \right|^2}$$

Formula 14

The „Min/Max/Avg/Current" - statistic for $EVM_{symbol}(k)$ is done according to chapter "RMS averaging" on page 122.

All statistics of $EVM_{symbol}(k)$ can be converted to unit 'percent':

$$EVM_{symbol,percent}(k) = 100\% \cdot EVM_{symbol}(k)$$

Formula 15

All statistics of $EVM_{symbol}(k)$ can be converted to unit 'dB':

$$EVM_{symbol,dB}(k) = 20 \cdot log10(EVM_{symbol}(k))$$

Formula 16

Different statistics of $EVM_{symbol,dB}(k)$ and $EVM_{symbol,percent}(k)$ are shown as:

- Traces of measurement "EVM vs Symbol".
  Unit can be switched manually.
- SCPI: `CONF:BURS:EVM:ESYM:IMM` , then fetch some traces
  Units can be switched before by:
  `CONF:BURS:EVM:ESYM:UNIT PCT`
  `CONF:BURS:EVM:ESYM:UNIT DB`

The RMS Error Vector Magnitude in a certain subcarrier m, averaged over all symbol instants is (using Formula 13):

$$EVM_{carrier}(m) = \sqrt{\frac{1}{SN_{max}} \cdot \sum_{k=1}^{SN_{max}} \left| EVM(m,k) \right|^2}$$

Formula 17

The „Min/Max/Avg/Current" - statistic for $EVM_{carrier}(m)$ is done according to chapter "RMS averaging" on page 122.

All statistics of $EVM_{carrier}(m)$ can be converted to unit 'percent':

$$EVM_{carrier,percent}(m) = 100\% \cdot EVM_{carrier}(m)$$

Formula 18

All statistics of $EVM_{carrier}(m)$ can be converted to unit 'dB':

$$EVM_{carrier,dB}(m) = 20 \cdot log10(EVM_{carrier}(m))$$

Formula 19

Different statistics of $EVM_{carrier,percent}(m)$ and $EVM_{carrier,dB}(m)$ are shown as:

- Traces of measurement "EVM vs Carrier".
  Unit can be switched manually.
- SCPI: `CONF:BURS:EVM:ECAR:IMM`

Unit can be switched before by:
```
CONF:BURS:EVM:ECAR:UNIT PCT
CONF:BURS:EVM:ECAR:UNIT DB
```

The RMS Error Vector Magnitude of the **whole slot**, using **all kind** of symbols, is (using Formula 14 and Formula 17):

$$EVM_{slot} = \sqrt{\frac{1}{M}\sum_{m=0}^{M-1}EVM_{carrier}(m)^2} = \sqrt{\frac{1}{SN_{max}}\sum_{k=1}^{SN_{max}}EVM_{symbol}(k)^2}$$

Formula 20

The „Min/Max/Avg/Current" - statistic for EVM_{slot} is done according to chapter "RMS averaging" on page 122.

All statistics of EVM_{slot} can be converted to unit 'percent':

$$EVM_{slot,percent} = 100\% \cdot EVM_{slot}$$

Formula 21

All statistics of EVM_{slot} can be converted to unit 'dB':

$$EVM_{slot,dB} = 20 \cdot log10(EVM_{slot})$$

Formula 22

Different statistics of $EVM_{slot,percent}$ and $EVM_{slot,dB}$ are shown as:

- The 2 rows called "EVM All Symbols" in the "Summary Table" measurement.
- SCPI: `FETC:BURS:SUMT:EVM:ALL`

The RMS Error Vector Magnitude of the **whole slot**, when using **only certain kinds of symbols** (e.g. only data symbols and header symbols, cf. parameter "Show 2nd EVM based on" on page 80) is calculated using Formula 13:

$$EVM_{slot,subset} = \sqrt{\frac{1}{L_{subset}}\sum_{m=0}^{M-1}\sum_{k\in Q_m}EVM(m,k)^2}$$

Formula 23

Q_m is a set containing all the symbol indices of subcarrier m, where symbols of the required type(s) can be found. L_{subset} is the total amount of symbols of the specified type(s) in the slot.

This means: In each subcarrier m the EVM of only certain symbol type(s) is calculated. The amount of symbols used in the calculation can vary from subcarrier to subcarrier and is equal to $|Q_m|$.

The „Min/Max/Avg/Current" - statistic for $EVM_{slot,subset}$ is done according to chapter "RMS averaging" on page 122.

All statistics of $EVM_{slot,subset}$ can be converted to unit 'percent':

$$EVM_{slot,subset,percent} = 100\% \cdot EVM_{slot,subset}$$

Formula 24

All statistics of $EVM_{slot,subset}$ can be converted to unit 'dB':

$$EVM_{slot,subset,dB} = 20 \cdot log10(EVM_{slot,subset})$$

Formula 25

Different statistics of $EVM_{slot,subset,percent}$ and $EVM_{slot,subset,dB}$ are shown as:

- The row 3 and 4 in the "Summary Table" measurement. Please refer to Fig. 28, results called "C" and "D".
- SCPI: For example:
```
FETC:BURS:SUMT:EVM:DATA
FETC:BURS:SUMT:EVM:PIL
```

Carrier Frequency Error

The total Carrier Frequency Error of a single subcarrier m is the sum of

- the non-decision-directed estimated mean Carrier Frequency Error of the whole slot Δf_{mean} which is typically large (cf. Fig. 44)
- and the decision-directed estimated frequency error of the single subcarrier m, called $\Delta f(m)$ which is typically small (cf. Fig. 45).

Please also refer to Fig. 46.

The total mean Frequency Error in 'Hz' of one subcarrier m is:

$$FreqError_{carrier}(m) = \Delta f_{mean} + \Delta f(m) \qquad \text{Formula 26}$$

The mean Carrier Frequency Error in 'Hz' of a whole single slot is (using Formula 26):

$$FreqError_{slot} = \frac{1}{M} \sum_{m=0}^{M-1} FreqError_{carrier}(m) \qquad \text{Formula 27}$$

The „Min/Max/Avg/Current" - statistic for $FreqError_{slot}$ is done according to chapter "MagMagnitude / MinMagnitude statistic" on page 124.
Different statistics of $FreqError_{slot}$ are shown as:

- The row called "Center Freq Error" in the "Summary Table" measurement.
- SCPI: `FETC:BURS:SUMT:FERR`

Amplitude Droop

Please refer to Fig. 45 and Fig. 46.
The amplitude droop value d(m) in subcarrier m is estimated in a way, that compensating the measured signal with an exponential function with exponent "-d(m)" minimizes the difference between the magnitude of the ideal signal and the magnitude of the measured signal in this subcarrier.
So only an exponential magnitude decrease or increase is considered by Amplitude Droop!

Estimating the value d(m) for the subcarrier m:

$$f(d,m) = \sum_{k=1}^{SN_{max}} \left(\left| IQ_{ref}(m,k) \right| - \left| IQ_{meas}(m,k) \right| \cdot e^{-d(m)\cdot(k-1)} \right)^2$$
$$d(m): \quad f(d(m),m) = \min_{d(m)} \left(f(d,m) \right) \qquad \text{Formula 28}$$

$d(m)$ is a positive or negative value and ideally 0.

To describe the mean exponential amplitude increase or decrease of a single slot the exponents d(m) can be converted to an corresponding average factor d_{slot} (using Formula 28):

$$d_{slot} = \sqrt{\frac{1}{M} \cdot \sum_{m=0}^{M-1} (e^{d(m)})^2} \qquad \text{Formula 29}$$

d_{slot} is a positive number and ideally 1.

The „Min/Max/Avg/Current" - statistic for d_{slot} is done according to chapter "RMS averaging" on page 122.

All statistics of the value d_{slot} can be converted to unit 'mdB/symbols' and are then called 'Amplitude Droop':

$$AmplitudeDroop_{mdB/sym} = 1000 \cdot 20 \cdot log10(d_{slot}) \qquad \text{Formula 30}$$

Different statistics of $AmplitudeDroop_{mdB/sym}$ are shown as:

- The row called "Amplitude Droop" in the "Summary Table" measurement.
- SCPI: `FETC:BURS:SUMT:AMPL`

A positive Amplitude Droop value means, that the measured signal's amplitude decreases versus time.

Crest Factor

The Crest Factor is also called "Peak-to-Average Power Ratio" (PAPR).

The application calculates the relation of the

- maximum power
- and the mean power of the signal $IQ_{Pvt}(t)$ (cf. Fig. 44 and Fig. 48) during the useful part of one slot.

The calculation requires:

- Frequency components outside the channel bandwidth were suppressed by a low pass filter
- The evaluation range goes from symbol instant S1 up to symbol instant SN_{max}, i.e. covers the useful part of the slot
- $IQ_{Pvt}(t)$ is sampled with a sample rate very high compared to the symbol rate of the signal, therefore we consider it quasi time-continuous here although it is sampled of course.
- No compensations (e.g. Amplitude Droop, channel compensation) were done on the signal.

The Crest Factor of the current found slot is:

$$IQ_{Pvt,Crest}(t) = IQ_{Pvt}(t) \quad \text{from slot's symbol time 1 to symbol time } SN_{max}$$

$$CrestFactor = \frac{max(|IQ_{Pvt,Crest}(t)|^2)}{\frac{1}{T_{sym} \cdot (SN_{max} - 1)} \int_{t=1 \cdot T_{sym}}^{SN_{max} \cdot T_{sym}} |IQ_{Pvt,Crest}(t)|^2 \, dt} \qquad \text{Formula 31}$$

The „Min/Max/Avg/Current" - statistic for $CrestFactor$ is done according to chapter "Arithmetic averaging" on page 123.

All statistics of $CrestFactor$ can be converted to unit 'dB':

$$CrestFactor_{db} = 10 \cdot log10(CrestFactor) \qquad \text{Formula 32}$$

Different statistics of $CrestFactor_{db}$ are shown as:

- The row called "Crest Factor" in the "Summary Table" measurement.
- SCPI: `FETC:BURS:SUMT:CRESt`

Gain Imbalance

The Gain Imbalance of a subcarrier m is g(m) (cf. Fig. 45), which is an estimate of the two parameters $v_i(m)$ and $v_q(m)$ in the transmitter (cf. Fig. 46).

The Gain Imbalance of a subcarrier m is a positive (i.e. the I path has a higher gain) or negative value and is ideally 0:

$$GainImbalance(m) = g(m) = \frac{v_i(m)}{v_q(m)} - 1$$

Formula 33

The Gain Imbalance of the whole slot is calculated as:

$$GainImbalance_{slot} = \sqrt{\frac{1}{M}\sum_{m=0}^{M-1} GainImbalance(m)^2}$$

Formula 34

$GainImbalance_{slot}$ is always positive, i.e. whether I or Q has more gain can not be distinguished anymore.
But values $GainImbalance(m) \neq 0$ can never result in an average value $GainImbalance_{slot} = 0$.

The „Min/Max/Avg/Current" - statistic for $GainImbalance_{slot}$ is done according to chapter "RMS averaging" on page 122.

All statistics of $GainImbalance_{slot}$ can be converted to unit 'percent:

$$GainImbalance_{slot,percent} = 100\% \cdot GainImbalance_{slot}$$

Formula 35

All statistics of $GainImbalance_{slot}$ can be converted to unit 'dB:

$$GainImbalance_{slot,dB} = -20 \cdot \log10\left(\frac{1 + \dfrac{GainImbalance_{slot}}{2}}{1 - \dfrac{GainImbalance_{slot}}{2}}\right)$$

Formula 36

Different statistics of $GainImbalance_{slot,percent}$ and $GainImbalance_{slot,dB}$ are shown as:

- The 2 rows called "Gain Imbalance" in the "Summary Table" measurement.
- SCPI: `FETC:BURS:SUMT:GIMB`.

IQ Offset

"IQ Offset" is also called "IQ Origin Offset" and relates to carrier leakage in the subcarriers.
The IQ Offset of a single subcarrier m is c(m) (cf. Fig. 45), which is an estimate of the two parameters $c_i(m)$ and $c_q(m)$ in the transmitter (cf. Fig. 46).

The IQ Offset of a subcarrier m is a positive value and ideally 0:

$$IqOffset(m) = \frac{\left| c_i(m) + j \cdot c_q(m) \right|^2}{C_{pow}}$$

<div align="right">Formula 37</div>

The IQ Offset of the whole slot is calculated as:

$$IqOffset_{slot} = \frac{1}{M} \sum_{m=0}^{M-1} IqOffset(m)$$

<div align="right">Formula 38</div>

The „Min/Max/Avg/Current" - statistic for $IqOffset_{slot}$ is done according to chapter "Arithmetic averaging" on page 123.

All statistics of $IqOffset_{slot}$ can be converted to unit "dB":

$$IqOffset_{slot,dB} = 10 \cdot log10\left(IqOffset_{slot}\right)$$

<div align="right">Formula 39</div>

Different statistics of $IqOffset_{slot,dB}$ are shown as:

- The row called "IQ Offset" in the "Summary Table" measurement.
- SCPI: `FETC:BURS:SUMT:IQOF`

Quadrature Error

The Quadrature Error of a subcarrier m is q(m) (cf. Fig. 45), which is an estimate of the quadrature error $\psi(m)$ in the transmitter (cf. [2]).

The Quadrature Error in rad of subcarrier m is a positive or negative number and ideally 0:
$$QuadraturError(m) = q(m)$$

<div align="right">Formula 40</div>

The Quadrature Error of the whole slot is calculated as:

$$QuadraturError_{slot} = \sqrt{\frac{1}{M} \sum_{m=0}^{M-1} QuadraturError(m)^2}$$

<div align="right">Formula 41</div>

$QuadraturError_{slot}$ is always positive, i.e. the sign of the error has gone. But values $QuadraturError(m) \neq 0$ can never result in an average value $QuadraturError_{slot} = 0$.

The „Min/Max/Avg/Current" - statistic for $QuadraturError_{slot}$ is done according to chapter "RMS averaging" on page 122.

All statistics of $QuadraturError_{slot}$ can be converted to unit 'degree':

$$QuadraturError_{slot,degree} = \frac{360^{\circ}}{2\pi} QuadraturError_{slot}$$

<div align="right">Formula 42</div>

Different statistics of $QuadraturError_{slot,degree}$ are shown as:

- The row called "Quadrature Error" in the "Summary Table" measurement.
- SCPI: `FETC:BURS:SUMT:QUAD`

Power of subcarriers

The power of a subcarrier (or a slot) is calculated using the signal $IQ_{meas}(m,k)$. But at the end of the signal processing in Fig. 45 $IQ_{meas}(m,k)$ was scaled in a way that it closely resembles the ideal reference signal $IQ_{Ref}(m,k)$, i.e. the sync and pilot symbols have a magnitude of about 1 Volt.

We use the factors p_m in the following calculations to compensate these scaling factors. Factor p_m only compensates the power losses and gains the signal processing blocks of Fig. 45 applied to a certain **single subcarrier** m:

- Initial amplitude and phase compensation in block A of Fig. 45

- Scaling compensation Δa_m in block F in of Fig. 45

- Mean power gain of pilot tracking (if activated) in block I in of Fig. 45

We also use p_{common}, which is an internally used factor to compensate the power losses and gains the signal processing applied to the the **whole IQ data** (cf. Fig. 44), i.e. it is common for all subcarriers:

- Scaling during capturing IQ data. Attenuators or pre-amplifier of the instrument are taken into account.

- The parameter "external attenuation" specified by the user is taken into account.

The mean power of a single subcarrier m is calculated at all measured symbol instants as:

$$CarrierPower(m) = \frac{p_{common} \cdot p_m}{R} \frac{1}{SN_{max}} \sum_{k=1}^{SN_{max}} |IQ_{meas}(m,k)|^2$$

Formula 43

R is the input impedance.

The „Min/Max/Avg/Current" - statistic for $CarrierPower(m)$ is done according to chapter "Arithmetic averaging" on page 123.

The value $CarrierPower(m)$ can be converted to unit 'dBm':

$$CarrierPower_{dbm}(m) = 10 \cdot log10\left(\frac{CarrierPower(m)}{1\,mW}\right)$$

Formula 44

Different statistics of $CarrierPower_{dbm}(m)$ are shown as:

- By SCPI only: FETCh:BURSt:SUMTable:SCMPower

The "Reference Power" of a single subcarrier m is calculated at all measured symbol instants of subcarrier m where sync or pilot symbols are:

$$CarrierRefPower(m) = \frac{p_{common} \cdot p_m}{R} \frac{1}{|Q_m|} \sum_{k \in Q_m} |IQ_{meas}(m,k)|^2$$

Formula 45

Q_m is a set of symbol indices: Where in the subcarrier m are sync symbols or pilot symbols $|Q_m|$ is the size of IDX_m. R is the input impedance.

The „Min/Max/Avg/Current" - statistic for $CarrierRefPower(m)$ is done according to chapter "Arithmetic averaging" on page 123.

All statistics of $CarrierRefPower(m)$ can be converted to unit 'dBm':

$$CarrierRefPower_{dbm}(m) = 10 \cdot log10\left(\frac{CarrierRefPower(m)}{1\,mW}\right)$$

Formula 46

Different statistics of $CarrierRefPower_{dbm}(m)$ are shown as:

- By SCPI only: FETCh:BURSt:SUMTable:SCRPower

Powers of a slot

The mean power of a slot is calculated as the mean of the measured power at all symbol instants.
We can use the already calculated mean powers of the subcarriers (Formula 43) and add them up:

$$BurstPower = \sum_{m=0}^{M-1} CarrierPower(m) \qquad \text{Formula 47}$$

The „Min/Max/Avg/Current" - statistic for $BurstPower$ is done according to chapter "Arithmetic averaging" on page 123.

All statistics of $BurstPower$ can be converted to unit 'dBm':

$$BurstPower_{dbm} = 10 \cdot log10 \left(\frac{BurstPower}{1\,mW} \right) \qquad \text{Formula 48}$$

Different statistics of $BurstPower_{dbm}$ are shown as:

- The row called "Burst Power" in the "Summary Table" measurement.
- SCPI: `FETC:BURS:SUMT:BPWR:`

The "Reference Power" of a slot is calculated as the mean measured power at all sync and pilot symbol instants.
We can use the already calculated mean "Reference Powers" of the subcarriers (Formula 45) and add them up using weighting:

$$ReferencePower = \frac{M}{K_{total}} \sum_{m=0}^{M-1} K_m \cdot CarrierRefPower(m) \qquad \text{Formula 49}$$

K_m is the number of sync or pilot symbols in subcarrier m. K_{total} is the number of sync or pilot symbols in the whole slot. M is the total number of subcarriers of the signal.

The „Min/Max/Avg/Current" - statistic for $ReferencePower$ is done according to chapter "Arithmetic averaging" on page 123.

All statistics of $ReferenceP\,ower$ can be converted to unit 'dBm':

$$ReferencePower_{dbm} = 10 \cdot log10 \left(\frac{ReferencePower}{1\,mW} \right) \qquad \text{Formula 50}$$

Different statistics of $ReferencePower_{dbm}$ are used or shown as:

- The result called "Reference Power" in the measurement "Power versus Time".
- The result called "Ref Pwr" in the measurement "ACP due to Transients".
- The result called "absolute Power of TX channel" in the measurement "ACP due to Modulation".
- SCPI: `FETC:BURS:PVTT:REFP`

Results of "Flatness Carriers" measurement

The total slot's Reference Power, $ReferenceP\,ower$, was calculated above using Formula 49.
Division by the number of subcarriers delivers the average subcarrier Reference Power, $AvgSCReferencePower$:

$$AvgSCReferencePower = \frac{1}{M} ReferencePower \qquad \text{Formula 51}$$

Note that this value is the same for all M subcarriers.

$CarrierRefPower(m)$, the Reference Power for each subcarrier was calculated above using Formula 45.
The Reference Power deviation for each subcarrier is:

$$SCRefPowerDeviation(m) = \frac{CarrierRefPower(m)}{AvgSCReferencePower} - 1 \qquad \text{Formula 52}$$

The Min/Max/Avg statistic of $SCRefPowerDeviation(m)$ is done according to chapter "Arithmetic averaging" on page 123. But the result that will be displayes as "StdDev" in unit "dB" is calculated as defined in Formula 81 in chapter RMS averaging, using the linear scale values.

All statistics of $SCRefPowerDeviation(m)$ can be converted to unit 'dB':

$$SCRefPowerDeviation_{dB}(m) = 10 \cdot log10\big(1 + SCRefPowerDeviation(m)\big) \qquad \text{Formula 53}$$

Different statistics of $SCRefPowerDeviation_{dB}(m)$ are used or shown as:

- The numeric result called "Ref Power Deviation" in the table of measurement "Flatness Carrier" and "Flatness Pilot".
- The traces of the measurement "Flatness Carrier".
- Some results of SCPI: FETCh:BURSt:SPECtrum:FLATness:ALL

For a detailed explanation of the summary table of measurement "Flatness Carriers" please refer to Table 4 on page 114.

Carrier	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Symbols
-4	S1	S9				P1				P5				P9	
-3	S2	S10													
-2	S3	S11				P2				P6				P10	
-1	S4	S12													
+1	S5	S13													
+2	S6	S14				P3				P7				P11	
+3	S7	S15													
+4	S8	S16				P4				P8				P12	

Fig. 49: Allocation of sync and pilot symbols for a Control Uplink Slot with 8 subcarriers

An Example:
Please refer to Fig. 49!

The total slot Reference Power $ReferencePower$ is the mean power of:
S1, S2, S3, S4, …. S16, P1, P2, P3, P4, …P11, P12.

The $AvgSCReferencePower$ is $ReferencePower$ divided by 8.

$CarrierRefPower(m)$, the Reference Power for each subcarrier, is for example for subcarrier -4 defined as the mean power of S1, S9, P1, P5, P9. For subcarrier -3 it is the mean power of S2 and S10.

Results of "Flatness Pilots" measurement

$CarrierRefPower(m)$, the Reference Power for each subcarrier was calculated above using Formula 45.

The pilot symbol powers are calculated at those symbol instants of subcarrier m where pilot symbols are:

$$PilotPower(m,k) = \frac{p_{common} \cdot p_m}{R} \left| IQ_{meas}(m,k) \right|^2 \quad \text{if (m,k) is a pilot symbols position} \qquad \text{Formula 54}$$

For $p_{common} \cdot p_m$ and R please refer to Formula 45.

The pilot symbol power deviation is calculated by comparing the power of each pilot symbol with the measured Reference Power of the corresponding subcarrier.

$$PilotPowerDeviation(m,k) = \frac{PilotPower(m,k)}{CarrierRefPower(m)} - 1 \quad \text{if (m,k) is a pilot position} \qquad \text{Formula 55}$$

The different statistics of the detailed per-symbol result $PilotPowerDeviation(m,k)$ are calculated this way: Min/max/avg done according to chapter "Arithmetic averaging" on page 123. But the result later displayed as "StdDev" in unit "dB" is calculated as defined in Formula 81 in chapter RMS averaging, using linear scale values.

All statistics of $PilotPowerDeviation(m,k)$ can be converted to unit 'dB':

$$PilotPowerDeviation_{dB}(m,k) = 10 \cdot log10\big(1 + PilotPowerDeviation(m,k)\big) \qquad \text{Formula 56}$$

Different statistics of $PilotPowerDeviation_{dB}(m,k)$ are used or shown as:

- The marker readings in the measurement "Flatness Pilot".

The detailed <u>per-symbol</u> result $PilotPowerDeviation(m,k)$ (a kind of sparse matrix) can be packed to 4 different kinds of <u>per-subcarrier</u> results, which are kind of sparse vectors:

The "Minimum" statistic for a subcarrier m is the minimum of the deviations at all pilot symbols in this subcarrier m of all measured slots.

$$PilotPowerDeviationSC_{min}(m) = \min(PilotPowerDeviation(m,k)) \text{ for all (m,k) being}$$
pilot positions
$$\qquad \text{Formula 57}$$

The "Maximum" statistic for a subcarrier m is the maximum of the deviations at all pilot symbols in this subcarrier m of all measured slots.

$$PilotPowerDeviationSC_{max}(m) = \max(PilotPowerDeviation(m,k)) \quad \text{for all (m,k)}$$
being pilot positions
$$\qquad \text{Formula 58}$$

The "Average" statistic for a subcarrier m is the arithmetic average of the deviations at all pilot symbols in this subcarrier m of all measured slots.

$$PilotPowerDeviationSC_{avg}(m) = \text{mean}(PilotPowerDeviation(m,k)) \quad \text{for all (m,k)}$$
being pilot positions
$$\qquad \text{Formula 59}$$

The "StdDev" statistic for a subcarrier m is the RMS value of the deviations at all pilot symbols in this subcarrier m of all measured slots.

$$PilotPowerDeviationSC_{StdDev}(m) = \sqrt{mean(PilotPowerDeviation(m,k)^2)} \quad \text{for all}$$

(m,k) being pilot positions

Formula 60

Note that all these per-subcarrier results are not defined for subcarriers m, which are not containing any pilot symbols at all.

All these per-subcarrier results can be converted to unit "dB" just like the corresponding per-symbol result $PilotPowerDeviation(m,k)$. Please refer to Formula 56.

These different per-subcarrier results are used or shown as:

- The results "Pilot Power Deviation" in the table of measurement "Flatness Pilot" or "Flatness Carrier".
- The traces in the measurement "Flatness Pilot".
- Some results of SCPI: FETCh:BURSt:SPECtrum:FLATness:ALL

An example:
Please refer to Fig. 49!

$CarrierRefPower(m)$, the Reference Power for each subcarrier, is for example for subcarrier -4 defined as the mean power of S1, S9, P1, P5, P9. For subcarrier -3 it is the mean power of S2 and S10.

The pilot symbol power deviation, $PilotPowerDeviation(m,k)$, is only defined where pilot symbols are. E.g. at (-4,6), (-2,6), (+2,6), (+4,6), (-4,10), etc.

For P1 at (-4,6) it is

$$PilotPowerDeviation(-4,6) = \frac{PilotPower(-4,6)}{CarrierRefPower(-4)} - 1$$

For P2 at (-2,6) it is

$$PilotPowerDeviation(-2,6) = \frac{PilotPower(-2,6)}{CarrierRefPower(-2)} - 1$$

Fig. 50 shows the summary table of measurements "Flatness Pilot" and "Flatness Carriers". All the contained results are explained in Table 4.

Flatness of SubCarrier Reference Powers and Pilot Symbol Powers						
	Min	Avg	StdDev	Max	Limit	Unit
Total Reference Power (Slot)	A	B	C	D	---	dBm
Avg Subcarrier Reference Power	E	F	G	H	---	dBm
Reference Power Deviation	I	J	K	L	M	dB
@ Carrier	N	---	---	O	---	---
Pilot Power Deviation	P	Q	R	S	T	dB
@ Carrier/symbol	U	---	---	V	---	---

Fig. 50: Summary table example of measurements "Flatness Pilot" and "Flatness Carriers"

Table 4: Description of the summary table of measurements "Flatness Pilot" and "Flatness Carriers"

Result	Description
A	Minimum of the Reference Powers (c.f. $ReferencePower_{dbm}$ in Formula 50) of all the slots measured so far.
B	Arithmetic average (calculated in Watts) of the Reference Powers (c.f. $ReferencePower_{dbm}$ in Formula 50) of all the slots measured so far.
C	Standard deviation (calculated in Watts) of the Reference Powers (c.f. $ReferencePower_{dbm}$ in Formula 50) of all the slots measured so far.
D	Maximum of the Reference Powers (c.f. $ReferencePower_{dbm}$ in Formula 50) of all the slots measured so far.
E	Result "A" divided by the number of subcarriers.
F	Result "F" divided by the number of subcarriers.
G	Result "G" divided by the number of subcarriers.
H	Result "H" divided by the number of subcarriers.
I	For each slot the result Reference Power Deviation is calculated for every subcarrier: Reference Power is measured for each subcarrier separately and compared to the slot's Average Subcarrier Reference Power, i.e. the slots Reference Power divided by the number of subcarriers. This result "I" is the minimum Subcarrier Reference Power Deviation measured so far.
J	Arithmetic average (linear scale calculation) of all the Subcarrier Reference Power Deviations measured so far. This result will always be zero because of the way it is defined respectively calculated.
K	Standard deviation (linear scale RMS calculation) of all the Subcarrier Reference Power Deviations measured so far..
L	Maximum Subcarrier Reference Power Deviation measured so far.
M	Results "I", "J", "K", "L" are checked against this limit. Check passes, if -1*limit < result < +1*limit.
N	Subcarrier in which result "I" was encountered
O	Subcarrier in which result "L" was encountered
P	Pilot Power Deviation is calculated for every pilot symbol in the slot: Compare the measured pilot symbol power against the measured Reference Power of the subcarrier the pilot symbol resides. Please refer to Formula 56. This result "P" is the minimum Pilot Power Deviation measured so far. Please refer to Formula 57
Q	Arithmetic average (linear scale calculation) of all Pilot Power Deviations measured so far. Please refer to Formula 59.
R	Standard deviation (linear scale RMS calculation) of all Pilot Power Deviations measured so far. Please refer to Formula 60.
S	Maximum Pilot Power Deviation measured so far. Please refer to Formula 58.
T	Results "P", "Q", "R", "S" are checked against this limit. Check passes, if -1*limit < result < +1*limit.
U	Subcarrier and symbol position in which result "P" was encountered
V	Subcarrier and symbol position in which result "S" was encountered

Results of ACP due to Transients

For the signal processing and the input signals please refer to Fig. 47.

The standard [1] tells that it is not sufficient for this measurement to measure only during the found slot, but some additional time before and after it. The parameter "measurement time" (in the "Demod Settings" dialog, page 82) tells the application to measure in the slot or subslot and additionally 6 symbol durations before and after it.

We define a signal corresponding to the power of the upper adjacent channel during this "measurement time".

$$AcpTransUpper(t) = \frac{p_{Acp}}{R} \cdot \left| ACP_{+1}(t) \right|^2 \qquad during\ the\ "measurement\ time" \qquad\qquad \text{Formula 61}$$

R is the input impedance.

$$AcpTransUpper(t)_{dBm} = 10 \cdot log10\left(\frac{AcpTransUpper(t)}{1\,mW} \right) \qquad\qquad \text{Formula 62}$$

Using $ReferencePower_{dbm}$ of Formula 50 we get the relative ACP power signal in unit "dB":

$$AcpTransUpper(t)_{dB} = AcpTransUpper(t)_{dBm} - ReferencePower_{dBm} \qquad\qquad \text{Formula 63}$$

Note that a signal showing the adjacent channel power during the immediate time around a certain single slot is related to the "Reference Power" that belongs to the **same** single slot.
Different statistics of $AcpTransUpper(t)_{dB}$ are shown as:

- Traces of measurement "ACP due to Transients Upper".
- SPCI: `CONF:BURS:SPEC:ACPR:TUPP:IMM` then fetch a trace

Cf. Formula 61 but now for the lower adjacent channel:

$$AcpTransLower(t) = p_{Acp} \cdot \left| ACP_{-1}(t) \right|^2 \qquad during\ the\ measurement\ time \qquad\qquad \text{Formula 64}$$

Converting to unit "dBm":

$$AcpTransLower(t)_{dBm} = 10 \cdot log10\left(\frac{AcpTransLower(t)}{1\,mW} \right) \qquad\qquad \text{Formula 65}$$

Using $ReferencePower_{dbm}$ of Formula 50 we get the relative ACP power signal in unit "dB":

$$AcpTransLower(t)_{dB} = AcpTransLower(t)_{dBm} - ReferencePower_{dBm} \qquad\qquad \text{Formula 66}$$

Note that a signal showing the absolute adjacent channel power during the immediate time around a certain slot is related to the Reference Power that belongs to the **same** slot.
Different statistics of $AcpTransLower(t)_{dB}$ are shown as:

- Traces of measurement "ACP due to Transients Lower".
- SPCI: CONF:BURS:SPEC:ACPR:TLOW:IMM then fetch a trace
Note: Averaging ACP results is done in linear scale, the result then converted back to unit dB.

In the above formulas p_{Acp} is an internally used correction factor to compensate for all power gains and losses applied to the input signals during data capturing and signal processing.

Channel		BW [kHz]	RRC	Offset [kHz]	Ref Pwr [dBm]	Maximum Power During Transient Measurement Time			
						Abs [dBm]	Rel [dB]	Limit [dB]	Delta to Limit [dB]
TX	Curr:	25.00	---	0.00	A	---	---	---	---
	Max:				B				---
Lower	Curr:	18.00	0.35	-25.00	---	C	G	K	M
	Max:					D	H		N
Upper	Curr:	18.00	0.35	25.00	---	E	I	L	O
	Max:					F	J		P

Fig. 51   Summary table of measurement "ACP due to Transients"

Note that in Fig. 51 all texts "Curr" will change to "Avg" if the parameter "ACP Display" in the Demod Settings dialog is switched from "ACP Curr" to "ACP Avg". The corresponding results will also change.

Table 5   Description of the summary table of the measurement "ACP due to Transients".

Result	Description
A	Depending on parameter "ACP Display" either the Reference Power (c.f. $ReferencePower_{dbm}$ in Formula 50) of the <u>last</u> found slot or the average of <u>all</u> slots found so far. This result is fetched from the demodulator.
B	The maximum value of all results $ReferencePower_{dbm}$ of <u>all</u> slots found so far
C	Depending on parameter "ACP Display" either the peak value of signal $AcpTransLower(t)_{dBm}$ of only the <u>last</u> found slot or the average of all the peak values measured in <u>all</u> slots found so far.
D	The peak value of all signals $AcpTransLower(t)_{dBm}$ of <u>all</u> slots found so far.
E	Depending on parameter "ACP Display" either the peak value of signal $AcpTransUpper(t)_{dBm}$ of only the <u>last</u> found slot or the average of all the peak values measured in <u>all</u> slots found so far.
F	The peak value of all signals $AcpTransUpper(t)_{dBm}$ of <u>all</u> slots found so far.
G	Depending on parameter "ACP Display" either the worst value measured in signal $AcpTransLower(t)_{dB}$ for the <u>last</u> found slot or the average of all those worst values of <u>all</u> slots found so far.
H	The worst value measured in all signals $AcpTransLower(t)_{dB}$ of <u>all</u> slots found so far. This result is considered to be the most important one for the lower adjacent channel.
I	Depending on parameter "ACP Display" either the worst value measured in signal $AcpTransUpper(t)_{dB}$ for the <u>last</u> found slot or the average of all those worst values of <u>all</u> slots found so far.
J	The worst value measured in all signals $AcpTransUpper(t)_{dB}$ of <u>all</u> slots found so far. This result is considered to be the most important one for the upper adjacent channel.
K	The limit for results "G" and "H".
L	The limit for results "I" and "J".
M	Margin for result "G": M = K – G, calculating in unit "dB". A positive value means "passed".
N	Margin for result "H": N = K – H, calculating in unit "dB". A positive value means "passed".
O	Margin for result "I": M = L – I, calculating in unit "dB". A positive value means "passed".
P	Margin for result "J": N = L – J, calculating in unit "dB". A positive value means "passed".

Note that the AVG results ("ACP Display" in the Demod Settings dialog must be switched on) of Fig. 51 (called C, G, E and I) will differ from the "average trace" (label "AV") in the lower half of the measurement "ACP due to Transients":
The numeric AVG results are calculated this way: For all measured slots search the worst value of its power-vs-time trace during the relevant time interval. Then average all those worst-case values (Watt). Note that those worst-case values can be at different positions.
The AVG-trace is calculated this way: Get the trace sample for a time t by averaging the powers (Watt) measured at that time t in all the slots found so far.

Results of ACP due to Modulation

For the signal processing please refer to Fig. 47.

The mean power in the ACP channel with index n during the useful part of the slot found in the TX channel (first symbol instant to last symbol instant) is:

$$AcpPower(n) = \frac{p_{Acp}}{R} \frac{1}{(SN_{max} - 1)} \int_{t=1 \cdot T}^{T \cdot SN_{max}} |ACP_n(t)|^2 dt \qquad \text{Formula 67}$$

Factor p_{Acp} is an internally used correction factor to compensate for all power gains and losses applied to the input signals during data capturing and signal processing.
R is the input impedance.

$AcpPower(n)$ can be converted to unit "dBm":

$$AcpPower(n)_{dBm} = 10 \cdot log10 \left(\frac{AcpPower(n)}{1\,mW} \right) \qquad \text{Formula 68}$$

$AcpPower(n)_{dBm}$ in each ACP channel is shown at these locations:

- The green bars (not the trace!) in the lower part of the measurement "ACP due to Modulation" show the maximum (i.e. worst) value measured. Exception: The bar in the TX channel corresponds to the maximum of the result $ReferencePower_{dbm}$ (cf. Formula 50).

- In the summary table (cf. Fig. 52), result A and B.

- SPCI: For example FETC:BURS:ACPM:CHAN0:ABSP:Max

Using $ReferencePower_{dbm}$ of Formula 50 we get the relative powers:

$$AcpPower(n)_{dB} = AcpPower(n)_{dBm} - ReferencePower_{dBm} \qquad \text{Formula 69}$$

Note that the mean power measured in the offset channels during the useful part of a certain single slot is related to the Reference Power that belongs to the **same** single slot.

Note: Averaging ACP results is done in linear scale, the result then converted back to unit dB.

Different statistics of $AcpPower(n)_{dB}$ in each ACP channel are shown as:

- result C and D in the summary table (cf. Fig. 52).
- SPCI: For example FETC:BURS:ACPM:CHAN3:RELP

ACP Due to Modulation Summary Table								
	-3	-2	-1	TX	+1	+2	+3	Unit
BW	18.00	18.00	18.00	25.00	18.00	18.00	18.00	kHz
RRC	0.35	0.35	0.35	---	0.35	0.35	0.35	
Offset	- 75.00	- 50.00	- 25.00	0.00	25.00	50.00	75.00	kHz
Average Power during Useful Part of Slots in Tx Channel								
Absolute Curr:	A	- 104.87	- 97.13	H	- 97.14	- 104.69	- 107.71	dBm
Max:	B	- 104.87	- 97.13	I	- 97.14	- 104.69	- 107.71	dBm
Relative Curr:	C	- 77.79	- 70.05	---	- 70.05	- 77.61	- 80.63	dB
Max:	D	- 77.79	- 70.05	---	- 70.05	- 77.61	- 80.63	dB
Limit	E	- 65.00	- 55.00	---	- 55.00	- 65.00	- 67.00	dB
Delta to Limit Curr:	F	12.79	15.05	---	15.05	12.61	13.63	dB
Max:	G	12.79	15.05	---	15.05	12.61	13.63	dB

Fig. 52:   Summary Table of measurement "ACP due to Modulation"

Note that in Fig. 52 all texts "Curr" will change to "Avg" if the parameter "ACP Display" in the Demod Settings dialog is switched from "ACP Curr" to "ACP Avg". The corresponding results will also change.

The results of Table 6 are explained in Table 6 for ACP channel -3. All other offset channels (not TX channel) conform to the same principle.

Table 6   Description of the "Summary Table" results of the measurement "ACP due to Modulation".

Result	Description
A	Depending on parameter "ACP Display" either the result $AcpPower(n)_{dBm}$ measured in this ACP channel during the useful part of the <u>last</u> found slot or the average of all these results measured in <u>all</u> slots found so far.
B	The maximum result $AcpPower(n)_{dBm}$ measured in this ACP channel during the useful part of <u>all</u> slots found so far.
C	Depending on parameter "ACP Display" either the result $AcpPower(n)_{dB}$ measured in this ACP channel during the useful part of only the <u>last</u> found slot or the average of <u>all</u> these results measured in <u>all</u> slots found so far.
D	The worst result $AcpPower(n)_{dB}$ measured in this ACP channel during the useful part of <u>all</u> slots found so far. This result is probably the most important one.
E	The limit for results "D" and "C".
F	Margin for result "D": F = E – C , calculating in unit "dB". A positive value means "passed".
G	Margin for result "G": G = E – D , calculating in unit "dB". A positive value means "passed".
H	Depending on parameter "ACP Display" either the Reference Power (c.f. $ReferencePower_{dbm}$ in Formula 50) of only the <u>last</u> found slot or the average of all these results measured in <u>all</u> slots found so far. These results are fetched from the demodulator
I	The maximum value of all results $ReferencePower_{dbm}$ of <u>all</u> slots found so far.

Results of Power versus Time

For the signal processing please refer to Fig. 48

Remark: This measurement does not make much sense for NDB slots. The standard [2] does not specify this case. Nevertheless the application allows measuring NDB slots.

Because the signal $IQ_{PVT}(t)$ uses a high oversampling rate relative to the symbol rate, it is considered quasi time-continuous in the following calculations although it is sampled of course.

There are several time periods or instants to calculate for this measurement.
One important parameter is called "Measurement Time" and can be seen in the "Demod Settings" dialog (cf. page 82). It makes sure that not only the burst itself but a few extra symbols before and after can be seen and measured in the PVT measurement, namely:
Measure in the duration of the slot or subslot and additionally 6 symbol durations before and after.
For the following calculations we therefore set in unit "symbol durations": $t_{meas} = 6$.

Time instant S1:
The first symbol instant of each found slot is equal to time t = 0 as you can see at the x axis of the lower part of measurement "Power versus Time".

Table 7   Definition of time "S1" in unit symbol durations.

	RAB	**NDB**	**NUB**	**CB**
S1	0	0	0	0

The time T1 determines the start of the slot or the subslot (depending on the set slot type). Calculation depends on the value t1 which is given in the standard [2]. Please refer to Table 8.
T1 is shown in the lower part of the measurement "Power versus Time" as a vertical line.
T1 also corresponds to the start of the green bar in lower part of the measurement "Power versus Time"

(except for NDB slots).

Table 8   Calculation of time "T1" in unit symbol durations.

	RAB	NDB	NUB	CB
t1	-2	0	-2	-2
T1=S1-t1	0-2 = -2	0-0 = 0	0-2 = -2	0-2 = -2

T_{start} is the time at the start of the PVT trace. The calculation of the power before the burst starts there. It depends on the used "measurement time". Please refer to Table 9.

Table 9   Calculation of time "T_{start}" in unit symbol durations.

	RAB	NDB	NUB	CB
T_{start} = T1- t_{meas}	-2-6 = -8	0-6 = -6	-2-6 = -8	-2-6 = -8

The time T3 defines where the calculation of the power after the burst starts. T3 depends on the number of symbols in the slot and on the value t3 that is given in the standard. Please refer to Table 10. T3 is shown in the lower part of the measurement "Power versus Time" as a vertical line (except for NDB slots).

Table 10   Calculation of time "T_3" in unit symbol durations.

	RAB	NDB	NUB	CB
t_3	2.5	0	2.5	2.5
SN_{max}	14	34	31	14
T_3=S1+SN_{max}-1+t_3	0+14-1+2.5 = 15.5	0+34-1+0.0 = 33.0	0+31-1+2.5=32.5	0+14-1+2.5=15.5

The time T_{end} specifies the time at the end of the PVT trace. The calculation of the power after the burst ends there. T_{end} depends on whether the slot uses a full or a subslot timeslot and the used "measurement time".

Table 11   Calculation of time "T_{end}" in unit symbol durations.

	RAB	NDB	NUB	CB
T_{Slot}	17	34	34	17
T_{end} = T1 + T_{slot} + t_{meas}	-2+17+6 = 21	0+34+6 = 40	-2+34+6 = 38	-2+17+6 = 21

The time $T_{slotend}$ specifies the time at the end of the slot or subslot. The calculation of the slot power ends there. $T_{slotend}$ depends on the sub or subslot length. Please refer to Table 12.
$T_{slotend}$ corresponds to the end of the green bar in lower part of the measurement "Power versus Time".

Table 12   Calculation of time "$T_{slotend}$" in unit symbol durations.

	RAB	NDB	NUB	CB
T_{Slot}	17	34	34	17
$T_{slotend}$ = T1 + T_{slot}	-2+17 = 15	0+34 = 34	-2+34 = 32	-2+17 = 15

Having calculated these time instants the actual PVT results can be calculated:

The signal for the lower part of the "Power versus Time" measurement must be cut correctly aligned to each found slot:

$$PVT(t) = \frac{p_{PVT}}{R} \left| IQ_{PVT}(t) \right|^2 \quad for \ t_{start} \le t \le t_{end}$$
Formula 70

Factor p_{PVT} is an internally used correction factor to compensate for all power gains and losses applied to the input signals during data capturing and signal processing.
R is the input impedance.
The „Min/Max/Avg/Current" - statistic for PVT_{before} is done according to chapter "Arithmetic averaging" on page 123.

All statistics of $PVT(t)$ can be converted to unit "dBm".

$$PVT_{dBm}(t) = 10 \cdot log10\left(\frac{PVT(t)}{1\,mW}\right)$$

Formula 71

Different statistics of $PVT_{dBm}(t)$ are shown as:

- The traces in the "Power versus Time" measurement.
- SCPI: `CONF:BURS PVT:IMM` then fetch some traces

The absolute mean power before the burst:
Measure from the start of the measurement time (T_{start}) until the time T_1:

$$PVT_{before} = \frac{p_{PVT}}{R} \frac{1}{T_1 - T_{start}} \int_{t=T_{start}}^{T_1} |IQ_{PVT}(t)|^2 dt$$

Formula 72

R is the input impedance.

The „Min/Max/Avg/Current" - statistic for PVT_{before} is done according to chapter "Arithmetic averaging" on page 123.

All statistics of PVT_{before} can be converted to unit "dBm":

$$PVT_{before,dBm} = 10 \cdot log10\left(\frac{PVT_{before}}{1\,mW}\right)$$

Formula 73

Different statistics of $PVT_{before,dBm}$ are shown as:

- Result "C" in the Summary Table of the PVT measurement, please refer to
- SCPI: FETC:BURS:PVTT:BEFB

The absolute mean power after the burst: Measure from the time T_3 until the end of the PVT trace (time T_{end}):

$$PVT_{after} = \frac{p_{PVT}}{R} \frac{1}{T_{end} - T_3} \int_{t=T_3}^{T_{end}} |IQ_{PVT}(t)|^2 dt$$

Formula 74

R is the input impedance.

The „Min/Max/Avg/Current" - statistic for PVT_{before} is done according to chapter "Arithmetic averaging" on page 123.

All statistics of PVT_{after} can be converted to unit "dBm":

$$PVT_{after,dBm} = 10 \cdot log10\left(\frac{PVT_{after}}{1\,mW}\right)$$

Formula 75

Different statistics of $PVT_{after,dBm}$ are shown as:

- Result "E" in the Summary Table of the PVT measurement, please refer to Fig. 53 .
- SCPI: `FETC:BURS:PVTT:AFTB`

The absolute mean power of the slot: Measure from the time T1 (slot or sub slot start)until the end of the slot or sub slot (time $T_{slotend}$):

$$PVT_{slot} = \frac{p_{PVT}}{R} \frac{1}{T_{slotend} - T1} \int_{t=T1}^{T_{slotend}} |IQ_{PVT}(t)|^2 dt$$

Formula 76

The „Min/Max/Avg/Current" - statistic for PVT_{before} is done according to chapter "Arithmetic averaging" on page 123.

All statistics of PVT_{slot} can be converted to unit "dBm":

$$PVT_{slot,dBm} = 10 \cdot log10\left(\frac{PVT_{slot}}{1\,mW}\right)$$ Formula 77

Different statistics of $PVT_{slot,dBm}$ are shown as:

- Result "B” in the Summary Table of the PVT measurement, please refer to Fig. 53.
- SCPI: FETC:BURS:PVTT:SLOT

Power vs Time Summary Table					
		Min	Curr	Avg	Max	Unit
Reference Power	A	5.26	5.92	5.69	5.93	dBm
Slot Power	B	4.83	5.61	5.35	5.62	dBm
Power before Burst	C	- 48.67	- 48.23	- 48.12	- 47.49	dBm
Relative to Ref Power	D	- 54.58	- 54.15	- 53.76	- 52.74	dB
Power after Burst	E	- 49.01	- 48.60	- 48.60	- 48.17	dBm
Relative to Ref Power	F	- 54.80	- 54.52	- 54.27	- 53.67	dB
Trigger to Sync	G	37.080 ms = 3.0 slots - 13.0 symbols				

Fig. 53   Summary Table of measurement "Power versus Time”

Table 13   Description of the "Summary Table” of the measurement "Power versus Time”.

Result	Description
A	This is the Reference Power (c.f. $ReferencePower_{dbm}$ in Formula 50) of a slot. This result is fetched from the demodulator. In contrast to result "B” this value is: Calculated by demodulation, i.e. more estimations and compensations done separately for each subcarrier. Calculated using only sync and pilot symbols. Calculated on a downsampled signal, oversampling 1.
B	$PVT_{slot,dBm}$, i.e. the mean power during the slot or subslot duration calculated by averaging the low pass filtered $IQ_{PVT}(t)$ signal.
C	$PVT_{before,dBm}$ of Formula 73, i.e. the mean power before the time T1.
D	D = C – A, using unit "dBm” which results in unit "dB”. I.e. the mean power before T1 (result "C”) measured for a certain slot is related to the Reference Power (result "A”) of the same slot.
E	$PVT_{after,dBm}$ of Formula 75, i.e. the mean power after the time T3.
F	F = E – A, using unit "dBm” which results in unit "dB”. I.e. the mean power after time T3 (result "E”) measured for a certain slot is related to the Reference Power (result "A”) of the same slot.
G	"Trigger to Sync” is the time from the event that triggered the start of the IQ data capturing to the first symbol instant "S1” of the first found slot in the current capture buffer. The result "Trigger to Sync” is most useful if an external trigger (please refer to parameter "Trigger Mode” on page 72) is used. No kind of min/max/average statistic is offered for the result "Trigger to Sync”. Be aware, that the trigger event time instant need not be equal to the time the first sample of the IQ data was captured at, namely if the parameter "Trigger Offset" (page 72) is not equal to zero. By choosing a negative parameter "Trigger Offset" the result "Trigger to Sync” can be zero or even negative. Please refer to Fig. 54 for an explanation how these parameters work: At the very start and the very end of the captured data there are short regions (shaded) where all slots are declined because of the internal signal processing needs. But a negative value "Trigger Offset" can take care that IQ data is captured even before the trigger event occurs. So the first symbol instant of the first found slot ("S1") appears very shortly after the trigger event in this example.
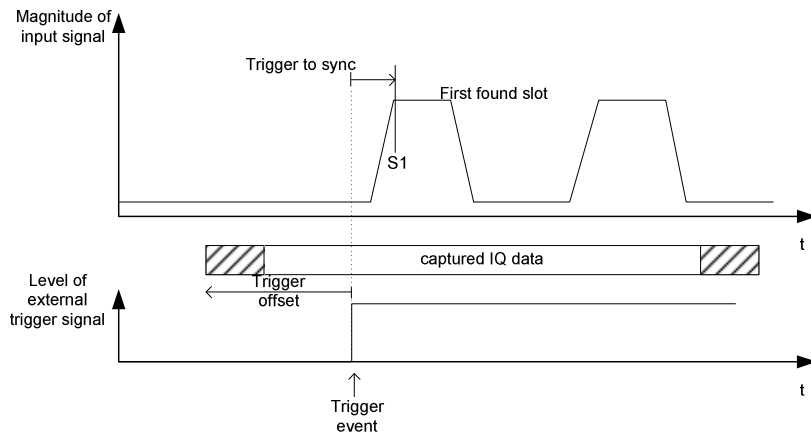
Fig. 54   Example for a negative "Trigger Offset" and a small positive "Trigger to Sync"

Calculating result statistics

Definitions / Requirements:

- The signal processing delivers many results (scalars or traces) named x(1), x(2), …. x(N) which are all of the same type.

- Each result may belong to a different slot or a different subcarrier or a different symbol, etc.

- The index 1,2, … N of the results distinguishes between the slots or subcarriers or symbols etc the result belongs to.

- At the start of the measurement we reset the statistic, then we count the single results with s = 1,2,3,4…

- x(s) is the placeholder for any single result. It does not matter here if x(s) itself was calculated by averaging other results.

Statement of the problem:
We want to calculate a statistic for an ensemble of results, i.e.

- a "maximum" of all of them

- a "minimum" of all of them

- an "average" or "mean" of all of them

- a "current" value of all of them.

The following chapters show which ways the application can use to calculate the "Min/Max/Avg/Current" – statistic for all values x(1), x(2), … x(N) if N is the total number of single results at the moment.

RMS averaging

"Current" statistic of an ensemble of N single results:

$$CurrentStatistic\,(x,N) = |x(N)|$$ Formula 78

In words: Take the magnitude of the last (current) result.

"Maximum" statistic of an ensemble of N single result:

$$MaximumStatistic\,(x,N) = max(\ |x(1)|, |x(2)|, \ ..., |x(N)|\ )$$ Formula 79

In words: Take the result with maximum magnitude.

"Minimum" statistic of an ensemble of N single result:

$$MinimumStatistic\,(x, N) = min(\ \big|x(1)\big|,\big| x(2)\big|,\ ...,\big| x(N)\big|\ )$$

Formula 80

In words: Take the result with minimum magnitude.

"Average" statistic of an ensemble of N single result:

$$AverageStatistic\,(x, N) = \sqrt{\frac{1}{N}\sum_{s=1}^{N}\big|x(s)\big|^2}$$

Formula 81

In words: Calculate the square root of the mean of the squared results.

Example:
For these results:
    x = 1, -4, 5, 8;
    N = 4;
The statistic would be:

- Min: abs(1) = 1

- Max: 8

- Avg: sqrt(1+16+25+64) = 10.29

- Curr: x(4) = 8

Arithmetic averaging

"Current" statistic of an ensemble of N single result:

$$CurrentStatistic\,(x, N) = x(N)$$

Formula 82

In words: Take the last (current) result.

"Maximum" statistic of an ensemble of N single result:

$$MaximumStatistic\,(x, N) = max(\ x(1), x(2),\ ..., x(N)\ )$$

Formula 83

In words: Take the largest result.

"Minimum" statistic of an ensemble of N single result:

$$MinimumStatistic\,(x, N) = min(\ x(1), x(2),\ ..., x(N)\ )$$

Formula 84

In words: Take the smallest result.

"Average" statistic of an ensemble of N single result:

$$AverageStatistic\,(x, N) = \frac{1}{N}\sum_{s=1}^{N}x(s)$$

Formula 85

In words: Calculate the arithmetic mean.

Example:
For these results:
    x = 1, -4, 5, 8;
    N = 4;
The statistic would be:

- Min: -4

- Max: 8

- Avg: (1 – 4 + 5 +8)/4 = 2.5

- Curr: x(4) = 8

MagMagnitude / MinMagnitude statistic

"Current" statistic of an ensemble of N single result:

$$CurrentStatistic\,(x,N) = x(N) \qquad\qquad \text{Formula 86}$$

In words: Take the last (current) result.

"Maximum" statistic of an ensemble of N single result:

$$MaximumStatistic\,(x,N) = x(s_{maxabs}) \quad with \left| x(s_{maxabs}) \right| = \max_s \left| x(s) \right| \qquad \text{Formula 87}$$

In words: Take the result with the maximum magnitude, but keep it's original sign. This is the result furthest from zero.

"Minimum" statistic of an ensemble of N single result:

$$MinimumStatistic\,(x,N) = x(s_{minabs}) \quad with \left| x(s_{minabs}) \right| = \min_s \left| x(s) \right| \qquad \text{Formula 88}$$

In words: Take the result with the minimum magnitude, but keep it's original sign. This is the result nearest to zero.

"Average" statistic of an ensemble of N single result:

$$AverageStatistic\,(x,N) = \frac{1}{N} \sum_{s=1}^{N} x(s) \qquad\qquad \text{Formula 89}$$

In words: Calculate the arithmetic mean.

Example:
For these results:
   x = 1, -12, 5, 8;
   N = 4;
The statistic would be:

- Min: -1
- Max: -12   ← !!!
- Avg: (1 – 12 + 5 +8)/4 = 0.5
- Curr: x(4) = 8

Literature

[1]. ETSI EN 300 394-1 V3.1.0, "Terrestrial Trunked Radio (TETRA); Conformance testing specification; Part 1: Radio."

[2]. ETSI EN 300 392-2 V3.2.1, "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)."

4 Remote Control

Description of commands

This section specifies all the remote control commands specific to the R&S FS-K110 option. Only those commands provided for this option are specified. For details of remote control commands provided by the host analyzer please refer to the analyzer user manual.

Notation

In the following sections, all commands implemented in the instrument are first listed in tables and then described in detail, arranged according to the command subsystems. The notation is adapted to the SCPI standard. The SCPI conformity information is included in the individual description of the commands.

Table of Commands

Command:	In the command column, the table provides an overview of the commands and their hierarchical arrangement (see indentations).
Parameter:	The parameter column indicates the requested parameters together with their specified range.
Unit:	The unit column indicates the basic unit of the physical parameters.
Comment:	In the comment column an indication is made on:
	− whether the command does not have a query form,
	− whether the command has only one query form
	− whether the command is implemented only with a certain option of the instrument
Indentations	The different levels of the SCPI command hierarchy are represented in the table by means of indentations to the right. The lower the level, the further the indentation to the right. Please note that the complete notation of the command always includes the higher levels as well.
	Example: `SENSe:FREQuency:CENTer` is represented in the table as follows:

```
SENSe                   first level
   :FREQuency           second level
      :CENTer           third level
```

Individual description	The individual description contains the complete notation of the command. An example for each command, the *RST value and the SCPI information are included as well.
Upper/lower case notation	Upper/lower case letters are used to mark the long or short form of the key words of a command in the description (see Section 3.5.2). The instrument itself does not distinguish between upper and lower case letters.
Special characters	A selection of key words with an identical effect exists for several commands. These keywords are indicated in the same line; they are separated by a vertical stroke. Only one of these keywords needs to be included in the header of the command. The effect of the command is independent of which of the keywords is used.
	Example: `SENSe:FREQuency:CW|:FIXed`

The two following commands with identical meaning can be created. They set the frequency of the fixed frequency signal to 1kHz:

`SENSe:FREQuency:CW 1E3 = SENSe:FREQuency:FIXed 1E3`

A vertical stroke in parameter indications marks alternative possibilities in the sense of "or". The effect of the command is different, depending on which parameter is used.

Example: Selection of the parameters for the command

`DISPlay:FORMat FULL | SPLit`

If parameter FULL is selected, full screen is displayed, in the case of SPLit, split screen is displayed.

[ ]	Key words in square brackets can be omitted when composing the header (cf. Section 3.5.2, Optional Keywords). The full command length must be accepted by the instrument for reasons of compatibility with the SCPI standards. Parameters in square brackets can be incorporated optionally in the command or omitted as well.
{ }	Parameters in braces can be incorporated optionally in the command, either not at all, once or several times.
Description of parameters	Due to the standardisation, the parameter section of SCPI commands consists always of the same syntactical elements. SCPI has therefore specified a series of definitions, which are used in the tables of commands. In the tables, these established definitions are indicated in angled brackets (<...>) and will be briefly explained in the following (see also Section 3.5.5, "Parameters").
<Boolean>	This keyword refers to parameters which can adopt two states, "on" and "off". The "off" state may either be indicated by the keyword OFF or by the numeric value 0, the "on" state is indicated by ON or any numeric value other than zero. Parameter queries are always returned the numeric value 0 or 1.
<numeric value>	
<num>	These keywords mark parameters which may be entered as numeric values or are set using specific keywords (character data).The following keywords given below are permitted:

MINimum	This keyword sets the parameter to the smallest possible value.
MAXimum	This keyword sets the parameter to the largest possible value.
DEFault	This keyword is used to reset the parameter to its default value.
UP	This keyword increments the parameter value.
DOWN	This keyword decrements the parameter value. The numeric values associated to MAXimum/ MINimum/DEFault can be queried by adding the corresponding keywords to the command. They must be entered following the quotation mark.

Example: `SENSe:FREQuency:CENTer? MAXimum`

returns the maximum possible numeric value of the center frequency as result.

<arbitrary block program data>This keyword is provided for commands the parameters of which consist of a binary data block.

ABORt Subsystem

The ABORt subsystem provide a mechanism by which running measurements can be aborted.

COMMAND	PARAMETERS	UNIT	COMMENT
:ABORt			no query

ABORt

Causes the current measurement being performed to be aborted.

Example:	**"**ABOR"	The R&S FS-K110 option will attempt to abort the current active measurement.

Characteristics:	*RST value:	-
	SCPI:	conforming

CALCulate: Subsystem

CALCulate:BURSt Subsystem

The CALCulate:BURSt subsystem performs a recalculation of the current IQ data based on the current settings. Use this command when it is desired to reprocess the existing IQ data with new settings. An example of when to use CALC:BURS would be if you are attempting to identify a burst type with the same acquisition data while trying different slot types or modulation. Function similar to that of hotkey "REFRESH".

COMMAND	PARAMETERS	UNIT	COMMENT

:CALCulate<1|2>
    :BURSt
        [:IMMediate]			

CALCulate:BURSt[:IMMediate]

> This command causes the measurement results to be recalculated using the current settings and acquisition data. *OPC? may follow this command to block until update is completed. The command will return an error if the measurement is busy or if there is no acquisition data available.

Example: `"CALC:BURS"`   Forces an update of the results
                    `"CALC:BURS"`   Forces an update of the results

                    `"*OPC?"`   Blocks further SCPI commands until measurement is completed.

Characteristics: *RST value: -
                    SCPI: device-specific

CALCulate:MARKer Subsystem

The CALCulate:MARKer subsystem controls the marker functions in the R&S FS-K110 option. CALCulate selections are mapped to screens as follows:

CALCulate 1: Screen A
CALCulate 2: Screen B

The R&S FS-K110 option supports one marker for screen A and one for screen B. Both markers may be independently switched on or off. The following table holds the R&S FS-K110 marker commands.

COMMAND	PARAMETERS	UNIT	COMMENT
:CALCulate<1|2>			
:MARKer<1>			
MAX			
MIN			
[:STATe]	<Boolean>		
:TRACe	<numeric_value>		
:XCARrier	<numeric_value>		
:XFRequency	<numeric_value>	HZ	
:XSYMbol	<numeric_value>		
:XTIMe	<numeric_value>	S	
:YRESult?			Units based on measurement

CALCulate<1|2>:MARKer<1>:MAX

This command sets the selected marker to the maximum peak value in the current trace. This command is valid for all measurements except: Bitstream, CCDF (currently not yet available), Constellation versus Carrier and Constellation versus Symbol.

Example: `"CALC2:MARK:MAX"` Sets marker 1 in screen B to the maximum value of the trace it is on.

Characteristics: *RST value: -
                SCPI: device-specific

CALCulate<1|2>:MARKer<1>:MIN

This command sets the selected marker to the minimum peak value in the current trace. This command is valid for all measurements except: Bitstream, CCDF (currently not yet available), Constellation versus Carrier and Constellation versus Symbol.

Example: `"CALC1:MARK:MIN"` Sets marker 1 in screen A to the minimum value of the trace it is on.

Characteristics: *RST value: -
                SCPI: device-specific

CALCulate<1|2>:MARKer<1>:STATe

This command switches the specified markers on or off. This command is valid for all measurements except: Bitstream, CCDF (currently not yet available), Constellation versus Carrier and Constellation versus Symbol.

Example: `"CALC1:MARK1:STATE ON"` Switches the screen A marker ON.

                       `"CALC2:MARK1:STATE OFF"` Switches the screen B marker OFF.

Characteristics: *RST value: 0
                SCPI: device-specific

CALCulate<1|2>:MARKer<1>:TRACe <numeric value>

This command assigns the selected marker to the indicated measurement trace in the selected measurement window. This command is valid for all measurements except Capture Memory and ACP due to Modulation which have only 1 trace. Spectrum FFT supports 2 traces: "current" and "average". Please refer to Fig. 55 for TRACe parameter to screen trace mapping.

Fig. 55   Trace Parameter to Screen Trace Mapping (NA: Not Available).

TRACe Numeric Parameter	Measurements with 4 Traces	ACP Trans	Spectrum FFT
1	Current	Current	Current
2	Minimum	NA	NA
3	Peak	Peak	NA
4	Average	NA	Average

Example: "`CALC2:MARK:TRAC 2`" Assigns marker 1 in screen B to trace 2.

Characteristics: *RST value: 1
                        SCPI: device-specific

Fig. 56 identifies which CALC:MARKer X positioning commands to use for a given measurement:

Fig. 56   Valid Marker X Positioning Commands, * Currently not yet available.

Measurement	SCPI Marker X position Command
Constellation vs. Carrier* Note: Both SCPI commands applicable.	CALCulate<1|2>:MARKer<1>:XCARrier CALCulate<1|2>:MARKer<1>:XSYMbol (Currently not yet **available**)
Constellation vs. Symbol*	CALCulate<1|2>:MARKer<1>:XSYMbol
EVM vs. Carrier	CALCulate<1|2>:MARKer<1>:XCARrier
EVM vs. Symbol	CALCulate<1|2>:MARKer<1>:XSYMbol
Magnitude Error vs. Symbol	CALCulate<1|2>:MARKer<1>:XSYMbol
Phase Error vs. Symbol	CALCulate<1|2>:MARKer<1>:XSYMbol
Power vs. Time	CALCulate<1|2>:MARKer<1>:XSYMbol
Spectrum FFT	CALCulate<1|2>:MARKer<1>:XFRequency
ACP due to Modulation	CALCulate<1|2>:MARKer<1>:XFRequency
ACP due to Transients	CALCulate<1|2>:MARKer<1>:XSYMbol
CCDF*	CALCulate<1|2>:MARKer<1>:XSYMbol
Capture Memory	CALCulate<1|2>:MARKer<1>:XTIMe

Marker X positioning commands

The following commands are used to position the active marker in the X direction:
- CALCulate<1|2>:MARKer<1>:XCAR
- CALCulate<1|2>:MARKer<1>:XFRE
- CALCulate<1|2>:MARKer<1>:XSYM
- CALCulate<1|2>:MARKer<1>:XTIM

CALCulate<1|2>:MARKer<1>:XCARrier

This command positions the selected marker to the indicated carrier x position or fetches the carrier x position. Note that for the Constellation vs. Carrier measurement, both XCAR and XSYM may be specified. When to use this command may be found in Fig. 56. The marker must be on to use this command.

Examples: "`CALC2:MARK:XCAR -7`" Positions marker 1 in screen B to carrier.
                      "`CALC2:MARK:XCAR?`"   Returns the current carrier x position of marker 1 in screen B.

Characteristics: *RST value: -
                        SCPI: device-specific

CALCulate<1|2>:MARKer<1>:XFRequency

This command positions the selected marker to the indicated frequency x position or fetches the frequency x position. When to use this command may be found in Fig. 56. The marker must be on to use this command.

Examples: `"CALC2:MARK:XFR 1GHZ"`   Positions marker 1 in screen B to 1 GHz.
                `"CALC2:MARK:XFR?"`   Returns the current frequency value of marker 1 in screen B in Hz.

Characteristics: *RST value: -
                      SCPI: device-specific

CALCulate<1|2>:MARKer<1>:XSYMbol

This command positions the selected marker to the indicated symbol x position or fetches the symbol x position. Note that for the Constellation vs. Carrier measurement, both XCAR and XSYM may be specified. When to use this command may be found in Fig. 56. The marker must be on to use this command.

Example: `"CALC2:MARK:XSYM 2"`   Positions marker 1 in screen B to symbol 2.
               `"CALC2:MARK:XSYM?"`   Returns the current time value of marker 1 in screen B.

Characteristics: *RST value: -
                      SCPI: device-specific

CALCulate<1|2>:MARKer<1>:XTIMe

This command positions the selected marker to the indicated time x position or fetches the time x position. Note that this command is valid only for the Capture Memory measurement which only appears in screen A. The marker must be on to use this command.

Example: `"CALC1:MARK:XTIM 0.05"`   Positions marker 1 in screen A to x position of 50ms.

               `"CALC1:MARK:XTIM?"`   Returns the current symbol value of marker 1 in screen A in seconds.

Characteristics: *RST value: -
                      SCPI: device-specific

CALCulate<1|2>:MARKer<1>:YRESult?

This command returns the selected marker's Y result for its current location. The units returned depend on the current active measurement and the marker's associated trace.

Example: `"CONF:BURS:CONS:CCAR"`   Select Constellation vs. Carrier measurement.
               `"CALC2:MARK:XCAR 1"`   Select carrier 1, screen B
               `"CALC2:MARK:XSYM 12"`   Select symbol 12, screen B
               `"CALC2:MARK:TRACE 1"`   Assign marker to I component (Trace 1), screen B
               `"CALC2:MARK:YRES?"`   Returns the Y-axis result (I-component) for the current carrier and symbol.
               `"CALC2:MARK:TRACE 2"`   Assign marker to Q component (Trace 2), screen B
               `"CALC2:MARK:YRES?"`   Returns the Y-axis result (Q-component) for the current carrier and symbol.

Characteristics: *RST value: -
                      SCPI: device-specific

CALCulate:LIMit Subsystem

The CALCulate:LIMit subsystem consists of the measurement limit values and their corresponding limit checks. The limits are associated with specific measurement results.
The following table deals with limits you can set for most of the results of the Measurement Results Summary Table (`CONFigure:BURSt:SUMTable`) The units for the following group of EVM limits commands have to be specified first with the UNIT:EVM command. This means choose the units for EVM to be percent, then set the limit value of 3. Otherwise the limit would have been 3 dB.

COMMAND	PARAMETERS	UNIT	COMMENT
:CALCulate<1|2>			
: LIMIt			
:BURSt			
:ACPMod			
:CHAN<{0..6}>			
:RELPower			
:BANDwidth<{0..3}>	<numeric_value>	DB	
[:CURRent]			
:RESult?			
:MAXimum			
:RESult?			
:ACPTrans			
:CHAN<{0..6}>			
:RELPower			
:BANDwidth <{0..3}>	<numeric_value>	DB	
[:CURRent]			
:RESult?			
:MAXimum			
:RESult?			
:ALL	<numeric_value>…		Returns all limits
:RESult?			Returns all limit results
:EVM			EVM All symbols
:ALL			Set units with UNIT:EVM first
[:AVERage]	<numeric_value>		
:RESult?			Set units with UNIT:EVM first
:MAXimum	<numeric_value>		
:RESult?			EVM Data Symbols only
:DATA			Set units with UNIT:EVM first
[:AVERage]	<numeric_value>		
:RESult?			Set units with UNIT:EVM first
:MAXimum	<numeric_value>		
:RESult?			EVM Data+Header Symbols
:DHEAder			Set units with UNIT:EVM first
[:AVERage]	<numeric_value>		
:RESult?			Set units with UNIT:EVM first
:MAXimum	<numeric_value>		
:RESult?			EVM Data+Sync+Pilot Symbols
:DSPilot			Set units with UNIT:EVM first
[:AVERage]	<numeric_value>		
:RESult?			Set units with UNIT:EVM first
:MAXimum	<numeric_value>		
:RESult?			EVM Sync+Pilot Symbols
:SPILot			Set units with UNIT:EVM first
[:AVERage]	<numeric_value>		
:RESult?			Set units with UNIT:EVM first
:MAXimum	<numeric_value>		
:RESult?			

COMMAND	PARAMETERS	UNIT	COMMENT
:CALCulate<1|2>			
: LIMIt			
:BURSt			
SPECtrum:			
:FLATness			
:DEVCarrier	<numeric_value>	DB	
[:AVERage]			
:RESult?			
:MAXimum			
:RESult?			
:RMS			
:RESult?			
:MINimum			
:RESult?			
: DEVPilot	<numeric_value>	DB	
[:AVERage]			
:RESult?			
:MAXimum			
:RESult?			
:RMS			
:RESult?			
:MINimum			
:RESult?			
:FERRor		HZ	
[:AVERage]	<numeric_value>		
:RESult?		HZ	
:MAXimum	<numeric_value>		
:RESult?			
:IQOFfset		DB	
[:AVERage]	<numeric_value>		
:RESult?		DB	
:MAXimum	<numeric_value>		
:RESult?			
:MAGError		DB	
[:AVERage]	<numeric_value>		
:RESult?		DB	
:MAXimum	<numeric_value>		
:RESult?			
:PHASerror		DEG	
[:AVERage]	<numeric_value>		
:RESult?		DEG	
:MAXimum	<numeric_value>		
:RESult?			

The following tables apply to the ACP due to Modulation measurement limit channel selection. For the ACP due to Modulation measurement six limit channels are available. After a preset the application uses the limits defined in the standard. You can change these limits as desired. The SCPI channel numbers CHAN<0…6> correspond to the following relative channel limits that are displayed on the measurement's display.

CHANnel Number	ACP due to Modulation Relative Channel Number
0	-3
1	-2
2	-1
3	Transmit channel -Not available
4	+1
5	+2

6	+3

The applications stores separate limit sets for the analysis of signals with 25 KHz, 50 KHz, 100 KHz and 150 KHz. So you have to specify the bandwidth you want to set limits for by using the following table. While measuring, the application will automatically use the limits for the signal bandwidth chosen by "[SENSe:]DEMod:FORMat:BANalyze:BANDwidth".

BANDwidth Number	Channel Bandwidth
0	25 KHz – 8 sub carriers
1	50 KHz – 16 sub carriers
2	100 KHz– 32 sub carriers
3	150 KHz– 48 sub carriers

CALCulate:LIMit:BURSt:ACPMod:CHAN<0…6>:RELPower:BANDwidth<0…3>

This command sets the limits for relative powers in the ACP due to Modulation measurement for the specified channel and the specified channel bandwidth, regardless of the current active channel bandwidth. Unit is "dB". See [SENSe:]DEMod:FORMat:BANalyze:BANDwidth.

Examples: "CALC:LIM:BURS:ACPM:CHAN4:RELP:BAND1 -20"
Assigns relative channel +1 a relative power limit of -20dB for the ACP due to Modulation measurement. This limit takes effect if the channel bandwidth is set to 50 KHz.

Characteristics: *RST value: -Standard Limits.
SCPI: device-specific

CALCulate:LIMit:BURSt:ACPMod:CHAN<0…6>:RELPower[:CURRent]:RESult?
CALCulate:LIMit:BURSt:ACPMod:CHAN<0…6>:RELPower:MAXimum:RESult?

This command returns the ACP due to Modulation relative power limit check result (0 = Passed, 1 = Failed). Note that the result value corresponds to the current active channel bandwidth limit. "CURRent" refers the result for the last found slot. "MAXimum" refers the worst measured ACP due to Modulation power ratio.

Examples: "CALC:LIM:BURS:ACPM:CHAN4:RELP:RES?"
Limit check result for relative power ratio of the ACP due to Modulation measurement for offset channel +1 is returned.

"CALC:LIM:BURS:ACPM:CHAN4:RELP:MAX:RES?"
Relative power maximum limit result for the ACP Modulation measurement is returned.

Characteristics: *RST value: 0
SCPI: device-specific

Fig. 57 applies to the ACP due to Transients measurement limit channel selection. For the ACP Transient measurement six limits are available. After a preset the application uses the limits defined in the standard. You can change these limits as desired. The SCPI channel numbers CHAN<0…6> correspond to the following relative channel limits that are displayed on the measurement display.

Fig. 57   ACP due to Transient Channels

Channel Number	ACP Transient Relative Channel Number
0	Reserved – not available
1	Reserved – not available
2	-1 (Lower)
3	Transmit channel - not available
4	1 (Upper)
5	Reserved – not available

6	Reserved – not available

The applications stores separate limit sets for the analysis of signals with 25 KHz, 50 KHz, 100 KHz and 150 KHz. So you have to specify the bandwidth you want to set limits for by using the following table. While measuring the application will automatically use the limits for the signal bandwidth chosen by "[SENSe:]DEMod:FORMat:BANalyze:BANDwidth".

Fig. 58   BANDwidth to Channel Bandwidth

BANDwidth Number	Channel Bandwidth
0	25 KHz – 8 sub carriers
1	50 KHz – 16 sub carriers
2	100 KHz– 32 sub carriers
3	150 KHz– 48 sub carriers

CALCulate:LIMit:BURSt:ACPTrans:CHAN<0…6>:RELPower:BANDwidth<0…3>

This command sets the ACP Due to Transients relative power limit for the specified offset channel and channel bandwidth in "dB". The limit for any valid channel bandwidth may be set regardless of the current active channel bandwidth.
See [SENSe:]DEMod:FORMat:BANalyze:BANDwidth.

Examples: "CALC:LIM:BURS:ACPT:CHAN2:RELP:BAND2 -30"
Assigns channel -1 a relative power limit of -30 dB for the ACP due to Transients measurement. The limit has an effect if the channel bandwidth is set to 100 KHz.

Characteristics: *RST value: Standard Limits
                        SCPI: device-specific

CALCulate:LIMit:BURSt:ACPTrans:CHAN<0…6>:RELPower[:CURRent]:RESult?
CALCulate:LIMit:BURSt:ACPTrans:CHAN<0…6>:RELPower:MAXimum:RESult?

This command returns the ACP due to Transients measurement's relative power limit check result (0 = Passed, 1 = Failed). The result value corresponds to the current active channel bandwidth limit.
"CURRent" returns the result for the last found slot.
"MAXimum" returns the worst measured ACP due to Modulation power ratio.

Examples: "CALC:LIM:BURS:ACPT:CHAN4:RELP:RES?"
Limit check result for the relative power ratio of the ACP due to Transients' measurement for the +1 channel for the last found slot is returned.

                      "CALC:LIM:BURS:ACPT:CHAN4:RELP:MAX:RES?"
Limit check result for the worst measured relative power ratio of the maximum limit result for the ACP due to Transients measurement channel +1 is returned.

Characteristics: *RST value: Standard Limits
                        SCPI: device-specific

CALCulate:LIMit:BURSt:ALL

This command sets or returns all the limit values as a group. The results are input or output as a list of comma separated ASCII strings. The results for the EVM limit values are dependent on EVM units (dB or Percent). The EVM units are specified with the UNIT:EVM command. The results are returned in the following order and format:

<average EVM All Result>,<max EVM All Limit >,
<average EVM Data+Sync+Pilot Result>,<max EVM Data+Sync+Pilot Result >,

<average EVM Data+Header Result>,<max EVM Data+Header Result >,
<average EVM Data Result>,<max EVM Data Result >,
<average EVM Sync+Pilot Result>,<max EVM Sync+Pilot Result >,
<average IQ Offset Result>,<max IQ Offset Result >,
<average Frequency Error Result>,<max Frequency Error Result >,
<average Phase Error Result>,<max Phase Error Result >
<average Magnitude Error Result>,<max Magnitude Error Result >

| **Example**: | `"UNIT:EVM PCT"` | EVM Percent Limits are selected to be returned. |
| | `"CALC:LIM:BURS:ALL?"` | All current summary table limits are returned in the specified comma separated ASCII format. |

| **Characteristics**: | *RST value: - |
| | SCPI: | device-specific |

CALCulate:LIMit:BURSt:ALL:RESult?

This command returns all the limit check results as a group. The results are returned as a list of 18 comma separated ASCII strings where "0" corresponds to passed (limit not exceeded) and "1" corresponds to failed (limit exceeded). The results for the EVM limit result values are dependent on EVM units (dB or percent). The EVM units are specified with the UNIT:EVM command. The results are returned in the following order:

<average EVM All Result>,<max EVM All Limit >,
<average EVM Data+Sync+Pilot Result>,<max EVM Data+Sync+Pilot Result >,
<average EVM Data+Header Result>,<max EVM Data+Header Result >,
<average EVM Data Result>,<max EVM Data Result >,
<average EVM Sync+Pilot Result>,<max EVM Sync+Pilot Result >,
<average IQ Offset Result>,<max IQ Offset Result >,
<average Frequency Error Result>,<max Frequency Error Result >,
<average Phase Error Result>,<max Phase Error Result >
<average Magnitude Error Result>,<max Magnitude Error Result >

| **Example**: | `"UNIT:EVM DB"` | EVM dB Limit Results are selected to be returned. |
| | `"CALC:LIM:BURS:ALL:RES?"` | All current summary table results are returned in the specified comma separated ASCII format. |

| **Characteristics**: | *RST value: - |
| | SCPI: | device-specific |

CALCulate:LIMit:BURSt:EVM:ALL[:AVERage]
CALCulate:LIMit:BURSt:EVM:ALL:MAXimum

These commands set or return the comparison limits for the average or maximum RMS EVM of a slot where all symbol types contributed to the EVM. The units for the EVM limits must be specified with the UNIT:EVM command prior to this command being issued.

| **Examples**: | `"CALC:LIM:BURS:EVM:ALL:MAX?"` | The comparison limit for the maximum measured EVM where all kind of symbols contributed to the EVM is returned. |
| | `"CALC:LIM:BURS:EVM:ALL -22"` | The comparison limit for the average measured EVM where all kind of symbols contributed to the EVM is set. |

| **Characteristics**: | *RST value: - |
| | SCPI: | device-specific |

CALCulate:LIMit:BURSt:EVM:ALL[:AVERage]:RESult?
CALCulate:LIMit:BURSt:EVM:ALL:MAXimum:RESult?

These commands return the limit check results for the average or maximum measured RMS-EVM of a slot where all kind of symbols contributed to the EVM. The results are returned as a Boolean value where 0 = Passed and 1 = Failed (limit exceeded).

Examples: `"CALC:LIM:BURS:EVM:ALL:MAX:RES?"`

The limit check result for the maximum measured EVM using all symbols is returned as a Boolean value. (0 = Passed, 1 = Failed).

Characteristics: *RST value: -
                     SCPI: device-specific

CALCulate:LIMit:BURSt:EVM:DATA[:AVERage]
CALCulate:LIMit:BURSt:EVM:DATA:MAXimum

These commands set or return the comparison limits for the average or maximum measured RMS EVM of a slot where only the data symbols contributed to the EVM. The units for the EVM limits must be specified with the UNIT:EVM command prior to this command being issued.

Examples: `"CALC:LIM:BURS:EVM:DATA:MAX?"`

The comparison limit for the maximum measured EVM where only data symbols contributed to the EVM is returned.

CALCulate:LIMit:BURSt:EVM:DATA[:AVERage]:RESult?
CALCulate:LIMit:BURSt:EVM:DATA:MAXimum:RESult?

These commands return the limit check results for the average or maximum measured RMS-EVM of a slot where only data symbols contributed to the EVM. The results are returned as a Boolean value where 0 = Passed and 1 = Failed (limit exceeded).

Examples: `"CALC:LIM:BURS:EVM:DATA:MAX:RES?"`

The limit check result for the maximum measured EVM using data symbols is returned as a Boolean value (0 = Passed, 1 = Failed).

Characteristics: *RST value: -
                     SCPI: device-specific

CALCulate:LIMit:BURSt:EVM:DHEA[:AVERage]
CALCulate:LIMit:BURSt:EVM:DHEA:MAXimum

These commands set or return the comparison limits for the average or maximum measured RMS EVM of a slot where the data and header symbols contributed to the EVM. The units for the EVM limits must be specified with the UNIT:EVM command prior to this command being issued..

Examples: `"CALC:LIM:BURS:EVM:DHEA:MAX?"`

The comparison limit for the maximum measured EVM where data and header symbols contributed to the EVM is returned.

CALCulate:LIMit:BURSt:EVM:DHEA [:AVERage]:RESult?
CALCulate:LIMit:BURSt:EVM:DHEA:MAXimum:RESult?

These commands return the limit check results for the average or maximum measured RMS-EVM of a slot where only data and header symbols contributed to the EVM. The results are returned as a Boolean value where 0 = Passed and 1 = Failed (limit exceeded).

Examples: `"CALC:LIM:BURS:EVM:DHEA:MAX:RES?"`

The limit check result for the maximum measured EVM using data and header symbols is returned as a Boolean value (0 = Passed, 1 = Failed).

Characteristics: *RST value: -
                     SCPI: device-specific

CALCulate:LIMit:BURSt:EVM:DSPilot[:AVERage]
CALCulate:LIMit:BURSt:EVM:DSPilot:MAXimum

These commands set or return the comparison limits for the average or maximum measured RMS EVM of a slot where the data, sync and pilot symbols contributed to the EVM. The units for the EVM limits must be specified with the UNIT:EVM command prior to this command being issued.

Examples: "CALC:LIM:BURS:EVM:DSP:MAX?"

The comparison limit for the maximum measured EVM where data, sync and pilot symbols contributed to the EVM is returned.

CALCulate:LIMit:BURSt:EVM:DSPilot [:AVERage]:RESult?
CALCulate:LIMit:BURSt:EVM:DSPilot:MAXimum:RESult?

These commands return the limit check results for the average or maximum measured RMS-EVM of a slot where only data, sync and pilot symbols contributed to the EVM. The results are returned as a Boolean value where 0 = Passed and 1 = Failed (limit exceeded).

Examples: "CALC:LIM:BURS:EVM:DSP:MAX:RES?"

The limit check result for the maximum measured EVM using data, sync and pilot symbols is returned as a Boolean value (0 = Passed, 1 = Failed).

Characteristics: *RST value: -
                         SCPI: device-specific

CALCulate:LIMit:BURSt:EVM:SPILot[:AVERage]
CALCulate:LIMit:BURSt:EVM:SPILot:MAXimum

These commands set or return the comparison limits for the average or maximum measured RMS EVM of a slot where the sync and pilot symbols contributed to the EVM. The units for the EVM limits must be specified with the UNIT:EVM command prior to this command being issued.

Examples: "CALC:LIM:BURS:EVM:SPIL:MAX?"

The comparison limit for the maximum measured EVM where sync and pilot symbols contributed to the EVM is returned.

CALCulate:LIMit:BURSt:EVM:SPILot [:AVERage]:RESult?
CALCulate:LIMit:BURSt:EVM:SPILot:MAXimum:RESult?

These commands return the limit check results for the average or maximum measured RMS-EVM of a slot where only sync and pilot symbols contributed to the EVM. The results are returned as a Boolean value where 0 = Passed and 1 = Failed (limit exceeded).

Examples: "CALC:LIM:BURS:EVM:SPIL:MAX:RES?"

The limit check result for the maximum measured EVM using sync and pilot symbols is returned as a Boolean value (0 = Passed, 1 = Failed).

Characteristics: *RST value: -
                         SCPI: device-specific

CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVCarrier
CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVCarrier?

These commands set or return the limits used in the Spectrum Flatness measurements to compare the subcarrier Reference Power deviation results against. There is one limit for all kinds of results, i.e. maximum, average, standard deviation (="RMS") and minimum result. The limit value must be a positive number. A value of +1 dB means that a measured deviation of larger than +1 dB or smaller than -1 dB causes the limit check to fail. Unit is always "dB".

Examples: `"CALC:LIM:BURS:SPEC:FLAT:DEVC?"`   Returns the set limit for the subcarrier Reference Power deviation results.

Characteristics: *RST value: +1 dB-
                      SCPI: device-specific

CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVCarrier[:AVERage]:RESult?
CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVCarrier:RMS:RESult?
CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVCarrier:MAXimum:RESult?
CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVCarrier:MINimum:RESult?

These commands return the limit check results for the measured subcarrier Reference Power deviation results (Spectrum Flatness measurement). The results are returned as a boolean value where 0 = Passed and 1 = Failed (limit exceeded).
Different statistics of the result can be compared against the same limit value (please refer to `CALC:LIM:BURS:SPEC:FLAT:DEVC`):
Standard deviation (="RMS"), maximum, average, minimum.

Example: To check if no subcarrier Reference Power differed more than 2 dB from the average subcarrier Reference Power, first set the corresponding limit value to 2 dB (`CALC:LIM:BURS:SPEC:FLAT:DEVC 2`]. Then after measuring the signal query if no power was too large (`CALCulate:LIMit:BURSt:SPECTrum:FLATness:DEVCarrier:MAXimum:RESult?`) AND if no power was too small (`CALCulate:LIMit:BURSt:SPECTrum:FLATness:DEVCarrier:MINimum:RESult?`)

Examples: `"CALC:LIM:BURS:SPEC:FLAT:DEVC:MAX:RES?"`
                                        The limit check result for the maximum measured subcarrier Reference Power deviation is returned as a Boolean value (0 = Passed, 1 = Failed).

Characteristics: *RST value: -
                      SCPI: device-specific

CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVPilot
CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVPilot?

These commands set or return the limits used in the Spectrum Flatness measurements to compare the pilot symbol power deviation results against. There is one limit for all kinds of results, i.e. maximum, average, standard deviation (="RMS") and minimum result. The limit value must be a positive number. A value of +1 dB means that a measured deviation of larger than +1 dB or smaller than -1 dB causes the limit check to fail. Unit is always "dB".

Examples: `"CALC:LIM:BURS:SPEC:FLAT:DEVP?"`   Returns the set limit for the pilot symbol power deviation results.

Characteristics: *RST value: +1 dB-
                      SCPI: device-specific

CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVPilot [:AVERage]:RESult?
CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVPilot:RMS:RESult?
CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVPilot:MAXimum:RESult?
CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVPilot:MINimum:RESult?

These commands return the limit check results for the measured pilot symbol power deviation results (Spectrum Flatness measurement). The results are returned as a boolean value where 0 = Passed and 1 = Failed (limit exceeded).
Different statistics of the result can be compared against the same limit value (please refer to `CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVPilot`):
Standard deviation (="RMS"), maximum, average, minimum.

Example: To check if no subcarrier pilot symbol power differed more than 2 dB from the subcarrier Reference Power, first set the corresponding limit value to 2 dB (`CALC:LIM:BURS:SPEC:FLAT:DEVP 2`]. Then after measuring the signal query if no power was too large (`CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVPilot:MAXimum:RESult?`) AND if no power was too small
(`CALCulate:LIMit:BURSt:SPECtrum:FLATness:DEVPilot:MINimum:RESult?`)

Examples: "`CALC:LIM:BURS:SPEC:FLAT:DEVP:MAX:RES`?"

The limit check result for the maximum measured pilot symbol power deviation is returned as a Boolean value (0 = Passed, 1 = Failed).

Characteristics: *RST value: -
SCPI: device-specific

Configure Subsystem

The following section describes measurement configuration using the CONFigure subsystem. When you trigger any kind of sweep in the MMI or via remote control ("RUN SGL", "RUN CONT", "REFRESH") it is not critical which measurement is initially selected. In the background, the R&S FS-K110 always performs all the supported measurements. Once the measurement (e.g. a "RUN SGL" measuring 100 slots) has completed, you may switch to any of the other measurement and immediately see those measurement results for the previously acquired 100 slots.

In remote control:

- You may also select any measurement when starting the sweep.

- After the measurement is completed you may "switch" to the measurement of interest via a "CONF:" remote control command like ""CONF:BURS:CONS:CSYM"

- You may then fetch this measurement's numeric results and traces as well as enable markers on this measurement's traces.

- After you have finished the fetching results from the current measurement, you may "switch" to other measurement of interest via a "CONF:" remote control command and so on.

- Once all the desired results are fetched, you can start a new measurement.

COMMAND	PARAMETERS	UNIT	COMMENT
:CONFigure			
:BURSt			
:CONStellation			
:CCARrier			
[:IMMediate]			
:CSYMbol			
[:IMMediate]			
:CARRier			
:SELect	-24 to 24 | ALL		
:SYMBol			
:SELect	ALL | DATA | HDR | SYNC | PIL		
:EVM			
:ECARrier			
[:IMMediate]			
:UNIT	DB | PCT		
:ESYMbol			
[:IMMediate]			
:UNIT	DB | PCT		
:MAGNitude			
[:IMMediate]			
:PHASe			
[:IMMediate]			
:PVT			
[:IMMediate]			
:SPECtrum			
:ACPR			
:FLAT			
:SELect	CARRier | PILot		
:MODulation			
[:IMMediate]			
:TLOWer			
[:IMMediate]			
:TUPPer			
[:IMMediate]			
:FFT			
[:IMMediate]			

COMMAND	PARAMETERS	UNIT	COMMENT
:CONFigure			
:BURSt			
:STATistics			
:BSTReam			
[:IMMediate]			
:CCDF			
[:IMMediate]			
SUMTable			
[:IMMediate]			
:EXTernal			
:ATTenuation	\<numeric_value\>	DB	
:POWer			
:AUTO	\<Boolean\>		Currently not yet available
:SWEep			
:TIME	\<numeric_value\>	S	Currently not yet available
:EXPected			
:RF	\<numeric_value\>	DBM	
:IQ	\<numeric_value\>	V	Analog Baseband input has its own value.

CONFigure:BURSt:CONStell:CCARrier[:IMMediate]

Switch to the "Constellation versus Carrier" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: "CONF:BURS:CONS:CCAR"   Switch to the "Constellation versus Carrier" measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:BURSt:CONStell:CSYMbol[:IMMediate]

Switch to the "Constellation versus Carrier" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: "CONF:BURS:CONS:CSYM"   Switch to the "Constellation versus Symbol" measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:BURSt:CONStell:CSYMbol:CARRier:SELect

This remote control command is only available when "Constellation versus Symbol" measurement is selected. Once the "Constellation versus Symbol" measurement is selected, the carrier selection may be changed to display the trace results using the selected carrier. The trace results are available immediately, no INIT:IMM is required. The valid range of parameters depends on the selected bandwidth of slots to analyze ("[SENSe:]DEMod:FORMat:BANalyze:BAND"). For 25 KHz (8 sub carriers) valid parameters are ALL, -4. -3. -2, -1, +1, +2. +3, +4.

Example:

`"[SENSe]:DEMod:FORmat:BANalyze:BANDwidth  B25"`	
`"INIT:IMM"`	
`"*OPC?"`	
`"CONF:BURS:CONS:CCAR:CARR:SEL -4"`	Carrier –4 is selected. (Fetch results)
`"CONF:BURS:CONS:CCAR:CARR:SEL`	Carrier 3 is selected. (Fetch results)
`"CONF:BURS:CONS:CCAR:CARR:SEL ALL"`	All carriers are selected. (Fetch results)

Characteristics: *RST value: ALL
                      SCPI: device-specific

CONFigure:BURSt:CONStell:SYMbol:SELect ALL | DATA | HDR | SYNC | PILOT

This remote control command is only available when the "Constellation versus Carrier" or the "Constellation versus Symbol" measurements are selected. Once a Constellation measurement is selected, the symbol selection may be changed to display the trace results using the selected symbol. The trace results are available immediately, no INIT:IMM is required.

Example:

`"CONF:BURS:CONS:CSYM"`	Select Constellation vs. Symbol
`"INIT:IMM"`	Run single
`"*OPC?"`	Wait for completion
`"CONF:BURS:CONS:SYMB:SEL PIL"`	Select Pilot symbols only (Fetch results)
`"CONF:BURS:CONS:SYMB:SEL SYN"`	Select Sync symbols only (Fetch results)

Characteristics: *RST value: ALL
                      SCPI: device-specific

See also: [SENSe]:DEMod:FORMat:BANalyze:BANDwidth

CONFigure:BURSt:EVM:ECARrier[:IMMediate]

Switch to the "EVM versus Carrier" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: `"CONF:BURS:EVM:ECAR"`   Switch to the "EVM versus Carrier" measurement.

Characteristics: *RST value: -
                      SCPI: device-specific

CONFigure:BURSt:EVM:ECARrier:UNIT <DB | PCT>

This remote control command specifies the units for the EVM versus Carrier measurement. After this command has been executed, the newly specified units are available immediately for fetching results.

DB	"EVM versus Carrier" measurement results will be returned in dB
PCT	"EVM versus Carrier" measurement results will be returned in percent

Example: `"CONF:BURS:EVM:ECAR:UNIT PCT"`   Configured to return "EVM versus Carrier" measurement results in percent units.

Characteristics: *RST value: PCT
                      SCPI: device-specific

CONFigure:BURSt:EVM:ESYMbol[:IMMediate]

Switch to the "EVM versus Symbol" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: `"CONF:BURS:EVM:ESYM"`   Switch to the "EVM versus Symbol" measurement.

Characteristics: *RST value: -
                      SCPI: device-specific

CONFigure:BURSt:EVM:ESYMbol:UNIT <DB | PCT>

This remote control command specifies the units for the EVM versus Symbol measurement After this command has been executed, the newly specified units are available immediately for fetching results.

DB	"EVM versus Symbol" measurement results will be returned in dB
PCT	"EVM versus Symbol" measurement results will be returned in percent

Example: `"CONF:BURS:EVM:ESYM:UNIT PCT"` Configured to return the "EVM vs. Symbol" measurement results in percent units.

Characteristics: *RST value: PCT
                      SCPI: device-specific

CONFigure:BURSt:MAGNitude[:IMMediate]

Switch to the "Magnitude Error Versus Symbol" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: `"CONF:BURS:MAGN"`   Switch to the "Magnitude Error versus Symbol" measurement.

Characteristics: *RST value: -
                      SCPI: device-specific

CONFigure:BURSt:PHASe[:IMMediate]

Switch to the "Phase Error versus Symbol" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: `"CONF:BURS:PHAS"`   Switch to the "Phase Error versus Symbol" measurement.

Characteristics: *RST value: -
                      SCPI: device-specific

CONFigure:BURSt:PVT[:IMMediate]

Switch to the "Power versus Time" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: "`CONF:BURS:PVT`"Switch to the "Power versus Time" measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:BURSt:SPECtrum:FFT[:IMMediate]

Switch to the "Spectrum FFT (Fast Fourier Transform)" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: "`CONF:BURS:SPEC:FFT`"   Switch to the "Spectrum FFT" measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:BURSt:SPECtrum:ACPR:MODulation[:IMMediate]

Switch to the "ACP (adjacent channel power) due to Modulation" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: "`CONF:BURS:SPEC:ACPR:MOD`"   Switch to the "ACP due to Modulation
"measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:BURSt:SPECtrum:ACPR:TUPPer[:IMMediate]

Switch to the "ACP (adjacent channel power) due to Transients - Upper Channel" (index+1) measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: "`CONF:BURS:SPEC:ACPR:TUPP`" Switch to the "ACP due to Transients - Upper Channel" measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:BURSt:SPECtrum:ACPR:TLOWer[:IMMediate]

Switch to the "ACP (adjacent channel power) due to Transients - Lower Channel" (index-1) measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: "`CONF:BURS:SPEC:ACPR:TLOW`" Switch to the "ACP due to Transients - Lower Channel" measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:BURSt:STATistics:CCDF[:IMMediate]

Switch to the "Complementary Cumulative Distribution Function" (CCDF) measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Currently not yet available**!**

Example: "CONF:BURS:STAT:CCDF" Switch to the CCDF measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:BURSt:STATistics:BSTReam[:IMMediate]

Switch to the "Bitstream" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: "CONF:BURS:STAT:BSTR" Switch to the "Bitstream" measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:BURSt:SUMTable[:IMMediate]

Switch to the "Summary Table" measurement. This command does not perform any measurement, but is required before fetching measurement results or handling markers for this measurement.

Example: "CONF:BURS:SUMT" Switch to the "Summary Table" measurement.

Characteristics: *RST value: -
SCPI: device-specific

CONFigure:EXTernal:ATTenuation <numeric value>

This remote control command is used to specify the user's external attenuation on the Analyzer's input. Positive values are attenuation and negative are gain. Set this value when you use an external pre-amplifier or an external attenuator and want the application to show correct power results.

Example: "CONF:EXT:ATT 9" The R&S FS-K110 option assumes an input signal attenuation of 9 dB

Characteristics: *RST value: 0
SCPI: device-specific

See DISPlay[:WINDow<1>]:TRACe<1|2>:Y[:SCALe]:RLEVel:OFFSet as an alternative.

CONFigure:POWer:EXPected:RF <numeric value>

This remote control command is used to specify the maximum average slot power you expect the signal at the Analyzer's RF input (not at the analog or digital Baseband input) to have. This is not the peak-power of the signal.

Example: "CONF:POW:EXP:RF 9" The R&S FS-K110 option assumes a maximum slot power of 9 dBm

Characteristics: *RST value: 0
SCPI: device-specific

See DISPlay[:WINDow<1>]:TRACe<1|2>:Y[:SCALe]:RLEVel:RF as an alternative.

CONFigure:POWer:EXPected:IQ <numeric value>

This remote control command is used to specify the maximum average slot power level in volts expected for the signal at the Analyzer's analog Baseband input (not RF or digital Baseband input).

Example:	`"CONF:POW:EXP:IQ 1.2V"`	The R&S FS-K110 option assumes a maximum analog Baseband slot power of 1.2V

Characteristics: *RST value: 1
SCPI   device-specific

See DISPlay[:WINDow<1>]:TRACe<1|2>:Y[:SCALe]:RLEVel:IQ as an alternative

CONFigure:POWer:AUTO

This remote control command controls the automatic power level detection and optimum input settings. When switched on, power level detection is performed at the start of each measurement sweep and the attenuator and pre-amplifiers are automatically adjusted.

Currently not yet available!

Example:	`"CONF:POW:AUTO ON"`	The R&S FS-K110 option will auto detect the signal input power.

Characteristics: *RST value: ON
SCPI: device-specific

See "DISPlay[:WINDow<1>]:TRACe<1|2>:Y[:SCALe]:RLEVel:AUTO" as an alternative

CONFigure:POWer:AUTO:SWEep:TIME

This remote control command is used to specify the seep time for the automatic power level detection.

Currently not yet available!

Example:	`"CONF:POW:AUTO:SWE:TIME 200MS"`	The auto detect measurement will use a sweep time of 200 ms

Characteristics: *RST value: 100ms
SCPI   device-specific

DISPlay Subsystem

The DISPLay subsystem controls the selection and presentation of textual and graphic information as well as of measurement data on the display. In the following commands, the numeric suffix for WINDow1 corresponds to screen A and WINDow2 corresponds to screen B.

COMMAND	PARAMETERS	UNIT	COMMENT
:DISPlay			
:FORmat	SPLit | SINGle		
:WINDow<1|2>			
:SELect			
:TABLe	<Boolean>		
:TRACe<1…4>			
:STATe	<Boolean>		
:X			
:MAXimum?			
:MINimum?			
:Y			
[:SCALe]			
:ECARrier			
:AUTO	<Boolean>		
:CENTer	<numeric_value>		
:SPAN	<numeric_value>		
:UNIT	DB | PCT		
:ESYMbol			
:AUTO	<Boolean>		
:CENTer	<numeric_value>		
:SPAN	<numeric_value>		
:UNIT	DB | PCT		
:MAGNitude			
:AUTO	<Boolean>		
:CENTer	<numeric_value>		
:SPAN	<numeric_value>		
:PHASe			
:AUTO	<Boolean>		
:CENTer	<numeric_value>		
:SPAN	<numeric_value>		
:RLEVel			
:AUTO	<Boolean>	V	
:IQ	<numeric_value>	DB	
:OFFSet	<numeric_value>	DBM	
:RF	<numeric_value>		

DISPlay:FORMat

This command sets the visible screen display type to full or split screen.

> **Example:**   ″DISP:FORM SINGle″   Sets the R&S FS-K110 display to full screen.

> **Characteristics:** *RST value:
>   SCPI: device-specific

DISPlay:WINDow<1|2>:SELect

This command selects whether screen A or screen B is active. This command is not available for the following measurements: ACP due to Modulation, ACP due to Transients (Upper and Lower), and Power versus Time.

Example: "DISP:WIND1 SEL"   Sets the R&S FS-K110 screen A active.

Characteristics: *RST value: 1
                       SCPI: device-specific

DISPlay:WINDow<1|2>:TABLe

This command selects whether the measurement "Summary Table" is displayed.

Example: "DISP:TABL ON"   Shows the results table

Characteristics: *RST value: OFF
                       SCPI: device-specific

DISPlay:WINDow<1|2>:TRACe1:STATe <boolean>

This command controls which traces are displayed. The numeric suffix for WINDow <1|2> must be 2 as only screen B traces are supported. The numeric suffix for TRACe <1…4> may be any valid trace for the current measurement. Please refer to Fig. 59 for TRACe parameter to screen trace mapping. This command is not available for the following measurements: ACP due to Modulation and Capture Memory. The last visible trace cannot be disabled.

Fig. 59   Trace Parameter to Screen Trace Mapping (NA: Not Available).

TRACe Numeric Parameter	Measurements with 4 Traces	ACP Trans	Spectrum FFT
1	Current	Current	Current
2	Minimum	NA	NA
3	Peak	Peak	NA
4	Average	NA	Average

Example: "DISP:WIND2:TRAC2:STAT ON" switches screen B average trace on.

Characteristics: *RST value: ON
                       SCPI: device specific

DISPlay:WINDow<1|2>:TRACe1:X:MINimum?
DISPlay:WINDow<1|2>:TRACe1:X:MAXimum?

These commands return the minimum and maximum values respectively for the X-axis data for the specified trace display and measurement. The numeric suffix for WINDow <1|2> selects screen A or screen B. The numeric suffix for TRACe <1…4> may be any valid trace for the current measurement. X axis units correspond to the units for the current measurement. Please refer to Fig. 59 for TRACe parameter to screen trace mapping.The minimum and maximum values are consistent with the corresponding TRACe:DATA? command. These commands are not supported for the following measurements: Bitstream, Constellation vs. Carrier, Constellation vs. Symbol, Summary Table and any measurement for which screen A is a table.

Example: "DISP:WIND2:TRAC1:X:MAX?"   returns the maximum X value for the Current trace on screen B.

Characteristics: *RST value: ---
                       SCPI: device specific

DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:ECARrier:AUTO
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:ESYMbol:AUTO
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:MAGNitude:AUTO
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:PHASE:AUTO

These commands control automatic scaling of the Y-axis for the specified trace display and measurement. Automatic scaling sets the Y-axis to automatically scale to best fit the measurement results. The numeric suffix for WINDow <1|2> must be 2 as the relevant results are always displayed in screen B. The numeric suffix for TRACe <1…4> must be 1. These commands support: EVM vs. Carrier, EVM vs. Symbol, Magnitude Error Versus Symbol and Phase Error Versus Symbol measurements.

Example: "DISP:WIND2:TRAC:Y:SCAL:ESYM:AUTO ON"
switches on automatic scaling of the Y-axis for the active traces of the EVM vs. Symbol measurement.

Characteristics: *RST value: ON
SCPI: device specific

DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:ECARrier:CENTer <numeric value>
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:ESYMbol:CENTer <numeric value>
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:MAGNitude:CENTer <numeric value>
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:PHASE:CENTer <numeric value>**>**

These commands set the center value of the Y-axis for the specified trace display and measurement. The numeric suffix for WINDow <1|2> must be 2 as the relevant results are always displayed in screen B. The numeric suffix for TRACe <1…4> must be 1. These commands support: EVM vs. Carrier, EVM vs. Symbol, Magnitude Error Versus Symbol and Phase Error Versus Symbol measurements. The CENTer value is only used when the corresponding AUTO property is off.

Example: "DISP:WIND2:TRAC:Y:SCAL:ECAR:CENT 27"
sets the center value for the Y-axis for the active traces of the EVM vs. Carrier measurement.

Characteristics: *RST value: ON

DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:ECARrier:SPAN <numeric value>
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:ESYMbol:SPAN <numeric value>
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:MAGNitude:SPAN <numeric value>
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:PHASE:SPAN <numeric value>

These commands set the span of the Y-axis for the specified trace display and measurement. The numeric suffix for WINDow <1|2> must be 2 as the relevant results are always displayed in screen B. The numeric suffix for TRACe <1…4> must be 1. These commands support: EVM vs. Carrier, EVM vs. Symbol, Magnitude Error Versus Symbol and Phase Error Versus Symbol measurements. The SPAN value is only used when the corresponding AUTO property is off.

Example: "DISP:WIND2:TRAC:Y:SCAL:MAGN:SPAN 7"
sets the span value for the Y-axis for the active traces on the Magnitude measurement.

Characteristics: *RST value: ON
SCPI: device specific

DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:ECARrier:UNIT <DB | **PCT**>
DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]:ESYMbol:UNIT <DB | **PCT**>

These commands set the units of the Y-axis for the specified trace display and measurement. The numeric suffix for WINDow <1|2> must be 2 as the relevant results are always displayed in screen B. The numeric suffix for TRACe <1…4> must be 1. These commands support: EVM vs. Carrier, EVM vs. Symbol, Magnitude Error Versus Symbol and Phase Error Versus Symbol measurements.

Example: "DISP:WIND2:TRAC:Y:SCAL:ECAR:UNIT PCT"
                     sets the units for the Y-axis to percent for the active traces on EVM vs. carrier.

Characteristics: *RST value: ON
                     SCPI: device specific

DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]RLEVel:AUTO

This remote control command controls the automatic power level detection and optimum input settings. When switched on, power level detection is performed at the start of each measurement sweep and the attenuator and pre-amplifiers are automatically adjusted.

Currently not yet available!

Example: "DISP:WIND1:TRAC:Y:SCAL:RLEV:AUTO ON"
                     The R&S FS-K110 option will auto detect the signal input power.

Characteristics: *RST value: ON
                     SCPI: device-specific

See CONFigure:POWer:AUTO as an alternative.

DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]RLEVel:IQ <numeric value>

This remote control command is used to specify the maximum average slot power level in volts expected for the signal at the Analyzer's analog Baseband (not RF) input.

Example: DISP:WIND1:TRAC:Y:SCAL:RLEV:IQ 1.2V
                     The R&S FS-K110 option assumes a maximum analog Baseband slot power of 1.2V

Characteristics: *RST value: 1
                     SCPI   device-specific

See CONFigure:POWer:EXPected:IQ as an alternative

DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]RLEVel:OFFSet

This remote control command is used to specify the user's external attenuation on the Analyzer's input. Positive values are attenuation and negative are gain. Set this value when you use an external pre-amplifier or an external attenuator and want the application to show correct power results. Both WINDow1 or WINDow2 are accepted and apply to both screens.

Example: "DISP:WIND1:TRAC:Y:SCAL:RLEV:OFFS –9"
                     The R&S FS-K110 option assumes an external RF input signal gain of 9 dB.

Characteristics: *RST value: 0
                     SCPI: device-specific

See CONFigure:EXTernal:ATTenuation as an alternative

DISPlay:WINDow<1|2>:TRACe1:Y[:SCALe]RLEVel:RF

This remote control command is used to specify the maximum average slot power you expect the signal at the Analyzer's RF input (not at the analog or digital Baseband) to have. This is not the peak-power of the signal.

Example: "`DISP:WIND1:TRAC:Y:SCAL:RLEV:RF 9`"
                     The R&S FS-K110 option assumes a maximum slot power of 9 dBm

Characteristics: *RST value: 0
                     SCPI: device-specific

See CONFigure:POWer:EXPected:RF as an alternative

FETCh - Subsystem

The FETCh subsystem contains commands for reading out results of complex measurement tasks. This subsystem is closely linked to the CONFigure and SENSe subsystems.

COMMAND	PARAMETERS	UNIT	COMMENT
:FETCh:			
BURSt			
:ACPMod			
:CHAN<{0..6}>			
:ABSPower?		DBM	
[:CURRent?]		DBM	
:MAXimum?		DBM	
:AVERage?		DBM	
:BANDwidth?		HZ	
:DELLimit?		DB	
[:CURRent?]		DB	
:MAXimum?		DB	
:AVERage?		DB	
:OFFSet?		HZ	
:RELPower?		DB	
[:CURRent?]		DB	
:MAXimum?		DB	
:AVERage?		DB	
:RRCosine?			
:RBW?		Hz	
:ACPTrans			
:CHAN<{0..6}>			
: ABSPower?		DBM	
[:CURRent?]		DBM	
:MAXimum?		DBM	
:AVERage?		DBM	
:BANDwidth?		HZ	
: DELLimit?		DB	
[:CURRent?]		DB	
:MAXimum?		DB	
:AVERage?		DB	
:OFFSet?		HZ	
: RELPower?		DB	
[:CURRent?]		DB	
:MAXimum?		DB	
:AVERage?		DB	
:RRCosine?			
:COUNt?			
:PVTTable			
:ALL?			
:AFTBpower?		DBM	
[:CURRent?]		DBM	
:AVERage?		DBM	
:MINimum?		DBM	
MAXimum?		DBM	
:BEFBpower?		DBM	
[:CURRent?]		DBM	
:AVERage?		DBM	
:MINimum?		DBM	
MAXimum?		DBM	

COMMAND	PARAMETERS	UNIT	COMMENT
:FETCh:			
:BURSt			
:PVTTable			
:REFPower?		DBM	
[:CURRent?]		DBM	
:AVERage?		DBM	
:MINimum?		DBM	
MAXimum?		DBM	
:RELafterpow?		DB	
[:CURRent?]		DB	
:AVERage?		DB	
:MINimum?		DB	
MAXimum?		DB	
:RELBeforepow?		DB	
[:CURRent?]		DB	
:AVERage?		DB	
:MINimum?		DB	
MAXimum?		DB	
:SLOTpower?		DBM	
[:CURRent?]		DBM	
:AVERage?		DBM	
:MINimum?		DBM	
MAXimum?		DBM	
:TRIGsync?		SEC	
:SPECtrum			The following are queries only.
FLATNESS			
:ALL?			Refer to description for units.
:FFT			
:RBW?		HZ	
:SUMTable			
:ALL?			Refer to description for units.
:AMPDroop			Refer to description for units.
[:CURRent?]			
:AVERage?			
:MINimum?			
MAXimum?			
:BPWR			
[:CURRent?]			
:AVERage?			
:MINimum?			
MAXimum?			
:CRESt			Refer to description for units.
[:CURRent?]			
:AVERage?			
:MINimum?			
MAXimum?			
:EVM			
:ALL			EVM All symbols
[:CURRent?]			Set units with UNIT:EVM first
:AVERage?			Set units with UNIT:EVM first
:MINimum?			Set units with UNIT:EVM first
:MAXimum?			Set units with UNIT:EVM first
:DATA			EVM Data Symbols only
[:CURRent?]			Set units with UNIT:EVM first
:AVERage?			Set units with UNIT:EVM first
:MINimum?			Set units with UNIT:EVM first
:MAXimum?			Set units with UNIT:EVM first
:DHEAder			EVM Data+Header Symbols
:DSPilot			EVM Data+Sync+Pilot Symbols

COMMAND	PARAMETERS	UNIT	COMMENT
:FETCh:			
:BURSt			
:PVTTable			
[:CURRent?]			Set units with UNIT:EVM first
:AVERage?			Set units with UNIT:EVM first
:MINimum?			Set units with UNIT:EVM first
:MAXimum?			Set units with UNIT:EVM first
:SPILot			EVM Sync+Pilot Symbols
[:CURRent?]			Set units with UNIT:EVM first
:AVERage?			Set units with UNIT:EVM first
:MINimum?			Set units with UNIT:EVM first
:MAXimum?			Set units with UNIT:EVM first
: :SUMTable			
:FERRor			The following are queries only.
[:CURRent?]		HZ	
:AVERage?		HZ	
:MINimum?		HZ	
MAXimum?		HZ	GIMB units set via UNIT:GIMB
:GIMBalance			Refer to description for units.
[:CURRent?]		DB	
:AVERage?		DB	
:MINimum?		DB	
:MAXimum?		DB	
:IQOFfset			
[:CURRent?]		DB	
:AVERage?		DB	
:MINimum?		DB	
:MAXimum?		DB	
:MAGError			
[:CURRent?]		DB	
:AVERage?		DB	
:MINimum?		DB	
:MAXimum?		DB	
:PHASeerror			
[:CURRent?]		DEG	
:AVERage?		DEG	
:MINimum?		DEG	
:MAXimum?		DEG	
:QUADerror			
[:CURRent?]		DEG	
:AVERage?		DEG	
:MINimum?		DEG	
:MAXimum?		DEG	
:SCMPower			
[:CURRent?]		dBm	
:AVERage?		dBm	
:MINimum?		dBm	
:MAXimum?		dBm	
:SCRPower			
[:CURRent?]		dBm	
:AVERage?		dBm	
:MINimum?		dBm	
:MAXimum?		dBm	

FETCh:BURSt:ACPMod:CHAN<0…6>

The following comments apply to the "ACP due to Modulation" measurement results. For the ACP measurements seven channels of data values are available. The SCPI channel numbers CHAN<0…6> correspond to the following relative channel numbers that are displayed in Fig. 60:

Fig. 60   ACP due to Modulation Relative Channel Number

Channel Number	ACP due to Modulation Relative Channel Number
0	-3
1	-2
2	-1
3	Transmit channel, TX
4	1
5	2
6	3

FETCh:BURSt:ACPMod:CHAN<0…6>:ABSPower[:CURRent]?
FETCh:BURSt:ACPMod:CHAN<0…6>:ABSPower:MAXimum?
FETCh:BURSt:ACPMod:CHAN<0…6>:ABSPower:AVERage?

This command returns the measured current, maximum and average determined absolute power in dBm.

Example: `"FETC:BURS:ACPM:CHAN3:ABSP:MAX?"`   The maximum calculated absolute power for the transmit channel from the most recent measurement is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:ACPMod:CHAN<0…6>:BANDwidth?

This command returns the filter bandwidth (symbol rate) in KHz, used to design the filter for the "ACP Modulation" measurement.

Example: `"FETC:BURS:ACPM:CHAN4:BAND?"`   The filter bandwidth used for measuring the upper channel in the most recent measurement is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:ACPMod:CHAN<0…6>:DELLimit[:CURRent]?
FETCh:BURSt:ACPMod:CHAN<0…6>:DELLimit:MAXimum?
FETCh:BURSt:ACPMod:CHAN<0…6>:DELLimit:AVERage?

This command returns the measured current, maximum and average results of the "Delta to Limit" value in dB.

Example: `"FETC:BURS:ACPM:CHAN3:DELL:MAX?"`   The maximum calculated delta to limit power for the transmit channel from the most recent measurement is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:ACPMod:CHAN<0…6>:OFFSet?

This command returns the frequency offset used for the "ACP Modulation" measurement in KHz.

Example: `"FETC:BURS:ACPM:CHAN3:OFFS?"`   The used offset for the transmit channel from the most recent measurement is returned.

Characteristics: *RST value: -
                      SCPI: device-specific

FETCh:BURSt:ACPMod:CHAN<0…6>:RELPower[:CURRent]?
FETCh:BURSt:ACPMod:CHAN<0…6>:RELPower:MAXimum?
FETCh:BURSt:ACPMod:CHAN<0…6>:RELPower:AVERage?

This command returns the measured current, maximum and average relative powers in dB of the ACP Modulation measurement.

Example: `"FETC:BURS:ACPM:CHAN3:RELP:MAX?"`   The maximum calculated relative power for the transmit channel from the most recent measurement is returned.

Characteristics: *RST value: -
                      SCPI: device-specific

FETCh:BURSt:ACPMod:CHAN<0…6>:RRCosine?

This command returns the roll-off factor used to design the Root Raised Cosine filter for the specified channel.

Example: `"FETC:BURS:ACPM:CHAN3:RRC?"`   The used roll-off factor of the Root Raised Cosine filter for the transmit channel from the most recent measurement is returned.

Characteristics: *RST value: -
                      SCPI: device-specific

FETCh:BURSt:ACPMod:RBW?

This command returns the RBW used for the FFT-based spectrum overview trace in the most recent ACP due to Modulation measurement. Units are Hertz. This command is valid only if the ACP due to Modulation measurement is selected. This filter bandwidth is only relevant for the spectrum overview. It does not affect any ACP results.

Example: `"FETC:BURS:ACPM:RBW?"`   The RBW used for the spectrum overview in the most recent ACP due to Modulation measurement is returned.

Characteristics: *RST value: -
                      SCPI: device-specific

FETCh:BURSt:ACPTrans:CHAN<0…6>

The following comments apply to the "ACP due to Transient" measurement results. For the ACP measurements seven channels of data values are available. The SCPI channel numbers CHAN<0…2> correspond to the following relative channel numbers that are displayed in Fig. 61:

Fig. 61   ACP due to Transients Relative Channel Numbers

Channel Number	ACP due to Transient Relative Channel Number
0	Reserved – not available
1	Reserved – not available
2	-1 (Lower)
3	Transmit channel
4	1 (Upper)
5	Reserved – not available
6	Reserved – not available

FETCh:BURSt:ACPTrans:CHAN<0…6>:ABSPower[:CURRent]?
FETCh:BURSt:ACPTrans:CHAN<0…6>:ABSPower:MAXimum?
FETCh:BURSt:ACPTrans:CHAN<0…6>:ABSPower:AVERage?

This command returns the measured current, maximum and average determined absolute power in dBm.

    Example: `"FETC:BURS:ACPT:CHAN2:ABSP:MAX?"` The maximum calculated absolute power for the lower channel from the most recent measurement is returned.

    Characteristics: *RST value: -
                    SCPI: device-specific

FETCh:BURSt:ACPTrans:CHAN<0…6>:BANDwidth?

This command returns the filter bandwidth (symbol rate) in KHz, used to design the filter for the given offset channel.

    Example: `"FETC:BURS:ACPT:CHAN4:BAND?"` The used filter bandwidth for the upper channel from the most recent measurement is returned.

    Characteristics: *RST value: -
                    SCPI: device-specific

FETCh:BURSt:ACPTrans:CHAN<0…6>:DELLimit[:CURRent]?
FETCh:BURSt:ACPTrans:CHAN<0…6>:DELLimit:MAXimum?
FETCh:BURSt:ACPTrans:CHAN<0…6>:DELLimit:AVERage?

This command returns the measured current, maximum and average result of the "Delta to Limit" value in dB.

    Example: `"FETC:BURS:ACPT:CHAN3:DELL:MAX?"` The maximum calculated delta to limit power for the transmit channel from the most recent measurement is returned.

    Characteristics: *RST value: -
                    SCPI: device-specific

FETCh:BURSt:ACPTrans:CHAN<0…6>:OFFSet?

This command returns the offset frequencies in KHz which were used in the ACP Transient measurement .

Example: `"FETC:BURS:ACPT:CHAN2:OFFS?"`   The used offset for the lower channel from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

FETCh:BURSt:ACPTrans:CHAN<0…6>:RELPower[:CURRent]?
FETCh:BURSt:ACPTrans:CHAN<0…6>:RELPower:MAXimum?
FETCh:BURSt:ACPTrans:CHAN<0…6>:RELPower:AVERage?

This command returns the measured current, maximum and average determined relative power in dB.

Example: `"FETC:BURS:ACPT:CHAN4:RELP:MAX?"`   The maximum calculated relative power for the upper channel from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

FETCh:BURSt: ACPTrans:CHAN<0…6>:RRCosine?

This command returns the roll-off factor of the Root Raised Cosine filter used for the specified channel.

Example: `"FETC:BURS:ACPT:CHAN4:RRC?"`   The calculated Root Raised Cosine for the upper channel from the most recent measurement is returned.

Characteristics: *RST value: -
SCPI: device-specific

FETCh:BURSt:COUNt?

This command returns the total number of burst found and analyzed.

Example: `"FETC:BURS:COUN?"`   The number of bursts analyzed is returned

Characteristics: *RST value: -
SCPI: device-specific

FETCh:BURSt:PVTTable:ALL?

This command returns the results from the R&S FS-K110 Power versus Time Summary Table measurement. Data will only be returned if the PVT Summary Table measurement type was previously executed. See CONF:BURSt:PVT. The results are returned as a list of strings separated by a comma ',' in the following ASCII format:
<current AFTBpower>, <min AFTBpower>,<average AFTBpower>,<max AFTBpower>, <current BEFBpower>, <min BEFBpower>,<average BEFBpower>,<max BEFBpower>, <current REFPower>, <min REFPower>,<average REFPower>,<max REFPower>, <current RELafterpow>, <min RELafterpow>,<average RELafterpow>,<max RELafterpow>, <current RELBeforepow>, <min RELBeforepow>,<average RELBeforepow>,<max RELBeforepow>, <current SLOTpower>, <min SLOTpower>,<average SLOTpower>,<max SLOTpower>, <TRIGsync>

Example: `"FETCh:BURSt:PVTT:ALL?"` All R&S FS-K110 PVT measurement results are returned in the specified ASCII format.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:PVTTable:AFTBpower[:CURRent]?
FETCh:BURSt:PVTTable:AFTBpower:AVERage?
FETCh:BURSt:PVTTable:AFTBpower:MINimum?
FETCh:BURSt:PVTTable:AFTBpower:MAXimum?

For the Power versus Time measurements, this command returns the measured current, average, minimum and maximum results for after burst power in dB. The Power versus Time measurement must be selected to obtain results.

Example: `"FETC:BURS:PVTT:AFTB:MAX?"` The maximum calculated after burst power for the most recent PVT measurement is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:PVTTable:BEFBpower[:CURRent]?
FETCh:BURSt:PVTTable:BEFBpower:AVERage?
FETCh:BURSt:PVTTable:BEFBpower:MINimum?
FETCh:BURSt:PVTTable:BEFBpower:MAXimum?

For the Power versus Time measurements, this command returns the measured current, average, minimum and maximum results for before burst power in dB. The Power versus Time measurement must be selected to obtain results.

Example: `"FETC:BURS:PVTT:BEFB:MAX?"` The maximum calculated before burst power for the most recent PVT measurement is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:PVTTable:REFPower[:CURRent]?
FETCh:BURSt:PVTTable:REFPower:AVERage?
FETCh:BURSt:PVTTable:REFPower:MINimum?
FETCh:BURSt:PVTTable:REFPower:MAXimum?

For the Power versus Time measurements, this command returns the measured current, average, minimum and maximum results for the reference power in dB. The Power versus Time measurement must be selected to obtain results.

Example: `"FETC:BURS:PVTT:REFP:MAX?"` The maximum calculated reference power for the most recent PVT measurement is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:PVTTable:RELafterpower[:CURRent]?
FETCh:BURSt:PVTTable:RELafterpower:AVERage?
FETCh:BURSt:PVTTable:RELafterpower:MINimum?
FETCh:BURSt:PVTTable:RELafterpower:MAXimum?

For the Power versus Time measurements, this command returns the measured current, average, minimum and maximum results for power after burst relative to reference power in dB. The Power versus Time measurement must be selected to obtain results.

Example: `"FETC:BURS:PVTT:REL:MAX?"`
                             The maximum calculated relative after burst power from the most recent PVT measurement is returned.

Characteristics: *RST value: -
                       SCPI: device-specific

FETCh:BURSt:PVTTable:RELBeforepower[:CURRent]?
FETCh:BURSt:PVTTable:RELBeforepower:AVERage?
FETCh:BURSt:PVTTable:RELBeforepower:MINimum?
FETCh:BURSt:PVTTable:RELBeforepower:MAXimum?

For the Power versus Time measurements, this command returns the measured current, average, minimum and maximum results for power before burst relative to reference power in dB. The Power versus Time measurement must be selected to obtain results.

Example: `"FETC:BURS:PVTT:RELB:MAX?"`
                             The maximum calculated relative before burst power from the most recent PVT measurement is returned.

Characteristics: *RST value: -
                       SCPI: device-specific

FETCh:BURSt:PVTTable:SLOTpower[:CURRent]?
FETCh:BURSt:PVTTable:SLOTpower:AVERage?
FETCh:BURSt:PVTTable:SLOTpower:MINimum?
FETCh:BURSt:PVTTable:SLOTpower:MAXimum?

For the Power versus Time measurements, this command returns the measured current, average, minimum and maximum results for slot power in dB. The Power versus Time measurement must be selected to obtain results.

Example: `"FETC:BURS:PVTT:SLOT:MAX?"`
                             The maximum calculated slot power from the most recent PVT measurement is returned.

Characteristics: *RST value: -
                       SCPI: device-specific

FETCh:BURSt:PVTTable:TRIGsync?

For the Power versus Time measurements, this command returns the measured trigger to sync time in seconds from the signal that triggered capturing of IQ data to the first symbol instant of the first found slot in the current capture buffer. This result is only useful if an external trigger is used. The Power versus Time measurement must be selected to obtain results.

Example: `FETC:BURS:PVTT:TRIG?`
                             The trigger to sync time in seconds from the most recent PVT measurement is returned.

Characteristics: *RST value: -
                       SCPI: device-specific

FETCh:BURSt:SPECtrum:FFT:RBW?

This command returns the RBW used for the most recent Spectrum FFT measurement. Units are Hertz. This command is valid only if the Spectrum FFT measurement is selected.

Example: `"FETC:BURS:SPEC:FFT:RBW?"` The RBW for the most recent Spectrum FFT measurement is returned.

Characteristics: *RST value: -
                   SCPI: device-specific

FETCh:BURSt:SPECtrum:FLATness:ALL?

This command returns the results of the Summary Table which is shared by measurements *Spectrum Flatness Carriers* and *Spectrum Flatness Pilots*. Data will only be returned if one of these measurements was previously selected by `CONF:BURS:SPEC:FLAT:SEL CARR` respectively `CONF:BURS:SPEC:FLAT:SEL PIL`. For the returned results it does not care which of the two measurements was selected.
The results are returned as a list of strings (same order as in the Summary Table) separated by a comma ',' in the following ASCII format:
<TotalRefPwr Min> ,<TotalRefPwr AVG> ,<TotalRefPwr StdDev> , <TotalRefPwr Max>,
<AvgSCRefPwr Min> ,<AvgSCRefPwr AVG> ,<AvgSCRefPwr StdDev> , <AvgSCRefPwr Max>,
<RefPwrDev Min> ,<RefPwrDev AVG> ,<RefPwrDev StdDev> ,<RefPwrDev Max> ,
<RefPwrDev Limit >, <MinRefPwrDev CarrierNo> ,<MaxRefPwrDev CarrierNo> ,
<PilotPwrDev Min> ,<PilotPwrDev AVG>, <PilotPwrDev StdDev>, <PilotPwrDev Max>,
<PilotPwr Dev Limit>,
<MinPilotPwrDev CarrierNo / MinPilotPwrDev SymbolNo> ,
<MaxPilotPwrDev CarrierNo / MaxPilotPwrDev SymbolNo>

Units are the same as in the Summary Table.

FETCh:BURSt:SUMTable:ALL?

This command returns the results from the R&S FS-K110 Summary Table measurement. Data will only be returned if the Summary Table measurement type was previously selected. See `CONF:BURS:SUMT..`. The results are returned as a list of strings separated by a comma ',' in the following ASCII format:
<min EVM all symbols>,<average EVM all symbols >,<max EVM all symbols >
<min EVM data+sync+pilot>,<average EVM data+sync+pilot>,<max EVM data+sync+pilot>,
<min EVM data+header>,<average EVM data+header >,<max EVM data+header>,
<min EVM data>,<average EVM data>,<max EVM data>,
<min EVM sync+pilot>,<average EVM sync+pilot>,<max EVM sync+pilot>,
<min IQ offset>, <average IQ offset>, <maximum IQ offset>,
<min gain imbalance>, <average gain imbalance>, <max gain imbalance>,
<min quadrature error>, <average quadrature error >, <max quadrature error >,
<min amplitude droop>, <average amplitude droop >, <max amplitude droop >,
<min frequency error>,<average frequency error>, <max frequency error>,
<min phase error>,<average phase error>, <max phase error>,
<min magnitude error>,<average magnitude error>, <max magnitude error>,
<min burst power>,<average burst power>,<max burst power>,
<min crest factor>,<average crest factor>, <max crest factor>
Note: "all symbols" includes: data, header, sync, and pilot symbols.

The units for the EVM results have to be specified before with the UNIT:EVM command. The units for the gain imbalance results have to be specified before with the UNIT:GIMB command.

Note that "FETCh: BURSt:SUMT:ALL?" does not return all results that the individual single commands "FETCh: BURSt:SUMT:xxx" can return. Especially the "current" results (i.e. results of the last found slot) and the commands "FETC:BURS:SUMT:SCMP" and "FETC:BURS:SUMT:SCMR" are excluded.

Example: `"FETCh: BURSt:SUMT:ALL?"`   All R&S FS-K110 measurement results are
                                                 returned in the specified ASCII format.

Characteristics: *RST value: -
                       SCPI: device-specific

FETCh:BURSt:SUMTable:AMPDroop[:CURRent?]
FETCh:BURSt:SUMTable:AMPDroop:AVERage?
FETCh:BURSt:SUMTable:AMPDroop:MAXimum?
FETCh:BURSt:SUMTable: AMPDroop:MINimum?

This command returns the measured current (i.e. of last found slot), average, minimum or maximum
determined amplitude droop of the slots in dB/sym.

Example: `"FETC:BURS:SUMT:AMPL:MAX?"`   The maximum calculated amplitude droop from
                                                     the most recent measurement is returned.

Characteristics: *RST value: -
                       SCPI: device-specific

FETCh:BURSt:SUMTable:BPWR[:CURRent?]
FETCh:BURSt:SUMTable:BPWR:AVERage?
FETCh:BURSt:SUMTable:BPWR:MAXimum?
FETCh:BURSt:SUMTable:BPWR:MINimum?

This command returns the measured current (i.e. of last found slot), average, minimum or maximum
result of the mean burst power (all symbol instances of the slot disregarding the symbol types) in dBm.

Example: `"FETC:BURS:SUMT:BPWR:MAX?"`   The maximum calculated burst power from
                                                     the most recent measurement is returned.

Characteristics: *RST value: -
                       SCPI: device-specific

FETCh:BURSt:SUMTable:CRESt[:CURRent?]
FETCh:BURSt:SUMTable:CRESt:AVERage?
FETCh:BURSt:SUMTable:CRESt:MAXimum?
FETCh:BURSt:SUMTable:CRESt:MINimum?

This command returns the measured current (i.e. of last found slot), average, minimum or maximum
determined crest factor (= ration of peak power to average power) of the slots in dB.

Example: `"FETC:BURS:SUMT:CRESt:MAX?"`   The maximum calculated crest factor from
                                                      the most recent measurement is returned.

Characteristics: *RST value: -
                       SCPI: device-specific

FETCh:BURSt:SUMTable:EVM:ALL[:CURRent?]
FETCh:BURSt:SUMTable:EVM:ALL:AVERage?
FETCh:BURSt:SUMTable:EVM:ALL:MAXimum?
FETCh:BURSt:SUMTable:EVM:ALL:MINimum?

This command returns the slots' RMS Error Vector Magnitude, taking the data, header, sync, and pilot
symbols into account. The units for the EVM results have to specified before with the UNIT:EVM
command.

Example: `"FETC:BURS:SUMT:EVM:ALL:MAX?"`   The maximum EVM recorded for all kind of
                                                        symbols is returned.

Characteristics: *RST value: -
                       SCPI: device-specific

FETCh:BURSt:SUMTable:EVM:DATA[:CURRent?]
FETCh:BURSt:SUMTable:EVM:DATA:AVERage?
FETCh:BURSt:SUMTable:EVM:DATA:MAXimum?
FETCh:BURSt:SUMTable:EVM:DATA:MINimum?

This command returns the slots' RMS Error Vector Magnitude measurement results, taking only the data symbols into account. The units for the EVM results have to be specified before with the UNIT:EVM command.

Example: `"FETC:BURS:SUMT:EVM:DATA:MAX?"` The maximum EVM recorded for the data symbols is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:SUMTable:EVM:DHEAder[:CURRent?]
FETCh:BURSt:SUMTable:EVM:DHEAder:AVERage?
FETCh:BURSt:SUMTable:EVM:DHEAder:MAXimum?
FETCh:BURSt:SUMTable:EVM:DHEAder:MINimum?

This command returns the slots' Error Vector Magnitude measurement results, taking only data and header symbols into account. The units for the EVM results have to be specified before with the UNIT:EVM command.

Example: `"FETC:BURS:SUMT:EVM:DHEA:MAX?"` The maximum EVM recorded for the data and header symbols is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:SUMTable:EVM:DSPilot[:CURRent?]
FETCh:BURSt:SUMTable:EVM:DSPilot:AVERage?
FETCh:BURSt:SUMTable:EVM:DSPilot:MAXimum?
FETCh:BURSt:SUMTable:EVM:DSPilot:MINimum?

This command returns the slots' Error Vector Magnitude measurement results, taking only data, sync and pilot symbols into account. The units for the EVM results have to be specified before with the UNIT:EVM command.

Example: `"FETC:BURS:SUMT:EVM:DSP:MAX?"` The maximum EVM recorded for the data and sync and pilot symbols is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:SUMTable:EVM:SPILot[:CURRent?]
FETCh:BURSt:SUMTable:EVM:SPILot:AVERage?
FETCh:BURSt:SUMTable:EVM:SPILot:MAXimum?
FETCh:BURSt:SUMTable:EVM:SPILot:MINimum?

This command returns the slots' Error Vector Magnitude measurement results, taking only sync and pilot symbols into account. The units for the EVM results have to be specified before with the UNIT:EVM command.

Example: `"FETC:BURS:SUMT:EVM:PIL:MAX?"` The maximum EVM recorded for the sync and pilot symbols is returned.

Characteristics: *RST value: -
                        SCPI: device-specific

FETCh:BURSt:SUMTable:FERRor[:CURRent?]
FETCh:BURSt:SUMTable:FERRor:AVERage?
FETCh:BURSt:SUMTable:FERRor:MAXimum?
FETCh:BURSt:SUMTable:FERRor:MINimum?

This command returns the measured current (i.e. of last found slot), average, minimum and maximum frequency error of the slots in Hz.

Example: `"FETC:BURS:SUMT:FERR:MAX?"`   The maximum frequency error is returned.

Characteristics: *RST value: -
                SCPI: device-specific

FETCh:BURSt:SUMTable:GIMBalance[:CURRent?]
FETCh:BURSt:SUMTable:GIMBalance:AVERage?
FETCh:BURSt:SUMTable:GIMBalance:MAXimum?
FETCh:BURSt:SUMTable:GIMBalance:MINimum?

This command returns the measured current (i.e. of last found slot), average, minimum and maximum IQ imbalance error. The units for the gain imbalance results are specified with the UNIT:GIMB command.

Example: `"FETC:BURS:SUMT:GIMB:MAX?"`   The maximum IQ gain imbalance error is returned.

Characteristics: *RST value: -
                SCPI: device-specific

FETCh:BURSt:SUMTable:IQOFfset[:CURRent?]
FETCh:BURSt:SUMTable:IQOFfset:AVERage?
FETCh:BURSt:SUMTable:IQOFfset: MAXimum?
FETCh:BURSt:SUMTable:IQOFfset: MINimum?

This command returns the measured current (i.e. of last found slot), average, minimum or maximum IQ Offset errors of the slots as percentage.

Example: `"FETC:BURS:SUMT:IQOF:MAX?"`   The maximum IQ Offset error from the most recent measurement is returned.

Characteristics: *RST value: -
                SCPI: device-specific

FETCh:BURSt:SUMTable:MAGerror[:CURRent?]
FETCh:BURSt:SUMTable:MAGerror:AVERage?
FETCh:BURSt:SUMTable:MAGerror: MAXimum?
FETCh:BURSt:SUMTable:MAGerror: MINimum?

This command returns the measured current (i.e. of last found slot), average, minimum or maximum RMS magnitude error of the slots in dB.

Example: `"FETC:BURS:SUMT:MAG:MAX?"`   The maximum magnitude error from the most recent measurement is returned.

Characteristics: *RST value: -
                SCPI: device-specific

FETCh:BURSt:SUMTable:PHASeerror[:CURRent?]
FETCh:BURSt:SUMTable:PHASeerror:AVERage?
FETCh:BURSt:SUMTable:PHASeerror: MAXimum?
FETCh:BURSt:SUMTable:PHASeerror: MINimum?

This command returns the measured current (i.e. of last found slot), average, minimum or maximum RMS phase error of the slots in degrees.

Example: `"FETC:BURS:SUMT:PHAS:MAX?"` The maximum phase error from the most recent measurement is returned.

Characteristics: *RST value: -
                      SCPI: device-specific

FETCh:BURSt:SUMTable:QUADerror[:CURRent?]
FETCh:BURSt:SUMTable:QUADerror:AVERage?
FETCh:BURSt:SUMTable:QUADerror: MAXimum?
FETCh:BURSt:SUMTable:QUADerror: MINimum?

This command returns the measured current (i.e. of last found slot), average, minimum or maximum quadrature error of the slots in degrees.

Example: `"FETC:BURS:SUMT:QUAD:MAX?"` The maximum quadrature error from the most recent measurement is returned.

Characteristics: *RST value: -
                      SCPI: device-specific

FETCh:BURSt:SUMTable:SCMPower[:CURRent?]
FETCh:BURSt:SUMTable:SCMPower:AVERage?
FETCh:BURSt:SUMTable:SCMPower:MAXimum?
FETCh:BURSt:SUMTable:SCMPower:MINimum?

This command returns the measured current, average, minimum or maximum of the Mean power in each subcarrier in dBm. For example, if a channel bandwidth of 100 kHz (32 carriers) is selected this is an array of 32 values with the first element in the array equal to the mean power in carrier -16. The mean power of data, header, sync and pilot symbols is calculated for these results.

Example: `"FETC:BURS:SUMT:SCMP:MAX?"` The maximum Mean power for each subcarrier from the most recent measurement is returned.

Characteristics: *RST value: -
                      SCPI: device-specific

FETCh:BURSt:SUMTable:SCRPower[:CURRent?]
FETCh:BURSt:SUMTable:SCRPower:AVERage?
FETCh:BURSt:SUMTable:SCRPower:MAXimum?
FETCh:BURSt:SUMTable:SCRPower:MINimum?

This command returns the measured current, average, minimum or maximum of the Reference power in each subcarrier in dBm. For example, if a channel bandwidth of 100 kHz (32 carriers) is selected this is an array of 32 values with the first element in the array equal to the mean power in carrier -16. "Reference Power" means that the mean power of sync and pilot symbols is calculated.

Example: `"FETC:BURS:SUMT:SCMR:MAX?"` The maximum Reference power for each subcarrier from the most recent measurement is returned.

Characteristics: *RST value: -
                      SCPI: device-specific

FORMat Subsystem

The FORMat subsystem specifies the data format of the data transmitted to and from the instrument.

COMMAND	PARAMETERS	UNIT	COMMENT
FORMat			
[:DATA]	ASCii | REAL | UINT		

FORMat[:DATA] ASCii | REAL | UINT

This command specifies the data format for the TRACe:DATA? data transmitted from the instrument to the control PC. It does not affect the way data is sent from control PC to the instrument. The FORMat command must be sent before the trace is requested (e.g. "TRACe2:DATA? TRACE1"). Please refer to Table 14 for information on which FORMat commands are supported for each measurement.

Example:	"FORM ASC"	The R&S FS-K110 option will send measurement trace data requested by the TRACE:DATA? command as comma separated ASCII values.
	"FORM REAL	The R&S FS-K110 option will send measurement trace data requested by the TRACE:DATA? command as 32-bit IEEE 754 floating-point numbers in the "definite length block format". This format is normally faster than the ASCII format.
	"FORM UINT	The R&S FS-K110 option will send Bitstream data requested by the TRACE:DATA? command as 8 bit unsigned numbers in the "definite length block format". This option is only available for the Bitstream measurement.

Characteristics: *RST value: ASCii
                    SCPI: conforming

INITiate Subsystem

The INITiate subsystem configures the instrument and initiates a new measurement. Based on the CONFigure:CONTinuous state, either a single measurement or continuous operation will occur when INITiate[:IMMediate] is issued. To configure the instrument to perform a particular measurement use the CONFigure:BURSt command subsystem.

COMMAND	PARAMETERS	UNIT	COMMENT
INITiate			
[:IMMediate]			no query
:CONTinuous	\<Boolean>		no query

INITiate[:IMMediate]

This remote control command requests the R&S FS-K110 option to start a new measurement sequence. If a measurement sequence is already in progress, then the command will be ignored. The OPC subsystem may be used to determine when a single measurement is completed.

Example: "INIT"   The R&S FS-K110 option will start a new measurement based on the INIT:CONT mode.

Characteristics: *RST value: -
SCPI: conforming

INITiate:CONTinuous \<Boolean>

This command determines whether the trigger system is continuously initiated (continuous) or performs single measurements (single).

Example: "INIT:CONT OFF" The R&S FS-K110 option will perform a non continuous measurement when initiated.

Characteristics: *RST value: OFF-
SCPI: conforming

INPut Subsystem

The INPut subsystem controls the input path characteristics of the instrument.

COMMAND	PARAMETERS	UNIT	COMMENT
:INPut			
:ATTenuation	< numeric_value >	DB	Cancels GAIN value
:DIQ	< numeric_value >	DB	FSQ-B17 option only
:RANGe			Full Scale Level
[:UPPer]	< numeric_value >	Volt	
AUTO	ON | OFF		Auto Set of Full Scale Level
:SRATe	< numeric_value >	Hz	Digital Input Sampling Rate
:AUTO	ON | OFF		Auto Set of Dig. Input SR
:EATT			
:AUTO	<Boolean>		
:STATe	<Boolean>		
:GAIN			Controls the preamplifier
:STATe	<Boolean>		Automatic setting
:SELect	RF | BB | DIQ | AIQ		FSQ-B71 / FSQ-B17 option only
:IQ			FSQ - B71 option only
:BALanced			
[:STATe]	<Boolean>		
:IMPedance	LOW | HIGH		
:TYPE	IQ | I | Q		

INPut:ATTenuation   <numeric value>

This remote control command specifies the RF attenuation that the Analyzer uses.
Currently not yet available!

Example: "INP:ATT 10"   Attenuation of the analyzer is set to 10 dB.

Characteristics: *RST value: 5 dB
                     SCPI: conforming

INPut<1|2>:DIQ:RANGe[:UPPer]   <numeric_value>

This command defines the voltage corresponding to the maximum input value of the digital
Baseband input (I or Q of a sample has integer value 7FFFF hex, the other is zero). C.f. parameter
Full Scale Level:
This command is only available with option FSQ B17 installed. This command is only of importance
if the digital Baseband input is used.

Example: "INP:DIQ:RANG?"   Returns set *Full Scale Level* of the digital Baseband input

Characteristics: *RST value: 1 V
                     SCPI: conforming

INPut<1|2>:DIQ:RANGe[:UPPer]   AUTO ON | OFF

This command corresponds to the *Auto* checkbox of the parameter *Full Scale Level.* This command
is only available with option FSQ B17 installed. This command is only of importance if the digital
Baseband input is used. This command is only useful if the device-under-test is an R&S test
transmitter that is capable of transmitting the *Full Scale Level* value via the LVDS connection. The
R&S FS-K110 will automatically set the received value as *Full Scale Level*.

Example: "INP:DIQ:RANG AUTO OFF"   Deactivates the automatic mode of parameter
                     Full Scale Level of the digital Baseband input

Characteristics: *RST value: OFF
                     SCPI: conforming

INPut<1|2>:DIQ:SRATe <numeric_value>

This command corresponds to the parameter *Digital Input Sampling Rate*. This command is only of importance if the digital Baseband input is used. This command is only available with option FSQ B17 installed.

Example: `"INP:DIQ:SRAT 2E6"`   Sets the *Digital Input Sampling Rate* of the digital
                                                                  Baseband input to 2 MHz

Characteristics: ***RST value: 10.0 MHZ
                      SCPI: conforming

INPut<1|2>:DIQ:SRATe AUTO   ON | OFF

This command corresponds to the *Auto* checkbox of the parameter *Digital Input Sampling Rate*. This command is only of importance if the digital Baseband input is used. This command is only available with option FSQ B17 installed. This command is only useful if the device-under-test is an R&S test transmitter that is capable of transmitting its digital sampling rate via the LVDS connection. The R&S FS-K110 will automatically set the received value as *Digital Input Sampling Rate*.

Example: `"INP:DIQ:SRAT AUTO ON"`   Activates the automatic mode for parameter
                                                                  Digital Input Sampling Rate of the digital Baseband
                                                                  input.

Characteristics: ***RST value: ON
                      SCPI: conforming

INPut:EATT <numeric value>

This command programs the attenuation of the electronic input attenuator. The attenuation can be varied in 5 dB steps from 0 to 30 dB. Other entries are rounded to the next lower integer value. The electronic attenuator is switched off in the default state.
Currently not yet available!

Example: `"INP:EATT?"`   Returns the current electronic attenuator setting in use

Characteristics: ***RST value: 0 dB
                      SCPI: conforming

INPut:EATT:AUTO <Boolean>

This command automatically couples the electronic input attenuation to the reference level and the attenuation of the mechanical attenuator (state ON) or switches the input attenuation to manual entry.
Currently not yet available!

Example: `"INP:EATT:AUTO ON"` Couples the attenuation of the electronic attenuator
                                                                  tothe reference level.

Characteristics: ***RST value: ON
                      SCPI: device-specific

The command is only available with the electronic attenuator option B25.

INPut:EATT:STATe <Boolean>

This command switches the electronic input attenuation into the signal path (state ON) or removes it from the signal path (state OFF).
Currently not yet available!

Example: `"INP:EATT:STAT ON"` Switches the electronic attenuator into the signal path.

Characteristics: ***RST value: OFF
                      SCPI: device-specific

The command is only available with the electronic attenuator option B25.

INPut:GAIN:STATe <Boolean>

This command controls the preamplifier for the instrument. The switchable gain is fixed at 20 dB. If the preamplifier option is not present, this command will return an error.

This command has no effect if the digital Baseband input is used.

Example: `"INP:GAIN:STAT ON"` Switches the 20 dB preamplifier on.

Characteristics: *RST value: OFF
                      SCPI: conforming

INPut:SELect RF | BB | DIQ | AIQ

This remote control command specifies whether the RF input or the analog Baseband input (option FSQ-B71) or the digital Baseband input (option FSQ-B17) is the currently selected signal input. Note that analog Baseband input requires the HW option FSQ-B71 and the digital Baseband input requires HW option FSQ-B17 to be installed.
Note: Option "BB" and option "AIQ" are equivalent and select the analog Baseband input.

Example: `"INPut:SEL BB"`   Select analog Baseband input

Characteristics: *RST value: RF
                      SCPI: conforming

INPut:IQ:BALanced[:STATe] <Boolean>

This remote control command specifies whether the analog Baseband IQ inputs are symmetrical (balanced) or asymmetrical (unbalanced). Note that this command requires option B71. When option B71 is not installed this command will return an error.

Example: `"INPut:IQ:BAL 1"` Specifies symmetrical (balanced) IQ inputs.

Characteristics: *RST value: TRUE
                      SCPI: conforming

INPut:IQ:IMPedance LOW | HIGH

This remote control command specifies the input impedance for the analog Baseband IQ inputs. The high impedance value is dependent on the analog Baseband hardware version installed in the instrument. When option B71 is not installed this command will return an error.

Example: `"INPut:IQ:IMP LOW"` Specifies low input impedance for IQ inputs.

Characteristics: *RST value: LOW
                      SCPI: conforming

INPut:IQ:TYPE IQ | I | Q

This remote control command specifies the input path for the analog Baseband input. The values which can be specified are as follows:
:INPut:IQ:TYPE IQ   I + j*Q (=default)
:INPut:IQ:TYPE I   I Only
:INPut:IQ:TYPE Q   Q Only
Note that this command requires option B71.

Example: `"INPut:IQ:TYPE I"`   Specifies only the I input is used for the analog Baseband path.

Characteristics: *RST value: IQ
                      SCPI: conforming

INSTrument Subsystem

The INSTrument subsystem controls the selection of the R&S FS-K110 option.

COMMAND	PARAMETERS	UNIT	COMMENT
:INSTrument			
NSELect	< numeric_value >		
SELect	TETRA2		

INSTrument:NSELect <numeric_value>

This remote control command selects active operation of the R&S FS-K110 option by specifying its associated option number.

Example: `"INST:NSEL 110"`   The R&S FS-K110 option is selected as the active option.

Characteristics: *RST value: -
                  SCPI: conforming

INSTrument:SELect TETRA2

This recomote control command selects active operation of the R&S FS-K110 option.

Example: `"INST:SEL TETRA2"`   The R&S FS-K110 option is selected as the active option.

Characteristics: *RST value: -
                  SCPI: conforming

SENSe Subsystem

The SENSe command is used to set and get the values of parameters in the remote instrument. The get variant of the SENSe command differs from set in that it takes no parameter values (unless otherwise stated) but is followed by the character '?' and will return the parameter's value in the same format as it is set.

e.g   SENS:FREQ 10GHZ   sets the frequency to 10 GHz
           SENS:FREQ?   response 10GHZ   returns the current frequency

:DEFault
Where a parameter has a default a value, the commands parameter can be substituted with :DEFault which will load the parameter with its default value. This will effectively reset the parameter to its default (reset) value.

:UP and :DOWN
In addition all numeric values will be able to take UP and DOWN in place of the parameter. This will increment and decrement the numeric value by an amount specified within the option.

:MIN/MAX
In addition all numeric values will be able to take either MINimum or MAXimum as arguments to determine the minimum and maximum allowable range for the command.

COMMAND	PARAMETERS	UNIT	COMMENT
[:SENSe]			
:BURSt			
:COUNt	<numeric_value>		
:STATe	<Boolean>		
:DEMod			
:FORMat			
:BANalyze			
:BANDwidth	B25 | B50 | B100 | B150		
:BTYPe	NDB | NUB | CUB | RAB		
:CADRoop	<Boolean>		
:CIQOffset	<Boolean>		
:MCARrier	KH1 | KH10		1KHz or 10KHz
:MODulation	QM4 | QM16 | QM64		
:PTRAcking	<Boolean>		
:FREQuency			
[:CENTer]	<numeric_value>	Hz	
:IQ			
:DITHer			
[:STATe]	<Boolean>		
:FREQuency			
[:CENTer]	<numeric_value>	Hz	IQ has its own value for CF
:LPASs			
[:STATe]	<Boolean>		
:SWAPiq	<Boolean>		
:SWEep			
:TIME	<numeric_value>	S	Sweep Time in Seconds
:SLOT	<numeric_value>		Sweep Time in Slots

[SENSe:]BURSt:COUNt   <numeric value>

This command defines the number of bursts that will be analyzed by the measurement. This is "number of slots to analyze" value under Data Capture Settings on the R&S FS-K110 General Settings Panel.

Example: `"BURS:COUN 16"` Sets the number of bursts to 16.

Characteristics: *RST value: 1
                      SCPI: device-specific

[SENSe:]BURSt:COUNt:STATe   <Boolean>

When this command is set to on, the burst count parameter will be used by the R&S FS-K110 measurement, otherwise the burst count parameter will be ignored. This is "No of Slots to Analyze" checkbox under Data Capture Settings on the R&S FS-K110 General Settings Panel.

Example: `"BURS:COUN:STAT 1"`   Sets the burst count state to ON

Characteristics: *RST value: OFF
                      SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:BANDwidth   B25 | B50 | B100 | B150

This command sets the analysis channel bandwidth that will be used when the measurement is performed. Note that when slot type is Random Access Burst (RAB), only the 25kHz (B25) channel bandwidth is supported. Selecting other channel bandwidths with slot type RAB will return an error.

B25   25 kHz (8 carrier) channel bandwidth
B50   50 kHz (16 carrier) channel bandwidth
B100   100 kHz (32 carrier) channel bandwidth
B150   150 kHz (48 carrier) channel bandwidth

Example: `"SENS:DEM:FORM:BAN:BAND B50"`   The R&S FS-K110 option analyses using 16 carriers.

Characteristics: *RST value: B25
                      SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:BTYPe   NDB | NUB | CUB | RAB

This command is used to specify the type of burst to be analyzed. Only bursts of the specified type take part in measurement analysis.

NDB   Normal Downlink Burst
NUB   Normal Uplink Burst
CUB   Control Uplink Burst
RAB   Random Access Burst

Example: `"SENS:DEM:FORM:BAN:BTYP NUB"` The R&S FS-K110 option analyzes using a normal uplink burst slot type.

Characteristics: *RST value: NUL
                      SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:CADRoop

This command sets whether amplitude droop compensation will be used when the measurement is performed.

Example: `"SENS:DEM:FORM:BAN:CADR 1` The R&S FS-K110 option analyzes using pilot tracking.

Characteristics: *RST value: OFF
                      SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:CIQOffset

This command sets whether IQ offset compensation will be used when the measurement is performed.

Example: "SENS:DEM:FORM:BAN:CIQO 1: The R&S FS-K110 option analyzes using pilot tracking.

Characteristics: *RST value: OFF
                        SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:MCARrier   KH1 | KH10

This command sets the maximum carrier offset that will be used when the measurement is performed.
KH1:   1 kHz maximum carrier offset.
KH10:   10 kHz maximum carrier offset.

Example: "SENS:DEM:FORM:BAN:MCAR KH1   The R&S FS-K110 option analyzes using a 1 KHz maximum carrier offset.

Characteristics: *RST value: 10KHz
                        SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:MODulation   QM4 | QM16 | QM6**4**

This command sets the analysis modulation format that will be used when the measurement is performed. Note that when slot type is Random Access Burst (RAB), only QM4 modulation is supported. Selecting other modulations with slot type RAB will return an error.

QM4   Quadrature Amplitude Modulation 4 (2 bits)
QM16   Quadrature Amplitude Modulation 16 (4 bits)
QM64   Quadrature Amplitude Modulation 64 (6 bits)

Example: "SENS:DEM:FORM:BAN:MOD QM16   The R&S FS-K110 option analyzes using a QAM16 modulation type.

Characteristics: *RST value: QAM64
                        SCPI: device-specific

[SENSe:]DEMod:FORMat:BANalyze:PTRAcking   <Boolean>

This command sets whether Pilot Tracking will be used when the measurement is performed.

Example: "SENS:DEM:FORM:BAN:PTRA 1"   The R&S FS-K110 option analyzes using pilot tracking.

Characteristics: *RST value: OFF
                        SCPI: device-specific

[SENSe]:FREQuency:CENTer   <numeric value>

The remote control command is used to specify the frequency that the Analyzer will use to make measurements against the input signal.

Example: "SENS:FREQ:CENT 50MHZ"   The R&S FS-K110 option uses the specified frequency value to set the Analyzer detection frequency.

Characteristics: *RST value: 1GHz
                        SCPI: conforming

[SENSe]:IQ:DITHer[:STATe] <Boolean>

This remote control command links a 2 MHz broad dithering signal at 42.67 MHz into the signal path of the analog Baseband inputs. Note that this command requires HW option B71.

Example: "SENS:IQ:DITH 1" switches on the 2 MHz broad dither signal

Characteristics: *RST value: FALSE
                      SCPI: conforming

[SENSe]:IQ:FREQuency[:CENTer] <numeric value>

This instruction sets the IQ value for Center Frequency. Note that this is an independent value for center frequency that is used while dithering is active. This command requires option B71.

Example: "SENS:IQ:FREQ:CENT 50MHZ

Characteristics: *RST value: 0
                      SCPI: conforming

[SENSe]:IQ:LPASs[:STATe] <Boolean>

This instruction switches an anti-aliasing filter into the I and Q branch of the analog Baseband inputs. Note that this command requires option B71.

Example: "SENS:IQ:LPASs 1"   Switches on the low pass filter for the IQ inputs.

Characteristics: *RST value: FALSE
                      SCPI: conforming

[SENSe:]SWAPiq <Boolean>

This command defines whether or not the recorded IQ pairs should be swapped (I<->Q) before being processed.

Example: "SENS:SWAP 1"   Specifies that IQ values should be swapped.

Characteristics: *RST value: FALSE
                      SCPI: conforming

[SENSe]:SWEep:TIME <numeric value>

This remote control command is used to specify the sweep acquisition period (capture time) for which the input signal is to be captured. Allowed range is 34 ms to 1.53 seconds. The slot value is automatically updated. See [SENSe]:SWEep:SLOT.

Example: "SENS:SWE:TIME 0.040"   The TEDS option uses 40ms as the specified
                                            sweep acquisition period.

Characteristics: *RST value: 85ms
                      SCPI: device-specific

[SENSe]:SWEep:SLOTs <numeric value>

This remote control command is used to specify the sweep acquisition period (capture time) in "TEDS slot duration" units for which the input signal is to be captured. Allowed range is 2.4 to 108 "TEDS slot duration" units. The time value is automatically updated. See [SENSe]:SWEep:TIME.

Example: "SENS:SWE:SLOT 10"   The TEDS option uses 10 TEDS slots for the specified
                                          sweep acquisition period.

Characteristics: *RST value: 6
                      SCPI: device-specific

STATus Subsystem

The STATus subsystem contains the commands for the status reporting system. Refer to section "Status Reporting Registers" for more information on the status registers. *RST does not influence the status registers.

COMMAND	PARAMETERS	UNIT	COMMENT
::STATus			
:QUEStionable			
:ACPLimit			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:LIMit<1|2|3>			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:POWer			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	
:SYNC			
[:EVENt]?	--	--	
:CONDition?	--	--	
:ENABle	0 to 65535	--	
:PTRansition	0 to 65535	--	
:NTRansition	0 to 65535	--	

STATus:QUEStionable:ACPLimit[:EVENt]?

This command queries the contents of the EVENt section of the STATus:QUEStionable:ACPLimit Register.

Readout deletes the contents of the EVENt section.

Example: "STAT:QUES:ACPL?"

Characteristics: *RST value: -
                      SCPI: device-specific

STATus:QUEStionable:ACPLimit:CONDition?

This command queries the contents of the CONDition section of the STATus:QUEStionable:ACPLimit register.

Readout does not delete the contents of the CONDition section.

Example: "STAT:QUES:ACPL:COND?"

Characteristics: *RST value: -
                      SCPI: Conforming

STATus:QUEStionable:ACPLimit:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable:ACPLimit register. The ENABle register selectively enables the individual events of the associated EVENt section for the summary bit.

Example: `"STAT:QUES:ACPL:ENAB 65535"`   All events bits will be represented in the
                                                        LIMit summary bit.

Characteristics: *RST value: 65535
                                SCPI: device-specific

STATus:QUEStionable:ACPLimit:PTRansition 0 to 65535

This command determines what bits in the STATus:QUEStionable:ACPLimit Condition register of screen A or B will set the corresponding bit in the STATus:QUEStionable:ACPLimit Event register when that bit has a positive transition (0 to 1).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: `"STAT:QUES:ACPL:PTR 65535"`All condition bits will be summarized in the
                                                        Event register when a positive transition occurs.

Characteristics: *RST value: -65535
                                SCPI: device-specific

STATus:QUEStionable:ACPLimit:NTRansition 0 to 65535

This command determines what bits in the STATus:QUEStionable:ACPLimit Condition register will set the corresponding bit in the STATus:QUEStionable:ACPLimit Event register when that bit has a negative transition (1 to 0).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: `"STAT:QUES:ACPL:NTR 65535"` All condition bits will be summarized in the
                                                        Event register when a positive transition occurs.

Characteristics: *RST value: 0
                                SCPI: device-specific

STATus:QUESionable:LIMit<1|2|3>[:EVENt]?

This command queries the contents of the EVENt section of the STATus:QUEStionable:LIMit register. Readout deletes the contents of the EVENt section.

Example: `"STAT:QUES:LIM?"`

Characteristics: *RST value: -
                                SCPI: device-specific

STATus:QUESionable:LIMit<1|2|3>:CONDition

This command queries the contents of the CONDition section of the STATus:QUEStionable:LIMit register. Readout does not delete the contents of the CONDition section.

Example: `"STAT:QUES:LIM:COND?"`

Characteristics: *RST value: -
                                SCPI: device-specific

STATus:QUESionable:LIMit<1|2|3>:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable:LIMit. The ENABle register selectively enables the individual events of the associated EVENt section for the summary bit.

Example:	`"STAT:QUES:LIM:ENAB 65535"`	All events bits will be represented in the LIMit summary bit.

Characteristics:	*RST value:	65535
	SCPI:	device-specific

STATus:QUESionable:LIMit<1|2|3>:PTRansition 0 to 65535

This command determines what bits in the STATus:QUESionable:LIMit Condition register will set the corresponding bit in the STATus:QUESionable:LIMit Event register when that bit has a positive transition (0 to 1).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example:	`"STAT:QUES:LIMit:PTR 65535"`	All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics:	*RST value:	65535
	SCPI:	device-specific

STATus:QUESionable:LIMit<1|2|3>:NTRansition 0 to 65535

This command determines what bits in the STATus:QUESionable:LIMit Condition register will set the corresponding bit in the STATus:QUESionable:LIMit Event register when that bit has a negative transition (1 to 0).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example:	`"STAT:QUES:LIM:NTR 65535"`	All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics:	*RST value:	0
	SCPI:	device-specific

STATus:QUESionable:POWer:CONDition?

This command queries the contents of the CONDition section of the STATus:QUEStionable:POWer register. Readout does not delete the contents of the CONDition section.

Example:	`"STAT:QUES:POW:COND?"`

Characteristics:	*RST value:	-
	SCPI:	device-specific

STATus:QUESionable:POWer:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable:POWer register. The ENABle register selectively enables the individual events of the associated EVENt section for the summary bit.

Example:	`"STAT:QUES:POW:ENAB 65535"`	All events bits will be represented in the POWer summary bit.

Characteristics:	*RST value:	65535
	SCPI:	device-specific

STATus:QUESionable:POWer:PTRansition 0 to 65535

This command determines what bits in the STATus:QUESionable:POWer Condition register will set the corresponding bit in the STATus:QUESionable:POWer Event register when that bit has a positive transition (0 to 1).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: `"STAT:QUES:POWer:PTR 65535"` All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: 65535
SCPI: device-specific

STATus:QUESionable:POWer:NTRansition 0 to 65535

This command determines what bits in the STATus:QUESionable:POWer Condition will set the corresponding bit in the STATus:QUESionable:POWer Event register when that bit has a negative transition (1 to 0).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: `"STAT:QUES:POW:NTR 65535"` All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: 0
SCPI: device-specific

STATus:QUEStionable:SYNC:CONDition?

This command queries the contents of the CONDition section of the STATus:QUEStionable:SYNC register. Readout does not delete the contents of the CONDition section.

Example: `"STAT:QUES:SYNC:COND?"`

Characteristics: *RST value: -
SCPI: Conforming

STATus:QUEStionable:SYNC:ENABle 0 to 65535

This command sets the bits of the ENABle section of the STATus:QUEStionable:SYNC register. The ENABle register selectively enables the individual events of the associated EVENt section for the summary bit.

Example: `"STAT:QUES:SYNC:ENAB 65535"` All events bits will be represented in the SYNC summary bit.

Characteristics: *RST value: 65535
SCPI: device-specific

STATus:QUEStionable:SYNC:PTRansition 0 to 65535

This command determines what bits in the STATus:QUEStionable:SYNC Condition register will set the corresponding bit in the STATus:QUEStionable:SYNC Event register when that bit has a positive transition (0 to 1).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: `"STAT:QUES:SYNC:PTR 65535"` All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: 65535
                      SCPI: device-specific

STATus:QUEStionable:SYNC:NTRansition 0 to 65535

This command determines what bits in the STATus:QUEStionable:SYNC Condition will set the corresponding bit in the STATus:QUEStionable:SYNC Event register when that bit has a negative transition (1 to 0).The variable <number> is the sum of the decimal values of the bits that are to be enabled.

Example: `"STAT:QUES:SYNC:NTR 65535"` All condition bits will be summarized in the Event register when a positive transition occurs.

Characteristics: *RST value: 0
                      SCPI: device-specific

Trace Subsystem

The trace subsystem controls access to the R&S FS-K110 option's internal trace memory.

COMMAND	PARAMETERS	UNIT	COMMENT
TRACe< 1| 2>			
[:DATA]	TRACE1 | TRACE2 | TRACE3 | TRACE4		Query only
:IQ			
:DATA			
:MEMory?			Currently not available yet!
:SRATe?		Hz	Query only

TRACe[:DATA]? TRACE1 | TRACE2 | TRACE3 | TRACE4

This command returns the measured trace data for the currently selected measurement. The desired measurement window is selected with the numeric suffix of the TRACe<1|2> command where TRACe1 equals screen A and TRACe2 equals screen B. The returned values are scaled in the current level units Note: For analog or digital Baseband operation the trace of measurement Magnitude Capture Display is returned in "Volt".

This command is not available while a measurement is in progress. The format of the returned data is controlled with the FORMat[:DATA] command. The FORMat[:DATA] command must be issued prior to the TRACe command. Refer to page 167 for information on which formats are supported by the measurement.

ASCII format (FORMat ASCii):

In ASCII format, a list of values separated by commas is returned (Comma Separated Values = CSV). The number of trace values returned for each measurement is shown in Table 14. The ASCII format is not as efficient for transferring large amounts of data. For larger traces use one of the binary formats: REAL or UINT.

Binary format (FORMat REAL):

If the transmission takes place using the REAL binary format, the data is transferred in block format (Definite Length Block Data according to IEEE 754). The general structure of the return values is shown in the following example:

#42568<trace value 1><trace value 2> …<trace value 642>

Where:

- #4: digits of the subsequent number of data bytes (4 in the example, "2568" consists of 4 digits)

- 2568: Number of subsequent data bytes (642 trace values x 4 per float)

- <trace value x>: 4 byte floating point measurement trace value

Binary format (FORMat UINT) (valid for Bitstream measurement only):

If the transmission takes place using the UINT binary format, the data is transferred in block format (Definite Length Block Data according to IEEE 754). The general structure of the return values is shown in the following example:

#3272<trace value 1><trace value 2> …<trace value 272>

Where:

- #3: digits of the subsequent number of data bytes (3 in the example, "272" consists of 3 digits)

- 272: Number of subsequent data bytes (272 symbols x 1 per UINT8)

- <trace value x>: 1 byte unsigned integer measurement bitstream value

Table 14   Number of values returned for measurements.

Measurement	FORMat:Data	Number of Values Returned
ACP due to Modulation	FORMat ASCii FORMat REAL Floating point values	642
ACP due to Transients - Lower	FORMat ASCii FORMat REAL Floating point values	642
ACP due to Transients – Upper	FORMat ASCii FORMat REAL Floating point values	642
Bitstream	FORMat ASCii FORMat UINT Hexadecimal values	TRACE1 – Number of Header symbols in slot. Depends on Slot type. TRACE2 – Number of Data symbols in slot. Depends on Slot type and Channel Bandwidth. Cf. Table 15
Capture Memory	FORMat ASCii FORMat REAL Floating point values	4000
Constellation vs. Carrier*		Currently not available yet.
Constellation vs. Symbol*		Currently not available yet.
EVM vs. Carrier	FORMat ASCii FORMat REAL Floating point values	<u>Channel Bandwidth</u> 8 – 25 kHz (8 carriers) 16 – 50 kHz (16 carriers) 32 – 100 kHz (32 carriers) 48 – 150 kHz (48 carriers)
EVM vs. Symbol Magnitude Error vs. Symbol Phase Error vs. Symbol	FORMat ASCii FORMat REAL Floating point values	<u>Slot Type</u> 34 – Normal Downlink Burst 31 – Normal Uplink Burst 14 – Control Uplink Burst 14 – Random Access Burst
Flatness Carrier (Not supported yet)	FORMat ASCii FORMat REAL Floating point values	<u>Channel Bandwidth</u> 8 – 25 kHz (8 carriers) 16 – 50 kHz (16 carriers) 32 – 100 kHz (32 carriers) 48 – 150 kHz (48 carriers)
Flatness Pilots (Not supported yet)	FORMat ASCii FORMat REAL Floating point values	<u>Channel Bandwidth</u> 8 – 25 kHz (8 carriers) 16 – 50 kHz (16 carriers) 32 – 100 kHz (32 carriers) 48 – 150 kHz (48 carriers) Note: Only subcarriers containing at least one pilot symbol can have a valid result. You have to ignore the result samples returned for subcarriers not containing any pilot symbols.
Power vs. Time	FORMat ASCii FORMat REAL Floating point values	642
Spectrum FFT	FORMat ASCii FORMat REAL Floating point values	642

Trace Mapping

The TRACE command parameter corresponds to the screen traces as shown in . The TRACEX parameter corresponds to the trace numbering arrangement on the display screen.

Table 15   Trace parameter to screen trace designation (NA: Not Available).

TRACe Parameter	Most measurements with 4 Traces	Flatness Not yet supported	Capture Memory	ACP Mod	ACP Trans	Bitstream	Spectrum FFT
TRACE1	Current	RMS	Capture Memory	Current	Current	Header Symbols	Current
TRACE2	Minimum	Minimum	NA	NA	NA	Payload Symbols	NA
TRACE3	Peak	Peak	NA	NA	Peak	NA	NA
TRACE4	Average	Average	NA	NA	Average	NA	Average

Bitstream Measurement

The Bitstream TRACE command supports 2 parameters: TRACE1 and TRACE2.
Specifying parameter TRACE1 returns the Header symbols only. Header symbol data is returned in sequential ascending order (H1, H2, H3, …). The amount of header symbols returned varies depending upon the current slot type. In the case of the Random Access Burst, no Header symbols are available and an error code is returned. Please refer to for header and payload sizes for each slot type.
Specifying parameter TRACE2 returns the payload data symbols only. The payload symbols are returned in sequential ascending order (D1, D2, D3, …). The amount of payload symbols varies depending upon the current slot type. Please refer to Table 15 for header and payload sizes for each slot type.
The format of the returned data is identical for header and payload symbols. Each symbol value is represented by a 1 byte unsigned integer value. Supported data formats are ASCII and UINT. Please refer to the FORMat[:DATA] command. If ASCII format is selected, data is represented as a series of comma separated hexadecimal ASCII values. No prefix such as "0x" is used.
For additional information concerning the positioning of header and payload symbols for the different slot types please refer to standard [2], Annex P.

Table 16   Number of header and payload symbols for each slot type.

Channel bandwidth	Random Access	Control uplink	Normal uplink	Normal downlink
25 KHz	Payload: 84 Header: 0	Payload: 76 Header: 8	Payload: 200 Header: 8	Payload: 204 Header: 32
50 KHz	N.A.	Payload: 160 Header: 8	Payload: 408 Header: 8	Payload: 440 Header: 32
100 KHz	N.A.	Payload: 328 Header: 8	Payload: 824 Header: 8	Payload: 912 Header: 32
150 KHz	N.A.	Payload: 496 Header: 8	Payload: 1240 Header: 8	Payload: 1384 Header: 32

Examples:

`"CONF:BURS:STAT:BSTR"`	Select the Bitstream measurement.
`"FORM:DATA UINT"`	The trace data will be returned as unsigned binary 8 bit integers in Definite Length Block Data according to IEEE 754.
`"TRACE2:DATA? TRACE1"`	The header data symbols associated with screen B, for the Bitstream measurement are returned. Note that TRACe1 is not a valid selection for measurements that display a results summary table in screen A.
`"FORM:DATA ASC"`	The trace data will be returned as comma separated floating point values in ASCII format.
`"CONF:BURS:SPEC:FFT"`	Select the Spectrum FFT measurement. Spectrum FFT has the Capture Memory buffer available. Note that Spectrum FFT has only two traces available: Average and Current (TRACE1 and TRACE4).
`"TRACE2:DATA? TRACE4"`	Returns the Spectrum FFT Average trace.
`"TRACE2:DATA? TRACE1"`	Returns the Spectrum FFT Current trace.
`"TRACE2:DATA? TRACE2"`	Returns an error "Not Available".
`"TRACE1:DATA? TRACE1"`	Returns the Capture Memory trace. Note that the Capture Memory trace is available only on measurements that do not have summary tables. Only TRACE1 is available for Capture Memory.

TRACe:IQ:DATA:SRATe?

This command returns the sampling rate in Hz for the current IQ data.

Example: `"TRAC:IQ:DATA:SRAT?"`   Returns the current sampling rate in Hertz.

Characteristics;   RST value: -
                       SCPI: device-specific

IQ Measurements

TRACe:IQ:DATA:MEMory?

Returns all the IQ data associated with the current measurement.
Currently not available yet..

Trigger Subsystem

The trigger subsystem is used to synchronize device action(s) with events.

COMMAND	PARAMETERS	UNIT	COMMENT
TRIGger			
[:SEQuence]			
:MODE	IMMediate | EXTernal | POWer		
:LEVel			
[:EXTernal]	\<numeric_value\>	V	
:POWer	\<numeric_value\>	DBM	
:AUTO	\<Boolean\>		**Currently not available yet!**.
:IQ	\<numeric_value\>	V	
:HOLDoff	\<numeric_value\>	S	Holdoff in seconds
:SLOT	\<numeric_value\>		Holdoff in Slots

TRIGger[:SEQuence]:MODE   IMM | EXT | POW

This command configures the triggering mode used by the instrument.

IMMediate   no triggering condition. This is the free run setting.

EXTernal   the next measurement is triggered by the signal at the external trigger input e.g. a gated trigger.

POWer   triggering of the measurement via signals which exceed the specified level.

Example: "TRIG:SEQ:IMM" AUTO triggering will occur for the next measurement at the specified power level value.

Characteristics: *RST value: IMMediate
                        SCPI: device-specific

TRIGger[:SEQuence]:LEVel[:EXTernal] \<numeric value\>

This command accepts the level of the external trigger input for which triggering will occur.

Example: "TRIG:LEV 1 V"

Characteristics: *RST value: 1 V
                        SCPI: device-specific

TRIGger[:SEQuence]:LEVel:POWer \<numeric value\>

This command accepts the level of the input signal in dBm for which triggering will occur. .

Example: "TRIG:LEV:POW 10 DBM"

Characteristics: *RST value: 0 DBM
                        SCPI: device-specific

TRIGger[:SEQuence]:LEVel:IQ \<numeric value\>

This command accepts the level of the analog Baseband trigger input for which triggering will occur.

Example: "TRIG:LEV:IQ 1 V"

Characteristics: *RST value: 1 V
                        SCPI: device-specific

TRIGger[:SEQuence]:LEVel:POWer:AUTO <Boolean>

This command specifies whether or not an automatic power trigger level calculation is performed before each main measurement. The setting of this command is ignored if the setting for TRIGger[:SEQuence]:MODE is not POWer.

Currently not available yet!

Example:	`"TRIG:LEV:POW:AUTO 1"`	Specifies that an automatic power trigger level calculation should be performed before the start of each main measurement.

Characteristics: *RST value: TRUE
                        SCPI: device-specific

TRIGger[:SEQuence]:HOLDoff <numeric value>

This command sets the length of the trigger delay in seconds. Allowed range is 0 to 100 seconds. The slot value is automatically updated. See TRIGger[:SEQuence]:HOLDoff:SLOT.

Example:	`"TRIG:HOLD 500us"`	The R&S FS-K110 option uses a delay period of 500us after the trigger condition has been met.

Characteristics: *RST value: 0s
                        SCPI: Conforming

TRIGger[:SEQuence]:HOLDoff:SLOT <numeric value>

This remote control command is used to specify the trigger delay period in "TEDS slot duration" units. Allowed range is -11 to 3000 "TEDS slot duration" units. The time value is automatically updated. See TRIGger[:SEQuence]:HOLDoff.

Example:	`"TRIG:HOLD:SLOT 5"`	The TEDS option uses a delay period of 5 slots after the trigger condition has been met.

Characteristics: *RST value: 0
                        SCPI: Conforming

UNIT Subsystem

The unit subsystem specifies the units for specific result types.

COMMAND	PARAMETERS	UNIT	COMMENT
:UNIT			
:EVM	DB | PCT		
:GIMBalance	DB | PCT		

UNIT:EVM DB | PCT

This command specifies the units for EVM Summary Table results. See FETCh:BURSt:SUMTable.

DB   EVM summary table results returned in dB

PCT   EVM summary table results returned in %

Example: "UNIT:EVM PCT" EVM results returned in %.

Characteristics: *RST value: DB
                     SCPI: device-specific

UNIT:GIMBalance DB | PCT

This command specifies the units for Gain Imbalance Summary Table results. See FETCh:BURSt:SUMTable.

DB   Gain Imbalance summary table results returned in dB

PCT   Gain Imbalance summary table results returned in %

Example: "UNIT:GIMB PCT"   Gain Imbalance results to be returned in %.

Characteristics: *RST value: DB
                     SCPI: device-specific

5 Status Reporting Registers

The status reporting system (see Fig. 62) stores all information on the present operating state of the instrument, e.g. that the instrument presently carries out a calibration and on errors which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via IEC bus.

The information is of a hierarchical structure. The register status byte (STB) defined in IEEE 488.2 and its associated mask register service request enable (SRE) form the uppermost level. The STB receives its information from the standard event status register (ESR) (defined in IEEE 488.2) with the associated mask register standard event status enable (ESE) and the STATus:OPERation and STATus:QUEStionable registers which are defined by SCPI. The STATus:OPERation and STATus:QUEStionable registers contain high level information on current instrument operational status which is collected from lower level registers. Note that for R&S FS-K110 register values to be reflected to the STATus:OPERation and STB registers, the corresponding bits must be enabled in the STATus:QUEStionable register. The STB bit corresponding to the STATus:QUEStionable register will not be cleared until the STATus:QUEStionable:EVENt register is read.

The IST flag ("Individual STatus") and the parallel poll enable register (PPE) allocated to it are also part of the status reporting system. The IST flag, like the SRQ, combines the entire instrument status in a single bit. The PPE fulfils the same function for the IST flag as the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB and thus is represented in.
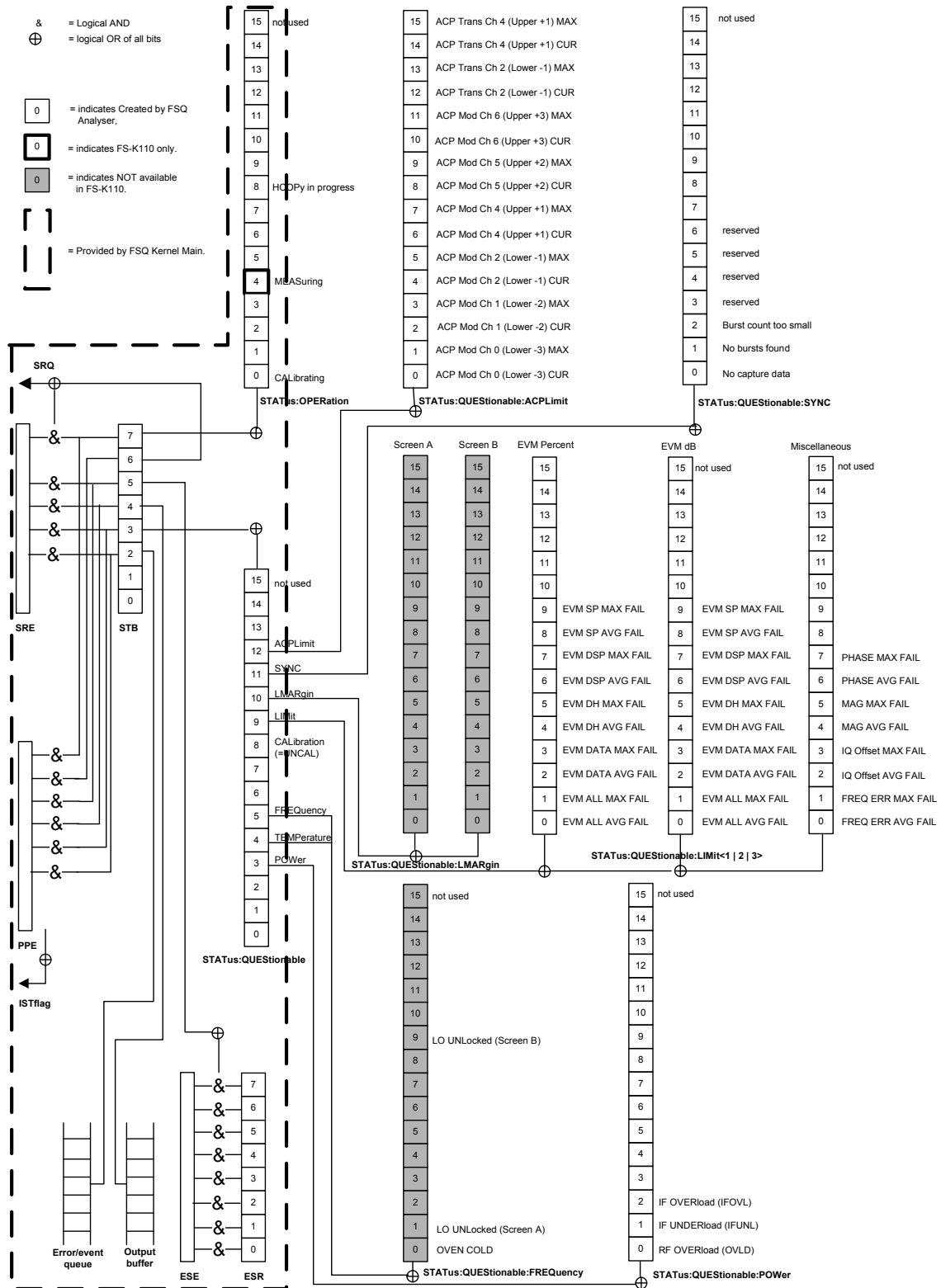
Fig. 62   Overview of the R&S FS-K110 status registers

Description of the Status Registers

All the status registers shown in Fig. 62 are the same as those provided by the base system, with the exception of the following:

STATus:OPERation – Although this register is provided by R&S FSP Kernel main, R&S FS-K110 makes use of bit 4 in this register. This register is available from the R&S FS-K110 command tree.

STATus: QUESTionable – Although this register is provided by R&S FSP Kernel main, R&S FS-K110 makes use of bits 9, 11, and 12 in this register. This register is available from the R&S FS-K110 command tree. Note that for the following R&S FS-K110 register values to be reflected to the STATus:QUES:CONDition register, the appropriate bits must be enabled with the STATus:QUEStionable:ENABle command. The default value for the ENABLE command is all bits off.

STATus:QUESTionable:ACPLimit – This register is provided by R&S FS-K110 and is available from the R&S FS-K110 command tree.

STATus:QUESTionable:LIMit<1|2|3> – This register is provided by R&S FS-K110 and is available from the R&S FS-K110 command tree.

STATus:QUESTionable:LMARgin<1 | 2> – These registers are provided by the analyser and are not available from the R&S FS-K110 command tree.

STATus:QUESTionable:POWer – This register is provided by R&S FS-K110 and is available from the R&S FS-K110 command tree.

STAT:QUES:ENAB – This register is provided by R&S FS-K110 and is available from the R&S FS-K110 command tree.

The deviations from the status register structure of the base system are detailed below.

STATus:OPERation Register

This register contains information regarding FSQ operating conditions. In the CONDition command, this register contains information on which actions the instrument is currently executing. In the EVENt command, this register contains information on which actions the instrument has executed since the last reading. Reading the EVENt portion causes the condition to clear. These registers can be read using commands:

"`STATus:OPERation:CONDition?`"

"`STATus:OPERation[:EVENt]?`".

Table 17   Register STATus:OPERation

Bit No	Meaning
0	**CALibrating** This bit is set as long as the instrument is performing a calibration.
1 to 3	These bits are not used
4	**MEASuring** A '1' in this bit position indicates that a FS-K110 measurement is in progress.
5 to 7	These bits are not used
8	**HardCOPy in progress** This bit is set while the instrument is printing a hardcopy.
9 to 14	These bits are not used
15	This bit is always 0

STATus:QUEStionable Register

This register contains composite information regarding operational conditions which may occur. Bits 9, 11, and 12 shown in bold are affected by the R&S FS-K110 specific registers. Note that for the R&S FS-K110 register values to be reflected to the STATus:QUEStionable register that the bits must be enabled with the STATus:QUEStionable:ENABle command. The default value for the ENABLE command is all bits off. The STATus:QUEStionable register can be queried by commands:

STATus:QUEStionable:CONDition?

STATus:QUEStionable[:EVENt]?.

Table 18   Register STATus:QUEStionable

Bit No	Meaning
0 to 2	These bits are not used
3	POWer This bit is set if a questionable power occurs (cf. also section "STATus:QUEStionable:POWer Register").
4	TEMPerature This bit is set if a questionable temperature occurs.
5	FREQuency The bit is set if a frequency is questionable (cf. section "STATus:QUEStionable:FREQuency Register").
6 to 7	These bits are not used
8	CALibration The bit is set if a measurement is performed uncalibrated
9	**LIMit** (device-specific) This bit is set if a limit value is violated (see also section STATus:QUEStionable:LIMit Register). Note: Limit registers are associated with limit for the EVM and Summary Table measurements only.
10	LMARgin (device-specific) This bit is set if a margin is violated (see also section STATus:QUEStionable:LMARgin Register)
11	**SYNC** This bit is set if a questionable R&S FS-K110 acquisition or demodulation condition occurs (see also section STATus:QUEStionable:SYNC).
12	**ACPLimit** This bit is set if a limit for the adjacent channel power measurement is violated (see also section "STATus: QUEStionable:ACPLimit Register").
13 to 14	These bits are not used
15	This bit is always 0

STATus:QUEStionable:ACPLimit Register - ACP Related Limits

This register contains information regarding limits for ACP due to Modulation and ACP due to Upper and Lower transient measurements. This register can be queried with commands:

STATus:QUEStionable:ACPL:CONDition?

STATus:QUEStionable:ACPL[:EVENt]?.

Table 19   Register STATus:QUEStionable:ACPL

Bit No	Limit Register 1 Meaning
0	**ACP Modulation Relative Channel -3 Current Limit Fail** This bit is set if the ACP Modulation 3rd lower channel current limit is exceeded.
1	**ACP Modulation Relative Channel -3 Maximum Limit Fail** This bit is set if the ACP Modulation 3rd lower channel maximum limit is exceeded.
2	**ACP Modulation Relative Channel -2 Current Limit Fail** This bit is set if the ACP Modulation 2nd lower channel current limit is exceeded
3	**ACP Modulation Relative Channel -2 Maximum Limit Fail** This bit is set if the ACP Modulation 2nd lower channel maximum limit is exceeded
4	**ACP Modulation Relative Channel -1 Current Limit Fail** This bit is set if the ACP Modulation 1st lower channel current limit is exceeded
5	**ACP Modulation Relative Channel -1 Maximum Limit Fail** This bit is set if the ACP Modulation 1st lower channel maximum limit is exceeded
6	**ACP Modulation Relative Channel 1 Current Limit Fail** This bit is set if the ACP Modulation 1st upper channel current limit is exceeded
7	**ACP Modulation Relative Channel 1 Maximum Limit Fail** This bit is set if the ACP Modulation 1st upper channel maximum limit is exceeded
8	**ACP Modulation Relative Channel 2 Current Limit Fail** This bit is set if the ACP Modulation 2nd upper channel current limit is exceeded
9	**ACP Modulation Relative Channel 2 Maximum Limit Fail** This bit is set if the ACP Modulation 2nd upper channel maximum limit is exceeded
10	**ACP Modulation Relative Channel 3 Current Limit Fail** This bit is set if the ACP Modulation 3rd upper channel current limit is exceeded
11	**ACP Modulation Relative Channel 3 Maximum Limit Fail** This bit is set if the ACP Modulation 3rd upper channel maximum limit is exceeded
12	**ACP Transient Lower Channel -1 Current Limit Fail** This bit is set if the ACP Transient 1st lower channel current limit is exceeded
13	**ACP Transient Lower Channel -1 Maximum Limit Fail** This bit is set if the ACP Transient 1st lower channel maximum limit is exceeded
14	**ACP Transient Upper Channel +1 Current Limit Fail** This bit is set if the ACP Transient 1st upper channel current limit is exceeded
15	**ACP Transient Upper Channel +1 Maximum Limit Fail** This bit is set if the ACP Transient 1st upper channel maximum limit is exceeded

STATus:QUEStionable:LIMit <1 | 2 | 3> Registers 1, 2 - EVM Related Limits

This register contains information regarding EVM limits for the Summary Table measurement (LIMit 1 corresponds to EVM limits in percent, LIMit 2 to EVM limits in dB, LIMit 3 to miscellaneous limits). Limit Registers 1 and 2 have identical bit layouts as shown below. These registers can be queried with commands:

```
STATus:QUEStionable:LIMit<1|2>:CONDition?
STATus:QUEStionable:LIMit<1|2>[:EVENt]?.
```

Table 20   Register STATus:QUEStionable:LIMit

Bit No	Limit Register 1 (percent and 2 (dB) Meaning
0	**EVM ALL Average Limit Fail** This bit is set if the EVM ALL average limit is exceeded.
1	**EVM ALL Maximum Limit Fail** This bit is set if the EVM ALL maximum limit is exceeded.
2	**EVM Data symbol Average Limit Fail** This bit is set if the EVM data symbol average limit is exceeded.
3	**EVM Data symbol Maximum Limit Fail** This bit is set if the EVM data symbol maximum limit is exceeded
4	**EVM Data + Header symbols Average Limit Fail** This bit is set if the EVM data + header symbols average limit is exceeded.
5	**EVM Data + Header symbols Maximum Limit Fail** This bit is set if the EVM data + header symbols maximum limit is exceeded.
6	**EVM Data + Sync + Pilot symbols Average Limit Fail** This bit is set if the EVM data + sync + pilot symbols average limit is exceeded
7	**EVM Data + Sync + Pilot symbols Maximum Limit Fail** This bit is set if the EVM data + sync + pilot symbols maximum limit is exceeded
8	**EVM Sync + Pilot symbols Average Limit Fail** This bit is set if the EVM sync + pilot symbols average limit is exceeded
9	**EVM Sync + Pilot symbols Maximum Limit Fail** This bit is set if the EVM sync + pilot symbols maximum limit is exceeded
10-15	These bits are not used

STATus:QUEStionable:LIMit<1 | 2 | 3> Register 3 - Miscellaneous Limits

This register contains information regarding miscellaneous limit conditions related to the Summary Table measurement (LIMit<1|2> corresponds to EVM related limits, LIMit<3> to miscellaneous limits). This register can be queried with commands:

STATus:QUEStionable:LIMit3:CONDition?

STATus:QUEStionable:LIMit3[:EVENt]?.

Table 21   Register STATus:QUEStionable:LIMit3

Bit No	Limit Register 3 Meaning
0	**Frequency Error Average Limit Fail** This bit is set if the Frequency Error average limit is exceeded.
1	**Frequency Error Maximum Limit Fail** This bit is set if the Frequency Error maximum limit is exceeded.
2	**IQ Offset Error Average Limit Fail** This bit is set if the IQ Offset error average limit is exceeded.
3	**IQ Offset Error Maximum Limit Fail** This bit is set if the IQ Offset error maximum limit is exceeded
4	**Magnitude Error Average Limit Fail** This bit is set if the Magnitude Error average limit is exceeded.
5	**Magnitude Error Maximum Limit Fail** This bit is set if the Magnitude Error maximum limit is exceeded.
6	**Phase Error Average Limit Fail** This bit is set if the Phase Error average limit is exceeded
7	**Phase Error Maximum Limit Fail** This bit is set if the Phase Error maximum limit is exceeded
8-15	These bits are not used

STATus:QUEStionable:POWer Register

This register contains information regarding the RF path signal power conditions The bits can be queried with commands:

`"STATus:QUEStionable:POWer:CONDition?"`

`"STATus:QUEStionable:POWer[:EVENt]?"`.

Table 22   Register STATus:QUEStionable:POWer

Bit No	Meaning
0	**RF OVERload** This bit is set if the RF input is overloaded. "OVLD" will be displayed during this condition.
1	**IF UNDERload** This bit is set if the IF path is under loaded. "IFUNL" will be displayed during this condition.
2	**IF OVERload** This bit is set if the IF path is over loaded. "IFOVL" will be displayed during this condition.
3 to 15	These bits are not used

STATus:QUEStionable:SYNC Register

This register contains signal processing related information about bursts and about pre-measurement conditions exceeding or falling short of expected values. The bits can be queried with commands:

"STATus:QUEStionable:SYNC:CONDition?"

"STATus:QUEStionable:SYNC[:EVENt]?".

Table 23   Register STATus:QUEStionable:SYNC

Bit No	Meaning
0	**No capture data** This bit is set if no capture data is present or a trigger has not occurred.
1	**No bursts found** This bit is set if a measurement is performed and no bursts (slots) are detected
2	**Burst count too small** This bit is set if a demodulation measurement is performed and there are not enough bursts detected to satisfy the "Number of Slots to Analyze". This parameter is set with SENSe:BURSt:COUNt command.
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7 to 14	These bits are not used
15	This bit is always 0

Error Reporting

Error reporting for the K110 option is carried out using the Service Request (SRQ) interrupt in the GPIB interface. When an error occurs a Service Request interrupt will be generated. The master can then query the slave instrument for the error that triggered the interrupt Errors are queried through the "SYSTem:ERRor" command.

6 Remote Control - Programming Examples

The following section provides some examples of commonly performed operations when using R&S FS-K110. For more general remote control examples please refer to the programming examples chapter in the instrument user manual.

Synchronization Entry of Option

The following example shows how to synchronize entering the R&S FS-K110 option.

```
analyzer% = 20,Instrument address
CALL IBWRT(analyzer%, "INST:SEL TETRA2;*OPC?") ,waits for 1 from *OPC?
```

Selecting Measurements

Measurements are selected using the command CONFigure:BURSt:<Meas Type> where <Meas Type> is as follows.

Table 24   Remote control commands for selecting measurements.

<Meas Type>	Measurement Type
CONSt:CCARrier	Constellation vs Carrier
CONSt:CSYMbol	Constellation vs Symbol
EVM:ECARrier	EVM vs Carrier
EVM:ESYMbol	EVM vs Symbol
MAGNitude	Magnitude Error vs Symbol
PHASe	Phase Error vs Symbol
PVT	Power vs Time (PVT)
SPECtrum:FFT	Spectrum FFT
SPECtrum:ACPR:MODulation	Spectrum ACPR due to Modulation
SPECtrum:ACPR:TUPPer	Spectrum ACPR due to Transients – Upper Channel
SPECtrum:ACPR:TLOWer	Spectrum ACPR due to Transients – Lower Channel
STATistics:BSTReam	Bitstream
SUMTable	Summary Table

The following example shows how to select a Spectrum FFT measurement:

```
REM select Spectrum FFT Measurement
CALL IBWRT(analyzer%, "CONF:BURS:SPECtrum:FFT")
```

Running Synchronized Measurements

The following examples show how measurements can be synchronized. Synchronization is necessary to ensure that the measurement has completed before the measurement results and markers are requested.

```
PUBLIC SUB SweepSync()

REM The command INITiate[:IMMediate] starts a single sweep if the
REM command INIT:CONT OFF was previously sent. It should be ensured that
REM the next command is only then executed when the entire sweep is
REM complete.
CALL IBWRT(analyzer%, "INIT:CONT OFF")

REM ------ First possibility: Use of *WAI (blocks until sweep is acquired)
CALL IBWRT(analyzer%, "INIT:IMM; *WAI")

REM ------ Second possibility: Use of *OPC? (blocks until sweep is acquired)
OpcOk$ = SPACE$(2) 'Space for *OPC? - Provide response
CALL IBWRT(analyzer%, "INIT:IMM; *OPC?")

REM ------ here the controller can service other instrument-------------
CALL IBRD(analyzer%, OpcOk$) 'Wait for "1" from *OPC?

REM ------- Third possibility: Use of *OPC --------------------------
REM In order to be able to use the service request function in
REM conjunction with a National Instruments GPIB driver, the setting
REM "Disable Auto Serial Poll" must be changed to "yes" by means of
REM IBCONF!
CALL IBWRT(analyzer%, "*SRE 32")  'Permit service request for ESR
CALL IBWRT(analyzer%, "*ESE 1")   'Set event-enable bit for operation-complete bit

CALL IBWRT(analyzer%, "INIT:IMM; *OPC") 'Start sweep and
                                        'synchronize with OPC

CALL WaitSRQ(boardID%,result%)    'Wait for service request

REM ------- Fourth possibility: Use of INIT:IMM ----------------------
REM In order to be able to use the service request function in
REM conjunction with a National Instruments GPIB driver, the setting
REM "Disable Auto Serial Poll" must be changed to "yes" by means of
REM IBCONF!
CALL IBWRT(analyzer%, "*SRE 128") 'Permit service request for STAT:OPERational
CALL IBWRT(analyzer%, "*ESE 0")   'Clear event-enable bit for operation-complete bit

CALL IBWRT(analyzer%, "STATus:OPERation:ENABle 16") 'Enable bit 4 (Measuring)of
                                                    'status operation register
CALL IBWRT(analyzer%, "STAT:OPERation:NTRansition 16") 'Set Negative
                              'transition to 1
CAL IBWRT(analyzer%, "STATus:OPERation:PTRansition 0") 'Set Positive
                              'transition to 0
CALL IBWRT(analyzer%, "INIT:IMM") 'Start sweep and synchronize with OPC

CALL WaitSRQ(boardID%,result%) 'Wait for service request

REM Continue main program here.

END SUB
REM                    ********************************************************************
```

7 List of Warnings & Error Messages

The list of possible warning & error messages are shown below:

Status Bar Message	Description
No bursts found	This message is displayed if no valid burst was detected in the input data. To correct this problem check the following:
	The connections between the DUT and analyzer are correct
	The input signal is of a sufficient level
	The capture time is long enough to capture at least one complete burst. If running with a Free Run trigger then the capture time must be greater than the burst length (ideally at least twice the burst length) to ensure that a complete burst is recorded.
	Check that the demod settings are correct
	Check the chapter "Trouble-shooting guide" on page 13.
No trigger found or No IQ Data	No trigger was found for capturing the input signal data. Either power or external signal level was set too high, or the external trigger connection has not been made.
Waiting for Capture	The application captures IQ data which can take over a second (cf. parameter Capture Time on page 71.

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