ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

Option SMIQB21

Bit Error Rate Test

1125.5490.02

**Before putting the product into operation for
the first time, make sure to read the following**

Safety Instructions

Rohde & Schwarz makes every effort to keep the safety standard of its products up to date and to offer its customers the highest possible degree of safety. Our products and the auxiliary equipment required for them are designed and tested in accordance with the relevant safety standards. Compliance with these standards is continuously monitored by our quality assurance system. This product has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards. To maintain this condition and to ensure safe operation, observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, Rohde & Schwarz 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 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 an 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 operating manual and within its performance limits (see data sheet, documentation, the following safety instructions). Using the products requires technical skills and knowledge of English. It is therefore essential that the products be used exclusively by skilled and specialized staff or thoroughly trained personnel with the required skills. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation.

Symbols and safety labels

Observe operating instructions	Weight indication for units >18 kg	Danger of electric shock	Warning! Hot surface	PE terminal	Ground	Ground terminal	Attention! Electrostatic sensitive devices

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

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 putting the product into operation. It is also absolutely essential to observe the additional safety instructions on personal safety that appear in other parts of the documentation. In these safety instructions, the word "product" refers to all merchandise sold and distributed by Rohde & Schwarz, including instruments, systems and all accessories.

Tags and their meaning

DANGER	This tag indicates a safety hazard with a high potential of risk for the user that can result in death or serious injuries.
WARNING	This tag indicates a safety hazard with a medium potential of risk for the user that can result in death or serious injuries.
CAUTION	This tag indicates a safety hazard with a low potential of risk for the user that can result in slight or minor injuries.
ATTENTION	This tag indicates the possibility of incorrect use that can cause damage to the product.
NOTE	This tag indicates a situation where the user should pay special attention to operating the product but which does not lead to damage.

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. It is therefore essential to make sure that the tags described here are always used only in connection with the associated documentation and the associated product. The use of tags in connection with unassociated products or unassociated documentation can result in misinterpretations and thus contribute to personal injury or material damage.

Basic safety instructions

1. The product may be operated only under the operating conditions and in the positions specified by the manufacturer. Its ventilation must not be obstructed during operation. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products: prescribed operating position is always with the housing floor facing down, IP protection 2X, pollution severity 2, overvoltage category 2, use only in enclosed spaces, max. operation altitude max. 2000 m. Unless specified otherwise in the data sheet, a tolerance of ±10% shall apply to the nominal voltage and of ±5% to the nominal frequency.

2. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed. The product may be opened only by authorized, specially trained personnel. Prior to performing any work on the product or opening the product, the product must be disconnected from the supply network. Any adjustments, replacements of parts, maintenance or repair must be carried out only by technical personnel 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).

3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens, e.g. nickel) such as aluminum cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties), consult a physician immediately to determine the cause.

4. If products/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, e.g. for disposal purposes, by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.

5. If handling the product yields 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.

6. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn life requires increased protection, pregnant women should be protected by appropriate measures. Persons with pacemakers may also be endangered by electromagnetic radiation. The employer is required to assess workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the danger.

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

8. Prior to switching on the product, it must be ensured 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.

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

10. 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.

11. If the product has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases, it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply. If products without power switches are integrated in racks or systems, a disconnecting device must be provided at the system level.

12. Never use the product if the power cable is damaged. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by e.g. tripping over the cable or suffering an electric shock.

13. The product may be operated only from TN/TT supply networks fused with max. 16 A.

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

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

16. 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.

17. Ensure that the connections with information technology equipment comply with IEC 950/EN 60950.

18. Never remove the cover or part of the housing while you are operating the product. This will expose circuits and components and can lead to injuries, fire or damage to the product.

19. 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 skilled electrician.

20. 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 suitable protection is provided for users and products.

21. Do not insert any objects into the openings in the housing that are not designed for this purpose. Never pour any liquids onto or into the housing. This can cause short circuits inside the product and/or electric shocks, fire or injuries.

22. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a thunderstorm) can reach the product. Otherwise the operating personnel will be endangered by electric shocks.

23. Rohde & Schwarz products are not protected against penetration of water, unless otherwise specified (see also safety instruction 1.). If this is not taken into account, there exists the danger of electric shock or damage to the product, which can also lead to personal injury.

24. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product was moved from a cold to a warm environment.

25. Do not close any slots or openings on the product, since they are necessary for ventilation and prevent the product from overheating. Do not place the product on soft surfaces such as sofas or rugs or inside a closed housing, unless this is well ventilated.

26. Do not place the product on heat-generating devices such as radiators or fan heaters. The temperature of the environment must not exceed the maximum temperature specified in the data sheet.

27. Batteries and storage batteries must not be exposed to high temperatures or fire. Keep batteries and storage batteries away from children. If batteries or storage batteries are improperly replaced, this can cause an explosion (warning: lithium cells). Replace the battery or storage battery only with the matching Rohde & Schwarz type (see spare parts list). Batteries and storage batteries are hazardous waste. Dispose of them only in specially marked containers. Observe local regulations regarding waste disposal. Do not short-circuit batteries or storage batteries.

28. Please be aware that in the event of a fire, toxic substances (gases, liquids etc.) that may be hazardous to your health may escape from the product.

29. Please be aware of the weight of the product. Be careful when moving it; otherwise you may injure your back or other parts of your body.

30. 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).

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

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

33. If a laser product (e.g. a CD/DVD drive) is integrated in a Rohde & Schwarz product, do not use any other settings or functions than those described in the documentation. Otherwise this may be hazardous to your health, since the laser beam can cause irreversible damage to your eyes. Never try to take such products apart, and never look into the laser beam.

Por favor lea imprescindiblemente antes de la primera puesta en funcionamiento las siguientes informaciones de seguridad

Informaciones de seguridad

Es el principio de Rohde & Schwarz de tener a sus productos siempre al día con los estandards de seguridad y de ofrecer a sus clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas de seguridad vigentes. Nuestra sección de gestión de la seguridad de calidad controla constantemente que sean cumplidas estas normas. Este producto ha sido fabricado y examinado según el comprobante de conformidad adjunto según las normas de la CE y ha salido de nuestra planta en estado impecable según los estandards técnicos de seguridad. Para poder preservar este estado y garantizar un funcionamiento libre de peligros, deberá el usuario atenerse a todas las informaciones, informaciones de seguridad y notas de alerta. 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 solamente fue elaborado para ser utilizado en la indústria y el laboratorio o para fines de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa pueda ser dañada. El uso del producto fuera de sus fines definidos o despreciando las informaciones de seguridad del fabricante queda en la responsabilidad del usuario. El fabricante no se hace en ninguna forma responsable de consecuencias a causa del maluso del producto.

Se parte del uso correcto del producto para los fines definidos si el producto es utilizado dentro de las instrucciones del correspondiente manual del uso y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso de los productos hace necesarios conocimientos profundos y el conocimiento del idioma inglés. Por eso se deberá tener en cuenta de exclusivamente autorizar para el uso de los productos a personas péritas o debidamente minuciosamente instruidas con los conocimientos citados. Si fuera necesaria indumentaria de seguridad para el uso de productos de R&S, encontrará la información debida en la documentación del producto en el capítulo correspondiente.

Símbolos y definiciones de seguridad

Ver manual de instrucciones del uso	Informaciones para maquinaria con uns peso de > 18kg	Peligro de golpe de corriente	¡Advertencia! Superficie caliente	Conexión a conductor protector	Conexión a tierra	Conexión a masa conductora	¡Cuidado! Elementos de construción con peligro de carga electroestática

potencia EN MARCHA/PARADA	Indicación Stand-by	Corriente continua DC	Corriente alterna AC	Corriente continua/alterna DC/AC	El aparato está protegido en su totalidad por un aislamiento de doble refuerzo

Tener en cuenta las informaciones de seguridad sirve para tratar de evitar daños y peligros de toda clase. Es necesario de que se lean las siguientes informaciones de seguridad concienzudamente y se tengan en cuenta debidamente antes de la puesta en funcionamiento del producto. También deberán ser tenidas en cuenta las informaciones para la protección de personas que encontrarán en otro capítulo de esta documentación y que también son obligatorias de seguir. En las informaciones de seguridad actuales hemos juntado todos los objetos vendidos por Rohde&Schwarz bajo la denominación de „producto", entre ellos también aparatos, instalaciones así como toda clase de accesorios.

Palabras de señal y su significado

PELIGRO	Indica un punto de peligro con gran potencial de riesgo para el ususario.Punto de peligro que puede llevar hasta la muerte o graves heridas.
ADVERTENCIA	Indica un punto de peligro con un protencial de riesgo mediano para el usuario. Punto de peligro que puede llevar hasta la muerte o graves heridas .
ATENCIÓN	Indica un punto de peligro con un protencial de riesgo pequeño para el usuario. Punto de peligro que puede llevar hasta heridas leves o pequeñas
CUIDADO	Indica la posibilidad de utilizar mal el producto y a consecuencia dañarlo.
INFORMACIÓN	Indica una situación en la que deberían seguirse las instrucciones en el uso del producto, pero que no consecuentemente deben de llevar a un daño del mismo.

Las palabras de señal corresponden a la definición habitual para aplicaciones civiles en el ámbito de la comunidad económica europea. Pueden existir definiciones diferentes a esta definición. Por eso se debera tener en cuenta que las palabras de señal aquí descritas sean utilizadas siempre solamente en combinación con la correspondiente documentación 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 malinterpretaciones y tener por consecuencia daños en personas u objetos.

Informaciones de seguridad elementales

1. El producto solamente debe ser utilizado según lo indicado por el fabricante referente a la situación y posición de funcionamiento sin que se obstruya la ventilación. Si no se convino de otra manera, es para los productos R&S válido lo que sigue:
como posición de funcionamiento se define principalmente la posición con el suelo de la caja para abajo , modo de protección IP 2X, grado de suciedad 2, categoría de sobrecarga eléctrica 2, utilizar solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar.
A menos que se especifique otra cosa en la hoja de datos, se aplicará una tolerancia de ±10% sobre el voltaje nominal y de ±5% sobre la frecuencia nominal.

2. En todos los trabajos deberán ser tenidas en cuenta las normas locales de seguridad de trabajo y de prevención de accidentes. El producto solamente debe de ser abierto por personal périto autorizado. Antes de efectuar trabajos en el producto o abrirlo deberá este ser desconectado de la corriente. El ajuste, el cambio de partes, la manutención y la reparación deberán ser solamente efectuadas por electricistas autorizados por R&S. Si se reponen partes con importancia para los aspectos de seguridad (por ejemplo el enchufe, los transformadores o los fusibles), solamente podrán ser sustituidos por partes originales. Despues de cada recambio de partes elementales para la seguridad deberá ser efectuado un control de

seguridad (control a primera vista, control de conductor protector, medición de resistencia de aislamiento, medición de medición de la corriente conductora, control de funcionamiento).

3. Como en todo producto de fabricación industrial no puede ser excluido en general de que se produzcan al usarlo elementos que puedan generar alergias, los llamados elementos alergénicos (por ejemplo el níquel). Si se produjeran en el trato con productos R&S reacciones alérgicas, como por ejemplo urticaria, estornudos frecuentes, irritación de la conjuntiva o dificultades al respirar, se deberá consultar inmediatamente a un médico para averigurar los motivos de estas reacciones.

4. Si productos / elementos de construcción son tratados fuera del funcionamiento definido de forma mecánica o térmica, pueden generarse elementos peligrosos (polvos de sustancia de metales pesados como por ejemplo plomo, berilio, níquel). La partición elemental del producto, como por ejemplo sucede en el tratamiento de materias residuales, debe de ser efectuada solamente por personal especializado para estos tratamientos. La partición elemental efectuada inadecuadamente puede generar daños para la salud. Se deben tener en cuenta las directivas nacionales referentes al tratamiento de materias residuales.

5. En el caso de que se produjeran agentes de peligro o combustibles en la aplicación del producto que debieran de ser transferidos a un tratamiento de materias residuales, como por ejemplo agentes refrigerantes que deben ser repuestos en periodos definidos, o aceites para motores, deberan ser tenidas en cuenta las prescripciones de seguridad del fabricante de estos agentes de peligro o combustibles y las regulaciones regionales para el tratamiento de materias residuales. Cuiden también de tener en cuenta en caso dado las prescripciones de seguridad especiales en la descripción del producto.

6. Ciertos productos, como por ejemplo las instalaciones de radiación HF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. En vista a la protección de la vida en desarrollo deberían ser protegidas personas embarazadas debidamente. También las personas con un bypass pueden correr peligro a causa de la radiación electromagnética. El empresario está comprometido a valorar y señalar areas de trabajo en las que se corra un riesgo de exposición a radiaciones aumentadas de riesgo aumentado para evitar riesgos.

7. La utilización de los productos requiere instrucciones especiales y una alta concentración en el manejo. Debe de ponerse por seguro de que las personas que manejen los productos estén a la altura de los requerimientos necesarios referente a sus aptitudes físicas, psíquicas y emocionales, ya que de otra manera no se pueden excluir lesiones o daños de objetos. El empresario lleva la responsabilidad de seleccionar el personal usuario apto para el manejo de los productos.

8. Antes de la puesta en marcha del producto se deberá tener por seguro de que la tensión preseleccionada en el producto equivalga a la del la red de distribución. Si es necesario cambiar la preselección de la tensión también se deberán en caso dabo cambiar los fusibles correspondientes del prodcuto.

9. Productos de la clase de seguridad I con alimentación móvil y enchufe individual de producto solamente deberán ser conectados para el funcionamiento a tomas de corriente de contacto de seguridad y con conductor protector conectado.

10. Queda prohibida toda clase de interrupción intencionada del conductor protector, tanto en la toma de corriente como en el mismo producto ya que puede tener como consecuencia el peligro de golpe de corriente por el producto. Si se utilizaran cables o enchufes de extensión se deberá poner al seguro, que es controlado su estado técnico de seguridad.

11. Si el producto no está equipado con un interruptor para desconectarlo de la red, se deberá considerar el enchufe del cable de distribución como interruptor. En estos casos deberá asegurar de que el enchufe sea de fácil acceso y nabejo (medida del cable de distribución 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 construciones o instalaciones, se deberá instalar el interruptor al nivel de la instalación.

12. No utilice nunca el producto si está dañado el cable eléctrico. Asegure a través de las medidas de protección y de instalación adecuadas de que el cable de eléctrico no pueda ser dañado o de que nadie pueda ser dañado por él, por ejemplo al tropezar o por un golpe de corriente.

13. Solamente está permitido el funcionamiento en redes de distribución TN/TT aseguradas con fusibles de como máximo 16 A.

14. 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. Si no tiene en consideración estas indicaciones se arriesga a que se originen chispas, fuego y/o heridas.

15. No sobrecargue las tomas de corriente, los cables de extensión o los enchufes de extensión ya que esto pudiera causar fuego o golpes de corriente.

16. En las mediciones en circuitos de corriente con una tensión de entrada de Ueff > 30 V se deberá tomar las precauciones debidas para impedir cualquier peligro (por ejemplo medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).

17. En caso de conexión con aparatos de la técnica informática se deberá tener en cuenta que estos cumplan los requisitos de la EC950/EN60950.

18. Nunca abra la tapa o parte de ella si el producto está en funcionamiento. Esto pone a descubierto los cables y componentes eléctricos y puede causar heridas, fuego o daños en el producto.

19. Si un producto es instalado fijamente en un lugar, se deberá primero conectar el conductor protector fijo con el conductor protector del aparato antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efectuadas por un electricista especializado.

20. En caso de que los productos que son instalados fijamente en un lugar sean sin protector implementado, autointerruptor o similares objetos de protección, deberá la toma de corriente estar protegida de manera que los productos o los usuarios estén suficientemente protegidos.

21. Por favor, no introduzca ningún objeto que no esté destinado a ello en los orificios de la caja del aparato. No vierta nunca ninguna clase de líquidos sobre o en la caja. Esto puede producir corto circuitos en el producto y/o puede causar golpes de corriente, fuego o heridas.

22. Asegúrese con la protección adecuada de que no pueda originarse en el producto una sobrecarga por ejemplo a causa de una tormenta. Si no se verá el personal que lo utilice expuesto al peligro de un golpe de corriente.

23. Los productos R&S no están protegidos contra el agua si no es que exista otra indicación, ver también punto 1. Si no se tiene en cuenta esto se arriesga el peligro de golpe de corriente o de daños en el producto lo cual también puede llevar al peligro de personas.

24. No utilice el producto bajo condiciones en las que pueda producirse y se hayan producido líquidos de condensación en o dentro del producto como por ejemplo cuando se desplaza el producto de un lugar frío a un lugar caliente.

25. Por favor no cierre ninguna ranura u orificio del producto, ya que estas son necesarias para la ventilación e impiden que el producto se caliente demasiado. No pongan el producto encima de materiales blandos como por ejemplo sofás o alfombras o dentro de una caja cerrada, si esta no está suficientemente ventilada.

26. No ponga el producto sobre aparatos que produzcan calor, como por ejemplo radiadores o calentadores. La temperatura ambiental no debe superar la temperatura máxima especificada en la hoja de datos.

27. Baterías y acumuladores no deben de ser expuestos a temperaturas altas o al fuego. Guardar baterías y acumuladores fuera del alcance de los niños. Si las baterías o los acumuladores no son cambiados con la debida atención existirá peligro de explosión (atención celulas de Litio). Cambiar las baterías o los acumuladores solamente por los del tipo R&S correspondiente (ver lista de piezas de recambio). Baterías y acumuladores son deshechos problemáticos. Por favor tirenlos en los recipientes especiales para este fín. Por favor tengan en cuenta las prescripciones nacionales de cada país referente al tratamiento de deshechos. Nunca sometan las baterías o acumuladores a un corto circuito.

28. Tengan en consideración de que en caso de un incendio pueden escaparse gases tóxicos del producto, que pueden causar daños a la salud.

29. Por favor tengan en cuenta que en caso de un incendio pueden desprenderse del producto agentes venenosos (gases, líquidos etc.) que pueden generar daños a la salud.

30. No sitúe el producto encima de superficies, vehículos, estantes o mesas, que por sus características de peso o de estabilidad no sean aptas para él. Siga siempre las instrucciones de instalación del fabricante cuando instale y asegure el producto en objetos o estructuras (por ejemplo paredes y estantes).

31. Las asas instaladas en los productos sirven solamente de ayuda para el manejo que solamente está previsto para personas. Por eso no está permitido utilizar las asas para la sujecion en o sobre medios de transporte como por ejemplo grúas, carretillas elevadoras de horquilla, carros etc. El usuario es responsable de que los productos sean sujetados de forma segura a los medios de transporte y de que las prescripciones de seguridad del fabricante de los medios de transporte sean tenidas en cuenta. En caso de que no se tengan en cuenta pueden causarse daños en personas y objetos.

32. Si llega a utilizar el producto dentro de un vehículo, queda en la responsabilidad absoluta del conductor que conducir el vehículo de manera segura. Asegure el producto dentro del vehículo debidamente para evitar en caso de un accidente las lesiones u otra clase de daños. No utilice nunca el producto dentro de un vehículo en movimiento si esto pudiera distraer al conductor. Siempre queda en la responsabilidad absoluta del conductor la seguridad del vehículo y el fabricante no asumirá ninguna clase de responsabilidad por accidentes o colisiones.

33. Dado el caso de que esté integrado un producto de laser en un producto R&S (por ejemplo CD/DVD-ROM) no utilice otras instalaciones o funciones que las descritas en la documentación. De otra manera pondrá en peligro su salud, ya que el rayo laser puede dañar irreversiblemente sus ojos. Nunca trate de descomponer estos productos. Nunca mire dentro del rayo laser.

Contents

Index

Technical Information
Option SMIQB21
Bit Error Rate Test

Specifications

The data supplied by the DUT are compared
with a reference random bit sequence.
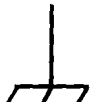
Pseudo-random bit sequences (PRBS)	2^9-1, 2^{11}-1, 2^{15}-1, 2^{16}-1, 2^{20}-1, 2^{21}-1, 2^{23}-1
Clock source	Supplied by DUT; a clock pulse is required for each valid bit
Clock rate	Max. 30 MHz
Synchronization time	24 clocks
Interface	9-pin sub-D connector, sub-D/BNC cable supplied with option
Data	TTL
Data enable	TTL
Clock	TTL
Restart	TTL
Setup time	10 ns
Hold time	2 ns
Polarity	Normal and inverted (data, clock, data enable)
Measurement time	Selectable through maximum number of data bits or bit errors (max. 2^{31} bits each), continuous measurement
Measurement result	BER in ppm (if selected number of data bits or bit errors is attained); status displays: not synchronized, no clock, no data

Safety Instructions

This unit has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards.

To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual.

Safety-related symbols used on equipment and documentation from R&S:

Observe operating instructions	Weight indication for units >18 kg	PE terminal	Ground terminal	Danger! Shock hazard	Warning! Hot surfaces	Ground	Attention! Electrostatic sensitive devices require special care

1. The unit may be used only in the operating conditions and positions specified by the manufacturer. Unless otherwise agreed, the following applies to R&S products:

   IP degree of protection 2X, Pollution severity 2, overvoltage category 2, altitude max. 2000 m.

   The unit may be operated only from supply networks fused with max. 16 A.

2. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures should be taken to avoid any hazards.

   (using, for example, appropriate measuring equipment, fusing, current limiting, electrical separation, insulation).

3. If the unit is to be permanently wired, the PE terminal of the unit must first be connected to the PE conductor on site before any other connections are made. Installation and cabling of the unit to be performed only by qualified technical personnel.

4. For permanently installed units without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused such as to provide suitable protection for the users and equipment.

5. Prior to switching on the unit, it must be ensured that the nominal voltage set on the unit matches the nominal voltage of the AC supply network.

   If a different voltage is to be set, the power fuse of the unit may have to be changed accordingly.

6. Units of protection class I with disconnectible AC supply cable and appliance connector may be operated only from a power socket with earthing contact and with the PE conductor connected.

7. It is not permissible to interrupt the PE conductor intentionally, neither in the incoming cable nor on the unit itself as this may cause the unit to become electrically hazardous.

   Any extension lines or multiple socket outlets used must be checked for compliance with relevant safety standards at regular intervals.

8. If the unit has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply.

   If units without power switches are integrated in racks or systems, a disconnecting device must be provided at system level.

9. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

   Prior to performing any work on the unit or opening the unit, the latter must be disconnected from the supply network.

   Any adjustments, replacements of parts, maintenance or repair may be carried out only by authorized R&S technical personnel.

   Only original parts may be used for replacing parts relevant to safety (eg power switches, power transformers, fuses). A safety test must be performed after each replacement of parts relevant to safety.

   (visual inspection, PE conductor test, insulation-resistance, leakage-current measurement, functional test).

Safety Instructions

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.

11. Lithium batteries must not be exposed to high temperatures or fire.

    Keep batteries away from children.

    If the battery is replaced improperly, there is danger of explosion. Only replace the battery by R&S type (see spare part list).

    Lithium batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

    Do not short-circuit the battery.

12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.

13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.

14. Any additional safety instructions given in this manual are also to be observed.

1 Installing Option SMIQB21

Software option SMIQB21 has to be enabled by entering a key upon installation. An option label containing the installation key is supplied and has to be affixed to the rear of SMIQ for service and repair purposes.

As a prerequisite, SMIQ must be fitted with hardware option SMIQB20 (modulation coder).
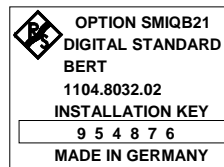
<== Example

Fig. 1-1   Option label with example of installation key

Enabling the option
(see Fig. 1-2)

➢ Switch on SMIQ.

➢ Call UTILITIES menu (select with rotary knob, confirm with [SELECT] key).

➢ Call INSTALL menu ==> [SELECT].

➢ Call OPTION TO INSTALL menu ==> [SELECT].

➢ Select option SMIQB21 BERT ==> [SELECT].

➢ Enter the 6-digit installation key shown on the option label into the INSTALLATION KEY line. Then press the [ENTER] key.

➢ You will receive a message confirming that the installation key has been verified and the option is installed.

➢ To make the option available, the unit has to be switched off and on again.

➢ Once the installation has been successfully completed, BER measurement can be selected from the main menu.
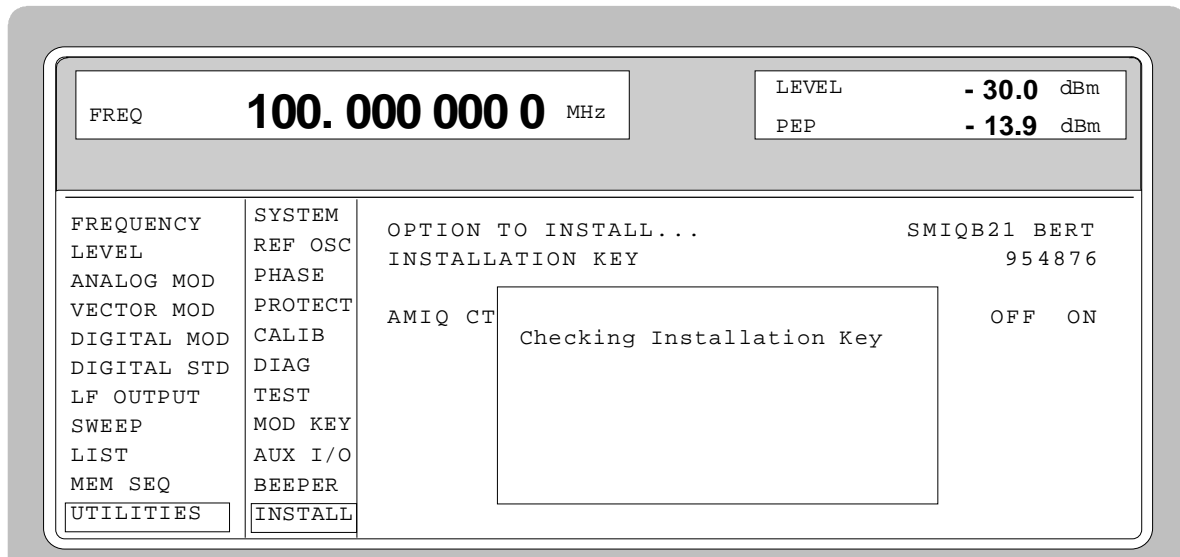
Fig. 1-2   Enabling option SMIQB21

Once the installation has been completed, the availability of the new option can be checked in the module list in the UTILITIES DIAG CONFIG menu.

1.1   Connector

The clock and data signals output by the DUT must have TTL level and are connected to the BER (bit error rate) input, a 9-contact SUB-D connector at the rear of the unit labelled BER. Pin assignment is as follows:

	SUB-D connector	**Adapter cable Order No. 1110.3551.00**
1,2,3,4,5	Ground	Screen
6	Bit clock input	CLOCK
7	Data input	DATA
8	Data enable input	DAT ENAB
9	Restart	RES

Polarity of clock and data signals, the PRBS polynomial used and the integration time can be set by manual or remote-control commands. The input signals are **not** terminated in the SMIQ but applied to ICs of type 74LVT14 via a 220 Ω resistor. A cable is supplied with the option. Its contacts are assigned to BNC connectors as shown in the above table.

2   Manual Operation

2.1   Measurement of the Bit Error Rate

Option SMIQB21 allows an evaluation of the signal demodulated and decoded by the DUT. For this purpose, a PRBS-modulated data sequence (PRBS = Pseudo Random Binary Sequence) is sent to the DUT. This data sequence can be generated continuously (by means of option SMIQB20) or in sections, in the latter case by means of option SMIQB60 using a loaded waveform.
The PRBS data sequence is decoded by the DUT and sent to the SMIQ in the form of clock and data signals. The SMIQ synchronizes to the known PRBS sequence and counts the bit errors.
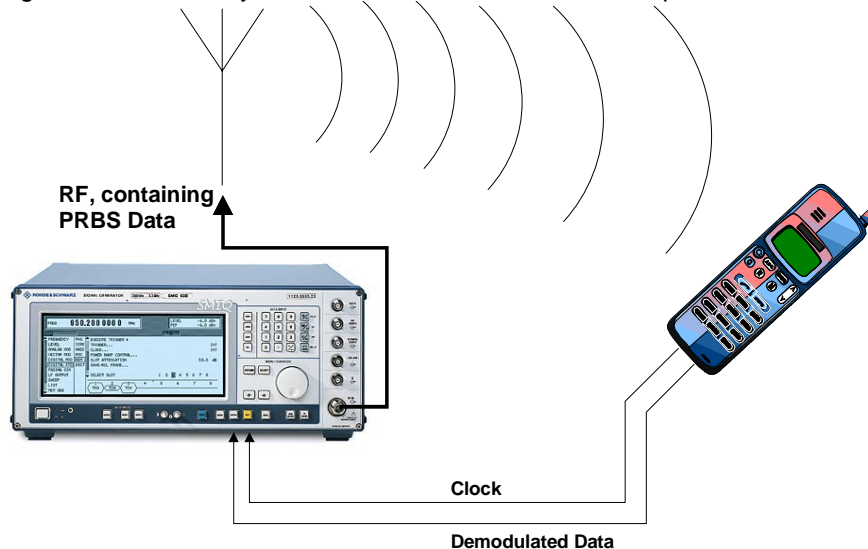
Fig. 2-1   Measurement of BER

Termination of a measurement can be induced by various criteria. With option SMIQB21, measurements can be stopped either manually or because of one of the following two criteria: a user-defined number of data bits has been transmitted or a maximum number of errors has been detected.

By means of the RESTART function (eg for IQ signals that are not generated continuously and therefore do not contain integer multiples of PRBS sequences) BER results can be integrated onto the (partial) sequences. In this way, long BER measurements can also be performed on short IQ signals (which normally do not allow BER measurement because the PRBS sequence is not continuous).

The BER measurement can also be performed separately (with data from another source).

2.2   Operating Menu

In the operating menu, the configuration for the BER measurement is made and the results are displayed.
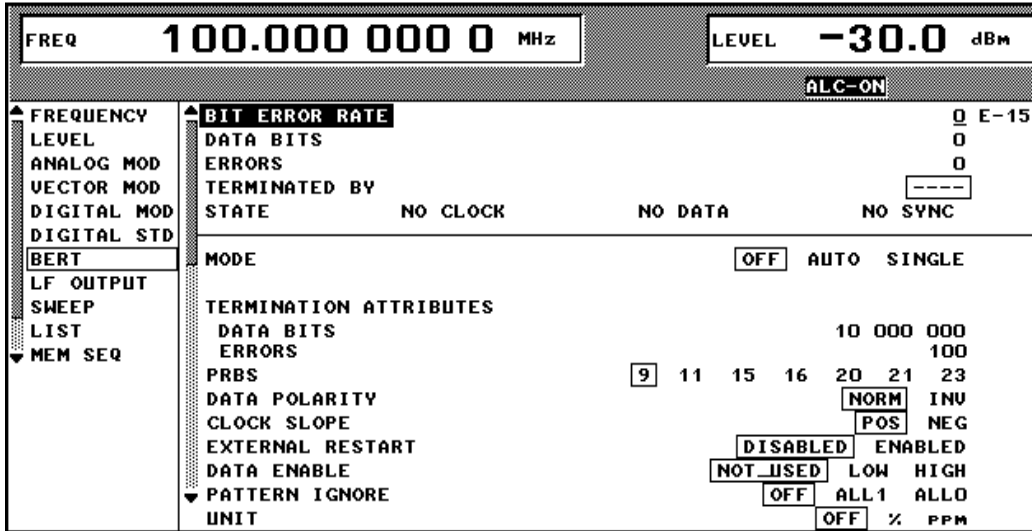
Fig. 2-2   Operating menu for BER measurement

In the upper section of the menu (display area), the measurement results are displayed together with the way in which they have been established, and additional information on the applied signal. In the lower section, settings can be made.

BIT ERROR RATE (BER) Cyclic display of the measured bit error rate, the ratio of detected errors to transmitted data bits.

DATA BITS Number of transmitted data bits.

ERRORS Number of detected errors.

TERMINATED BY The displayed measurement result was obtained as follows:

NUMBER OF DATA BITS	The defined number of data bits was reached.
NUMBER OF ERRORS	The defined number of errors was detected.
USER	The measurement was interrupted manually by the user.
----	Measurement in progress.

STATE

The status information described in the following tells the user whether the BER measurement is working. The STATE display signals the status of clock line, data line and synchronization. If the clock signal changes, CLOCK is indicated as status, otherwise NO CLOCK. The same applies to the data display DATA or NO DATA. NO DATA may be displayed because DATA ENABLE is not set to NOT USED or the data enable signal does not enable the data. SYNC indicates a successful attempt of PRBS synchronization by the analyzer. It is not before all three of CLOCK, DATA and SYNC are "active" that the measurement results are valid.

CLOCK	Change of clock signal.
NO CLOCK	No change of clock signal.
DATA	Change of data signal.
NO DATA	No change of data signal.
SYNC	Successful synchronization to PRBS.
NO SYNC	No synchronization.

The seven parameters listed above (data bits, error bits, error rate, attribute "terminated", attribute CLOCK, attribute DATA, attribute SYNC) are jointly polled by the IEC/IEEE bus query `:BERT:RES?` .

MODE

Setting for the BER measurement.

OFF   Terminate measurement.

AUTO   Continuous measurement of bit error rate. If one or both criteria for termination are fulfilled, a new measurement is initiated automatically. Depending on the settings made, a measurement may take considerable time. During the first measurement, intermediate results are displayed. For the measurements that follow, only the final results are shown. The parameters DATA BITS and ERRORS are continuously updated and indicate the relative values for the measurement in progress.

SINGLE Single measurement of bit error rate. During the measurement, SMIQ cyclically displays the updated values for rate, number of errors and number of data bits. If any one of the termination criteria (TERMINATION ATTRIBUTES [DATA BITS] and TERMINATION ATTRIBUTES [ERRORS]) is reached, the measurement is stopped. A single measurement is initiated only if the menu item EXECUTE SINGLE is selected.

IEC/IEEE-bus command   `:BERT:STAT ON`
                         `:BERT:SEQ SING`

EXECUTE SINGLE➤

Initiates a single BER measurement. This menu item is only displayed if MODE = SINGLE is set.

IEC/IEEE-bus command   `:TRIG:BERT:IMM`

TERMINATION ATTRIBUTES

DATA BITS Setting the termination criterion "Number of transmitted data bits".

IEC/IEEE-bus command `:BERT:SET:MCO <1>`

ERRORS   Setting the termination criterion "Maximum number of detected errors".

IEC/IEEE-bus command `:BERT:SET:MERR <1>`

PRBS	Setting the period length of data: 9, 11, 15, 16, 20, 21, 23 bits.

Note: Data inversion for PRBS15 and PRBS23, which is contained in the standard, is performed automatically when the PRBS is selected. DATA POLARITY remains unaffected.

IEC/IEEE-bus command `:BERT:SET:TYPE PRBS9`

DATA POLARITY   Setting the data bit polarity.

NORM	Normal polarity
INV	Inverted polarity

IEC/IEEE-bus command   `:BERT:SET:DATA NORM`

CLOCK SLOPE   Setting the clock edge polarity.

POS	Rising edge
NEG	Falling edge

IEC/IEEE-bus command   `:BERT:SET:CLOC RIS`

EXTERNAL RESTART   Activating/deactivating an external restart of the BER measurement.

Note: *An enabled RESTART works always independently of PATTERN IGNORE or DATA ENABLE.*

DISABLED	Deactivated
ENABLED	Activated

IEC/IEEE-bus command   `:BERT:SET:REST INT`

DATA ENABLE   Setting the polarity of the DUT's DATA ENABLE signal.

Note: *If the data are not enabled, the execution of the BER measurement is stopped completely. The identification circuit for PATTERN IGNORE as well as the PRBS generator of the BER measurement wait as long as data are not enabled. If the data are enabled, the measurement is continued.*

NOT USED	Irrespective of the data enable signal applied, all data at the BERT data input are used for the BER measurement.
LOW	Only the data applied at the BERT data input with a low-level data enable signal are used for the BER measurement.
HIGH	Only the data applied at the BERT data input with a high-level data enable signal are used for the BER measurement.

IEC/IEEE-bus command   `:BERT:SET:DEN OFF`

PATTERN IGNORE   In the event of a so-called frame error (eg an error detected in the check sum), some mobile radio standards communicate a complete "0" or "1" frame to the BERT instead of the detected frame data. This is to signal to the BERT that this frame is not to be used for the BER measurement.

OFF	PATTERN IGNORE is not active.
ALL 1	Bit sequences consisting of 31 or more subsequent "1" data are not used (ie ignored) for the BER measurement.
ALL 0	Bit sequences consisting of 31 or more subsequent "0" data are not used (ie ignored) for the BER measurement.

IEC/IEEE-bus command   `:BERT:SET:IGN OFF`

Notes:

- *While ignoring the bits, the PRBS generator for the BER measurement keeps running. Following the "0" or "1" sequence, the BER measurement is continued as if the ignored sequence had contained PRBS data.*
- *If PATTERN IGNORE is switched on, synchronization time is 32 bits longer.*
- *If PATTERN IGNORE and RESTART are active at the same time, the presence of the restart signal causes the measurement to stop* **immediately**. *None of the 32 bits within the PATTERN IGNORE detector is evaluated.*
- *If DATA ENABLE and PATTERN IGNORE are active at the same time, DATA ENABLE is given priority, ie bits that are not enabled are not examined for "0" or "1" sequences.*
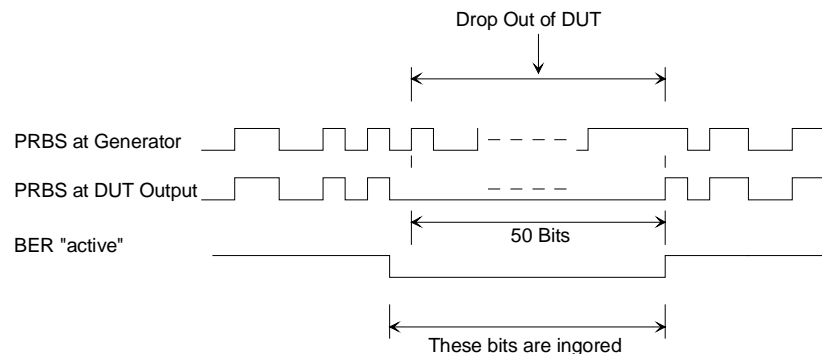
Example 50 bits were set to "0" by the DUT. These 50 bits plus the preceding "0" are ignored in the measurement.

UNIT   Setting the unit for displaying the bit error rate.

OFF	No unit, decade values
%	Relative frequency in percent
ppm	Relative frequency in parts per million

IEC/IEEE-bus command   `:BERT:UNIT OFF`

2.3   Signal Path and Waveform

See also section 1.1, "Connector".

Test setup   The signal is computed using one of the modulation sources listed above and then output by the SMIQ and sent to the DUT (device under test). The latter demodulates the source bits contained and returns them to SMIQ together with a transfer clock. In the SMIQ, the data bits are checked for errors. The total of the transmitted bits and the faulty bits are counted. The quotient of error bits/total bits is the BER.

PRBS data   To be able to detect faulty bits in a BER measurement, the data generation polynomial must be known. Data are calculated with the aid of so-called pseudo-random binary sequences (PRBS). These are quasi-random bit sequences which are repeated according to the selected polynomial.

An advantage of the PRBS data is that the bit error detector has only to know the polynomial but not the total sequence. Furthermore, the analysis can be started anywhere in the bit stream, ie the bit-stream source and the analyzer need not be synchronized.

Transfer clock   Should the DUT not provide a transfer clock, the bit clock can be taken from the output connector PAR-DATA for the generation of the signal using option SMIQB11 (DGEN). If AMIQ is used as the IQ source, a marker channel may be programmed as clock output. However, the clock-to-data ratio is to be observed.

2.4   Test Method

Generation of PRBS data

PRBS data are generated with the aid of a shift register with feedback points determined by the polynomial. A random start status yields one subsequent state. The start status and therefore the subsequent status occur only once in the whole sequence.

Feedback of data stream

If the shift register is filled with a data sequence at the beginning of a measurement and the register is then switched from "filling" to "feedback", the register generates the same data sequence as it expects to receive. Faulty bits can thus be identified and counted by comparing the received data to the results obtained from the shift register.

This method has the advantage that the analyzer can be used separately from signal generation (logically and with respect to time). Consequently, delays caused by the DUT, the use of other PRBS sources and transmission over long distances with spatially separated transmitter and receiver, do not cause any problems.

Errors in start status

If a bit error is already present in the start status (faulty bits are not detected during filling), the shift register starts from an incorrect position in the data sequence. As a result all subsequent states will be faulty. Since, statistically, every second bit is faulty, the BER will be about 50%. In this case the measurement is started again automatically, without the user realizing.

BER measurement <u>with uninterrupted repetition</u> of the random sequence

The (non-integrating) BER measurement operates on the basis of random sequences that are run continuously. These sequences are either generated continuously or by cyclic output of a stored sequence, with the number of encoded bits being an integer multiple of the length of the random sequence. The length of the random sequence is 2 to the power of the degree of the polynomial less 1, ie PRBS9 has a length of 511 (2^9 equals 512 less 1).

This type of BER measurement is selected by either setting External Restart to DISABLED or by issuing the IEC/IEEE-bus command `:BERT:SET:REST INT`. The CLOCK and DATA lines are sufficient for this measurement.

The data to be analyzed are interrupted by other data

The data bits contain data like sync, preambles, other channels, etc in addition to the PRBS data. To mark the data to be evaluated, a DAT ENABle signal has to be sent with the data. Either this DAT ENABle signal is generated by the DUT or an additional channel of the IQ source is used (eg marker channel of AMIQ).

The BER measurement in the SMIQ has to be adjusted for the use of a DAT ENABle signal; this is done by setting the required polarity in the menu or by means of IEC/IEEE-bus command (`:BERT:SET:DEN Low|High`). Data Enable = high means that data are only counted by the DUT and subjected to the BER measurement if the data enable input is set to 1.

**BER measurement
<u>with interrupted</u>
random sequence
- integrating BER
measurement**

Due to the type of data, oversampling and the finite memory length of SMIQ (option SMIQB60) or AMIQ, it may happen that the generated random sequence is not cyclically repeated at the memory wrap-around but has a break at this point. In a normal BER measurement operating exclusively with CLOCK and DATA signals, a break of this kind would lead to approx. 50% faulty bits due to the loss of synchronization.

A random sequence with a break can be processed by means of the **integrating BER measurement** and is switched on in the menu under EXTERNAL RESTART (or by the remote-control command `BERT:SET:REST EXT`). The BER measurement is to be stopped in time and then restarted at the beginning of the data sequence. The measurement is stopped and started via a signal at the RES input (pin 9 of SUB-D connector): A transition from logic 0 to 1 causes a partial result to be generated and the measurement to be stopped. A transition from 1 to 0 starts the measurement for the next sub-interval. This measurement is synchronized anew.
This input is best connected to an AMIQ marker channel or the SMIQ trigger output, with a single 1 encoded both at the start and at the end of the data sequence. This causes the BER measurement to stop briefly at memory wrap-around (the break) and start again. The partial results are integrated.

When the signals are interrupted by other data (eg preambles), these data will normally cause bit errors. The BER measurement for these data can then be interrupted using the data enable input .

In the integrating BER measurement, partial BER results are added up (controlled by a signal at the RES input) until the predefined total number of data or error bits is attained or exceeded.

Note:

Since the test hardware can be programmed flexibly, other bit error measurement techniques such as comparison with the output pattern, masking of certain time and data ranges, are also possible. In this matter, please contact your nearest R&S representative.

2.4.1 PRBS Polynomials

For generating and testing the PRBS, a shift register with feedback is used. The feedback depends on the type of polynomial used. The sequence length of a generator is the result of $2^n - 1$, n being the degree of the polynomial.
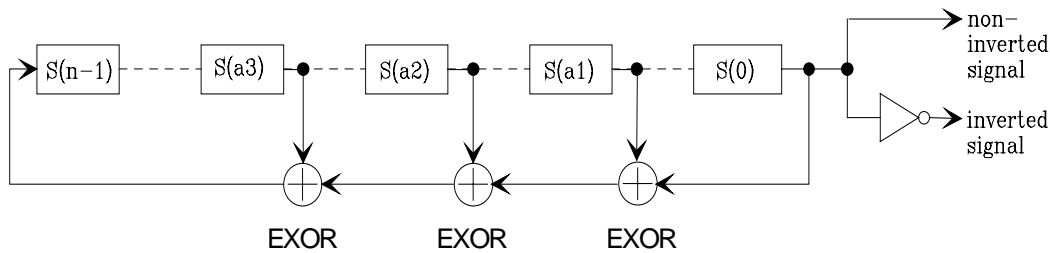

Fig. 2-3 PRBS polynomials

PN generator	N	a1	a2	a3	Output	acc. to standard
PN9	9	4	-	-	non-inverted	ITU-T Rec. O.153 Fascicle IV.4
PN11	11	2	-	-	non-inverted	ITU-T Rec. O.152 Fascicle IV.4
PN15	15	1	-	-	inverted	ITU-T Rec. O.151 Fascicle IV.4
PN16	16	5	3	2	non-inverted	--
PN20	20	3	-	-	non-inverted	ITU-T Rec. O.153 Fascicle IV.4
PN21	21	2	-	-	non-inverted	--
PN23	23	5	-	-	inverted	ITU-T Rec. O.151 Fascicle IV.4

2.4.2 Measurement Result, Accuracy, Measurement Time

Value range Measurement results for the bit error rate (ie the quotient of error bits and total bits) are usually found between 10^{-2} and 10^{-9}. This means that a large number of bits may have to be checked before a faulty bit is detected. Because of the large number of bits involved the measurement time is usually very long.

Since 32-bit-wide counters are used for the total bits and the error bits, the maximum measurement time is 4.29×10^9 bits.

Statistics The BER measurement measures statistical bit errors, ie errors which do not occur at regular intervals but at random. Although a single measurement determines the exact number of errors in the measured interval, a statistically reliable BER can only be obtained when a sufficient number of errors occurs in the observed interval. Only this ensures that the single BER measurement result approaches the true error rate with high probability .

Termination criteria

To keep the measurement time short with low and high bit error rates, two termination criteria have been defined in SMIQ for the BER measurement.

- Criterion 1:   Total number of bits
  The measurement is terminated when the specific number of data bits is reached. Due to this criterion the BER measurement is reliably stopped after the specified number of bits even if no error or only a few errors were detected; the measurement result is not statistically reliable (few bit errors).

- Criterion 2:   Number of errors

  The measurement is terminated when the specified number of bit errors is detected. With this criterion, the measurement is rapidly terminated when high bit error rates occur. Since a great number of errors is counted, the measurement result is statistically reliable.

The two criteria are used together. The criterion which finally yields a valid result is indicated in the results screen ("Measurement terminated by...").

Interruption of measurement

At the end of a measurement, the restart of a new one is delayed until the first measurement result has been queried with `:BERT:RES?`. The resulting brief measurement interruption is irrelevant because the subsequent measurement will be synchronized within 24 data bits.

2.4.3 Possible Problems with BER Measurement and Related Solutions

Fault	Possible cause	Fault description/remedy
BER measurement does not synchronize	No signals received from DUT or the signal level is not correct.	➢ Check displays for activity at BER measurement inputs. If a status is displayed (Clock, Data, Sync) for a line, there is activity.
	The selected PRBS is not correct.	Normally, the PRBS on which the data are based is used as the default setting. If the PRBS is changed, the BER measurement cannot synchronize to the data (because the polynomial is not correct).
	A wrong clock edge is used, which violates setup or hold times.	➢ Check the bit clock signal, the data signal and the data enable signal, if any, on an oscilloscope. The fault may also be caused by reflections on the clock line, which switch the data signal twice into the BER measurement, eg on lines without termination. The SMIQ input is **not** terminated.
	Incorrect polarity of data signal (or data enable signal).	In this case the PRBS cannot synchronize. Note that an inversion of the output signal specified for some cases by the PRBS standard is performed automatically upon PRBS selection. Manual inversion of the data signal is therefore not required.
	A bit error occurs during synchronization (nine data bits with PRBS9)	The BER measurement is started at a wrong position so that about 50% of the subsequent data bits are identified as faulty.
No clock received from DUT	When testing RF components, clock recovery is not available. An external clock is however required for clocking the data during the BER measurement	Instead of a clock recovery circuit, the bit clock at the PAR-DATA connector of the SMIQ may be possibly used as a replacement. This is possible if DGEN (SMIQB11) is used as a data source. However, this bit clock is not possible with all modulation types. Also, the delay between data and clock has to be observed.
Measured BER too high	The data are clocked with the wrong edge and/or the eye aperture of the data is not optimally met.	➢ Check the clock/data relationship by means of an oscilloscope and set optimum timing.
	BER measurement does not synchronize	If data that are not cyclically continued (ie when a break occurs at the memory wrap-around), the measurement will identify about 50% of the bits as faulty after the wrap-around. Make sure the measurement is started optimally at the beginning of the sequence by means of a signal on the REStart line (see: "BER measurement <u>with interrupted</u> random sequence – integrating BER measurement" in section 2.4, "Test Method").

3 Remote Control

3.1 Description of IEEE/ IEC Bus Commands – Source:BERT Subsystem

Command	Parameter	Default Unit	Remark
[:SOURce]			
:BERT			
:STATe	ON | OFF		
:SEQuence	AUTO | SINGle		
:SETup			
:MCOunt	1 to 4294967294		
:MERRor	1 to 4294967294		
:TYPE	PRBS9 | PRBS11 | PRBS15 | PRBS16 | PRBS20 | PRBS21 | PRBS23		
:DATA			
[:POLarity]	NORMal | INVerted		
:CLOCk			
[:POLarity]	RISing | FALLing		
:RESTart	INTernal | EXTernal		
:DENable	OFF | LOW | HIGH		
:MASK	OFF | LOW | HIGH		
:IGNore	OFF | ONE | ZERO		Alias
:UNIT	OFF | PCT | PPM		
:STARt	(without)		
:STOP	(without)		
:RESULT?			Query only

:BERT:STATe ON | OFF

This command switches the bit error rate test on or off. The command `:BERT:STARt` sets the status internally to `ON`, while the command `:BERT:STOP` sets it to `OFF`.

Example: `:BERT:STAT ON`   *RST value is OFF

:BERT:SEQuence AUTO | SINGle

This command switches between continuous (`AUTO`) and single measurement (`SINGle`). A single measurement is terminated once the set number of data bits or error bits is reached. The continuous measurement is a sequence of automatically started single measurements.

By means of the command `:BERT:STARt`, the status is internally set to `AUTO`.

Example: `:BERT:SEQ SING`   *RST value is AUTO

:BERT:SETup:MCOunt 1 to 4294967294

This command sets the total number of data bits to be measured (data excluded by `:BERT:SETup:DENable` do not count). When the internal data counter reaches or – in integrated BER test – exceeds this number, the single BER measurement is terminated. If this is followed by the query `:BERT:RES?`, SMIQ signals with the fourth result that a BER measurement has been completed. This fourth result then has the value 1.

Valid value range: 1 to 4294967295 (2^{32}-1)

Example: `:BERT:SET:MCO 1e6`   *RST value is 10.000.000

:BERT:SETup:MERRor 1 to 4294967294

This command sets the number of error bits to be measured. When the internal bit error counter reaches or – in integrating BER test – exceeds this number, the SMIQ responds to a `:BERT:RES?` query by signalling with the fourth result = 1 that a single BER measurement has been terminated.

Valid value range: 1 to 4294967295 (2^{32}-1)

Example: `:BERT:SET:MERR 100`   *RST value is 100

:BERT:SETup:TYPE PRBS9 | PRBS11 | PRBS15 | PRBS16 | PRBS20 | PRBS21 | PRBS23

With this command, various sequence lengths can be set for the pseudo-random bit sequence. The data generated by the PRBS generator are used as a reference.

Example: `:BERT:SET:TYPE PRBS15`   *RST value is PRBS9

:BERT:SETup:DATA[:POLarity] NORMal | INVerted

This command defines the polarity of the external data signal.

NORMal: High level stands for a logic 1, low level for a logic 0.

INVerted: Low level stands for a logic 1, high level for a logic 0.

Example: `:BERT:SET:DATA INV`   *RST value is NORM

:BERT:SETup:CLOCk[:POLarity] RISing | FALLing

This command defines which edge of the externally fed clock signal is active.

Example: `:BERT:SET:CLOC FALL`   *RST value is RIS

:BERT:SETup:RESTart INTernal | EXTernal

INTernal   The reset signal for the BER test is generated internally by the program. This setting is suited for random sequences fitting cyclically into the SMIQ memory and therefore allowing an uninterrupted repetition of the random sequence.

EXTernal   If the random sequence cannot be continued without interruption at memory wrap-around, the BER test has to be stopped in time and then restarted at the beginning of the data sequence. The measurement is stopped and started via a 0-1-0 edge at the restart input. Partial BER results (data and error bits) are added up until the predefined total number of data or error bits is reached or exceeded. These partial results are not affected by a restart.

Example: `:BERT:SET:RES EXT`   *RST value is INT

:BERT:SETup:DENable OFF | LOW | HIGH

> The SMIQ has an input (data enable) allowing the temporary suspension of the BER test for processing data bursts or data interrupted by other data. This command configures this input.

> OFF   Any signal applied to the input is ignored; all data are used for the BER measurement.

> HIGH   If a high level signal is applied to the input, its data bits are counted and the bit errors detected and counted. If a low level signal is applied, the measurement is interrupted.

> LOW   If a low level signal is applied to the input, its data bits are counted and the bit error detected and counted. If a high level signal is applied, the measurement is interrupted.

> Example: `:BERT:SET:DEN HIGH`   *RST value is OFF

:BERT:SETup:MASK OFF | LOW | HIGH

> This command is equivalent (alias) to the command `:BERT:SETup:DENable` described above.

> Example: `:BERT:SET:MASK HIGH`   *RST value is OFF

:BERT:SETup:IGNore OFF | ONE | ZERO

> This command determines what to do with faulty data (frame errors) that were set to 0 or 1.

> OFF   Pattern Ignore is not active.

> ONE   Bit sequences consisting of 30 or more subsequent "1" data are not used (ie ignored) for the BER test.

> ZERO   Bit sequences consisting of 30 or more subsequent "0" data are not used (ie ignored) for the BER measurement.

> Example: `:BERT:SET:IGN ONE`   *RST value is OFF

:BERT:UNIT OFF | PCT | PPM

> This command sets the unit for displaying the error rate. It is only for display on SMIQ; it has no effect on results queried by `:BERT:RES?`.

> Example: `:BERT:SET PCT`   *RST value is OFF

:BERT:STARt

> This command starts a bit error rate test. The command `:BERT:STAT` is set to `ON` and `BERT:SEQ` to `AUTO`.

> Example: `:BERT:STAR`

:BERT:STOP

> The command stops an ongoing bit error rate test. If no measurement is in progress, this command has no effect. `:BERT:STAT` is set to `OFF`.

> Example: `:BERT:STOP`

:BERT:RESult?

This query refers to the result of the most recent BER measurement. The response consists of seven results separated by commas. In the first measurement following the start, intermediate results for the number of data bits, error bits and error rate are also queried. In the following measurements (only for `:BERT:SEQ AUTO`), only the final results of each single measurement are queried.

Example: `:BERT:RES?`

Response: `"10000,5,5E-4,1,1,1,1"`

Result: `1    ,2,3    ,4,5,6,7`

Result 1	Number of data bits from current query.
Result 2	Number of error bits from current query.
Result 3	Error rate. If no termination criterion has been reached since the beginning of the BER test, the current quotient of "Number of error bits" and "Number of data bits" is entered. As soon as at least one final result has been reached in continuous measurement, the most recent final result is entered. This means the error rate displayed changes less rapidly.
Result 4	1 A BER measurement has been terminated, ie the number of data bits or error bits predefined by commands `:BERT:SET MCOunt <n>` or `:BERT:SET MERRor <n>` is reached, or the measurement was stopped by the command `:BERT:STOP`. 0 The BER measurement has not been terminated.
Result 5	1 Following the start of a BER measurement (by the command `:BERT: STARt`), an edge was detected on the clock line. 0 The clock line is not active.
Result 6	1 Following the start of a BER measurement (by the command `:BERT: STARt`), a data change edge was detected on the data line. This data change only refers to clocked data. If there is no clock, no data change is detected. 0 The data line is not active.
Result 7	1 The BER measurement is synchronized, ie both clock and data line are active and the "Number of error bits" to "Number of data bits" ratio is better than 0.1, so the measurement result can be assumed to be realistic. 0 The BER measurement is not synchronized.

4   Performance Test

4.1   Test Instructions BERT

Test assembly   ➢ For the functional test, the inputs and outputs of this interface are
                                   connected via a connector (Operating manual SMIQ, Table 5-1,
                                   item 27).

Measurement   ➢ SMIQ settings
                                   UTILITIES/TEST/TEST MCOD BERT

                                   ⇨ Error messages may not occur.

4.2   Performance Test Report

For nominal data and limit values refer to the data sheet supplied with the instrument.

Characteristic	Min.	Actual	Max.	Unit