Demo Guide
and
Extended Operating Guide

V1.09

Power Analysis for
R&S® NRP-Z Sensors

R&S® SMA-K28
1405.3950.02

This guide can be used for R&S®SMF-K28 in the same way. Screenshots are different dependent on the instrument.

ROHDE & SCHWARZ

Test and Measurement

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.
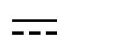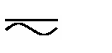
Se parte del uso correcto del producto para los fines definidos si el producto es utilizado conforme a las indicaciones de la correspondiente documentación del producto y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso del producto 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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ROHDE & SCHWARZ

Customer Support

Technical support – where and when you need it

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

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

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Contents

0 Introduction

This document is a step-by-step guide to setting up and using the R&S®SMA-K28 power analysis option with R&S®NRP-Z sensors. The guide includes a description of all available keys, buttons and knobs for easily carrying out a variety of tasks. The remainder of this document will refer to the R&S®SMA-K28 option, R&S®NRP-Z and R&S®SMA100A as SMA-K28, NRP-Z and SMA100A respectively.

The guide does not have to be read in its entirety. It is designed so that users need only refer to those sections that are of interest. However, all users should at least read Chapters 0 to 3 to gain an understanding of the basic features and functions.

The SCPI examples demonstrate how to execute the tasks via remote control over a GPIB, LAN (VXI11) or USB interface.

Where applicable, examples are supplemented with notes and remarks for purposes of clarity.

This is not an operating manual. For a detailed description of all dialogs and functions, refer to the SMA100A operating manual.

Key Features

- o   Fast frequency sweep measurements (power versus frequency)
- o   Fast power sweep measurements (power versus power, full power range with single sweep)
- o   Time trace measurements (power vs. time, sensor-dependent)
- o   Pulse data measurements, sensor-dependent
- o   Extensive range of settings
- o   Measurement trace, hold trace, reference trace
- o   Full remote control (GPIB, LAN, USB)
- o   Special hardcopy support

Components Required for the Demo

SMA100A signal generator (3 GHz or 6 GHz model)
(Examples can be executed without the SMA-K23 or SMA-K24 options)

SMA-K28 power analysis option for NRP-Z sensors

NRP-Z81 wideband power sensor, applicable to all chapters

   and/or

NRP-Z21 universal power sensor, no pulse data measurements available
(refer to Chapters 4, 5 and 7)

NRP-Z3 USB trigger adapter or NRP-Z4 passive USB adapter

DUT (bandpass or similar filter) for frequency sweep measurements

The NRP-Z91/92 sensors are restricted to frequency or level sweep measurements (refer to Chapter 4). Time mode is not available.

Notes on SCPI Commands

For clarity and to make them stand out, the SCPI commands are shown in bold type without related interface commands.

UPPER and lower case letters indicate the SHORT and long forms of the SMA-K28 commands.
e.g. POWer:POW = short form
POWer = long form

Info about binary data transmission (binary header in line with IEEE 488.2):

<ARBITRARY BLOCK PROGRAM DATA> is formatted as follows:

#nd…d<data>nl

\# Notification for block data
nNumber of digits (single digit) that identifies the data length
        (non zero!)
d…dLength of <data> (in bytes/characters)

<data>pure data

nloptional

To purge the received data, determine the length of the binary header and subtract this number of characters.

Test Conditions

The examples were recorded and tested with the following firmware:

o   SMA firmware, version 2.10.001.26,
o   NRP-Z21 firmware, version 4.13
o   NRP-Z81 firmware, version 1.20.

Screenshots may differ from the actual displays on the instrument due to missing or installed generator options.

1 Sensors, Traces, Measurement Modes and Viewing Modes

List of Current NRP Sensors and Features Related to SMA-K28

Sensor	Frequency Power Sweep	Sweep Timing [*] Aperture Time / Average	Time Trace Measurement (Gate Mode)	Time Trace Resolution	Pulse Data Measurement
NRP-Z11	√	fast: 2 ms / 1 normal : 20 ms / 1	√	10 µs	-
NRP-Z21 NRP-Z22 NRP-Z23 NRP-Z24	√	fast: 2 ms / 1 normal : 20 ms / 1	√	10 µs	-
NRP-Z31	√	fast: 2 ms / 1 normal : 20 ms / 1	√	10 µs	-
NRP-Z27 NRP-Z37	Only for use with R&S FSMR				
NRP-Z28	√	fast: 2 ms / 1 normal : 20 ms / 1	√	10 µs	-
NRP-Z98	√	fast: not avail. normal : 10 ms / 1	√	10 µs	-
NRP-Z51 NRP-Z52 NRP-Z55 NRP-Z56 NRP-Z57	√	fast: 2 ms / 1 normal : 10 ms / 1	-	-	-

Sensor	Frequency Power Sweep	Sweep Timing* Aperture Time / Average	Time Trace Measurement (Gate Mode)	Time Trace Resolution	Pulse Data Measurement
NRP-Z81 NRP-Z85	√	fast: 10 µs / 256 normal : 10 µs / 1048	√	12.5 ns High Res** 2 ns	√
NRP-Z91 NRP-Z92	√	fast: not avail. normal : 10 ms / 1	-	-	-

* The aperture time and average factor are sensor parameters that determine the integration time of the power measurement (integration time = 2 x aperture time x average factor).
The integration time is required to calculate the noise contribution and the corresponding measurement uncertainty (refer to chapter *Comments on Measurement Accuracy*).

** If resolution/point < 12.5 ns

Sensors and Traces

All sensors can be used in the same order and with the same index for remote control of SMA-K28 as in the power viewer of the generator.

By default, the sensor and the corresponding trace have the same number (i.e. sensor 1 is assigned to trace 1).

The maximum number of traces is the same as the maximum number of sensors.

If the corresponding trace is occupied (with HOLD trace or REF trace), there is **no** automatic trace assignment. The user must assign this sensor to the desired trace.

In general the user has the flexibility to assign any sensor to any trace.

Available Traces

Three different traces are available for the SMA-K28 power analysis:

o   Measurement trace directly connected to a sensor
o   Hold trace (frozen measurement trace), not saved
o   Reference trace (only one reference buffer available)
     Any trace can be saved to a reference buffer and recalled as a reference trace.

Measurement Modes

With the exception of the NRP-Z27 and NRP-Z37, each sensor of the NRP family can be used for frequency and level sweep measurements.

Some sensors, such as the NRP-Z2x and NRP-Z8x, also support time trace measurements (measuring the envelope of RF signals).

NRP-Z8x sensors can also measure (calculate) pulse data characteristics (e.g. rise/fall time or pulse width) of the indicated signal.

See Chapter 1.1 for a list of all sensors and features related to SMA-K28.

The properties of the sensors can be checked in the setup menu under NRP-Z Info/Update.

Select the desired sensor with the rotary knob ⭕ and press 🔘 it.

The following screen will be displayed.
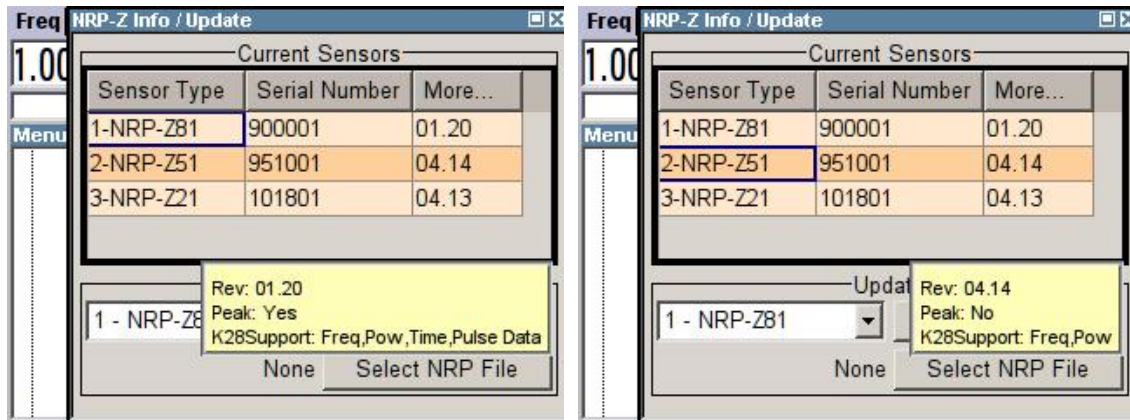
Rev:Indicates the firmware version of the sensor.
Peak: Indicates if this sensor also measures the peak value of the signal.
K28Support:Indicates which SMA-K28 measurement functions are available.

Display Modes

All measurement results are graphically displayed in a window, which can be configured using the

REARR   key.

Frequency and level sweep measurements can be displayed in three different modes:

o   Standard view
o   Marker view
o   Full screen

As stated in the previous section, some sensors can measure the envelope of the RF signal (time trace measurements). In this case an additional display mode is available:

o   Gate mode view

The NRP-Z8x family of sensors features an additional display mode:

o   Pulse data view

Refer to chapter *Configuring the Viewing Modes* for information on how to configure the viewing modes.

Connect a sensor (NRP-Z81) to the NRP connector on the generator.

2 Setup

Use PRESET to set the generator to a defined state.

PRESET   Press the PRESET key

RF ON/OFF   Press the RF ON/OFF key

LEVEL   Press the LEVEL key and   enter 0 dBm   0   ENTER x1 dB(m)

ESC CLOSE   Press the ESC key

The rotary knob ⟳ can be used to select one of the blocks as shown in the generator display below.

Select the RF block and check the box by
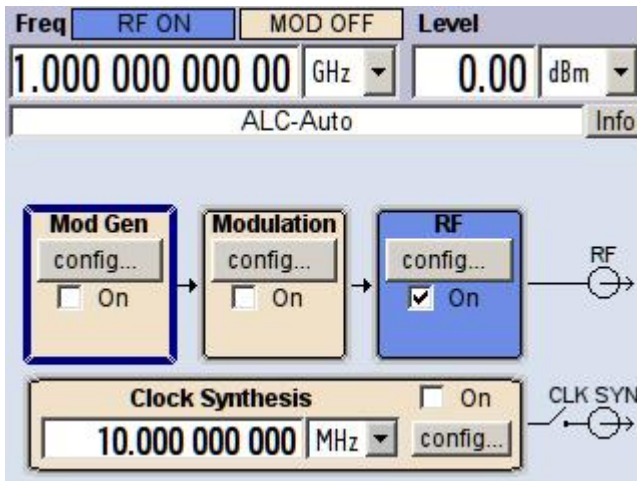
pressing the 🔘 rotary knob. The following menu is displayed:
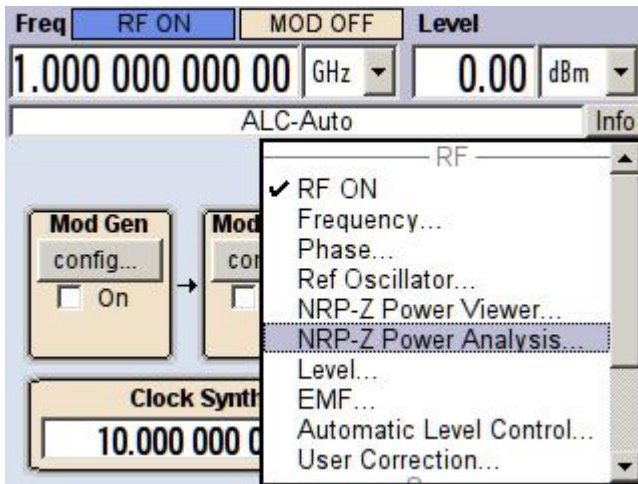
Select **NRP-Z Power Analysis…** from the menu ⬤ and press the rotary knob ⬆ again.
The main display for the NRP-Z Power Analysis or SMA-K28 option appears:
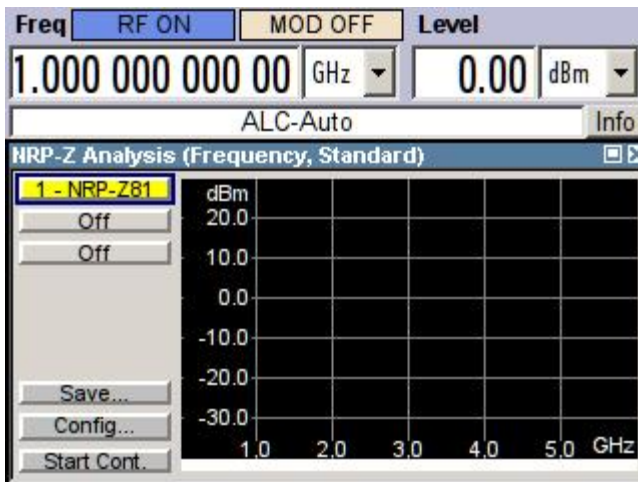
Some front panel keys are assigned special functions if the power analysis is active (but only when an SMA-K28 option window/dialog is active, i.e. this window is in focus). Keep in mind that this behavior is "very" context sensitive.

Return to chapter *Time Mode*.

3 NRP-Z Power Analysis – Special Function Keys

Some front panel keys are assigned special functions if the power analysis is active (but only when an SMA-K28 option window/dialog is active, i.e. this window is in focus). Keep in mind that this behavior is very context sensitive.

Key	Function	Additional information
REARR	Changes the display mode	Available display modes: 　Standard view 　Marker view 　Gate mode view * 　Pulse data view * 　Full screen * Sensor dependent/setting dependent
ON/OFF TOGGLE	Start/stop measurement	Regardless of the viewing mode, the main graphic dialog must be in focus (highlighted with a blue border around the corresponding block).
BACK-SPACE	Reset/restart auto scaling	Especially when scaling mode is set to Expand.
SETUP	Opens NRP-Z Analysis menu	Standard generator SETUP menu can be selected.
MENU	Opens NRP-Z Analysis menu (same as SETUP key)	Standard generator MENU menu can be selected.

These keys are indispensable when setting the main display window to modes other than standard view because there are no other settings keys in the dialog window.

4 Frequency Sweep Mode

Manual settings Using Front Panel Keys

Test setup:

R&S SMA 100A
Signal Generator
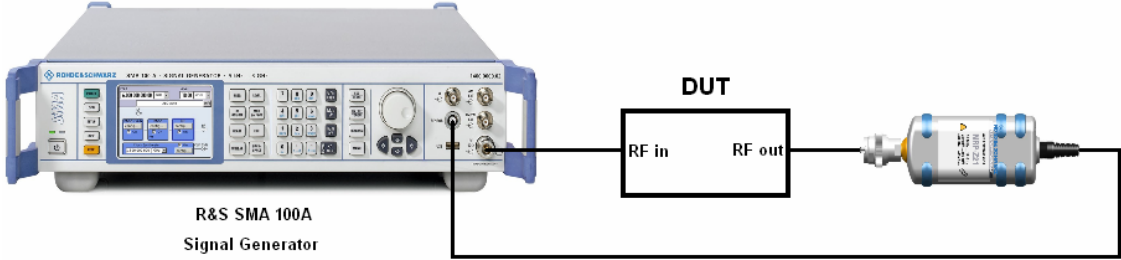
This section demonstrates how to use NRP-Z Analysis with the full screen view.

 Repeatedly press the **REARR** key until the following screen is displayed:
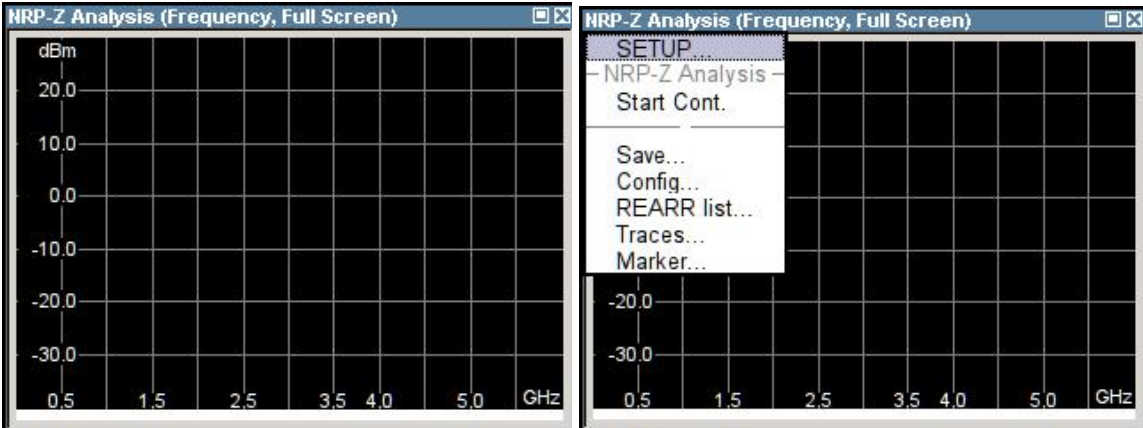
Select from the menu on the right-hand screen.

Configure the sweep settings according to the DUT.
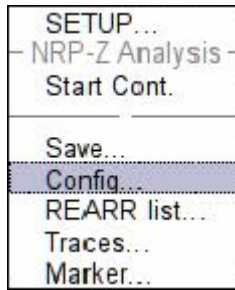
Select **Config…** with the rotary knob ⟳ [menu] and press it. ⬆ :
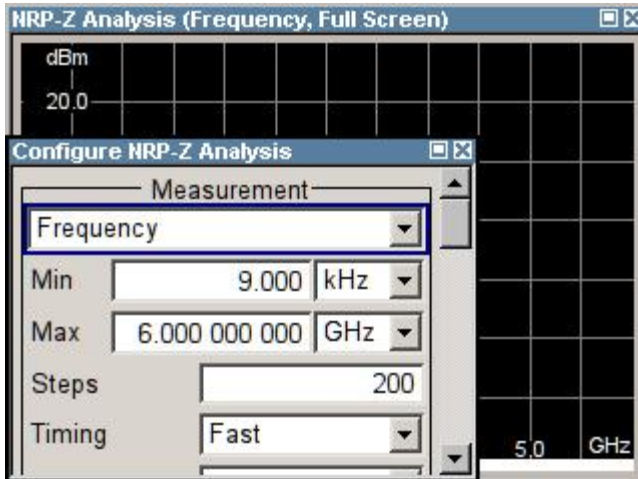
Min frequency = 1 GHz

Select **Min** box with the rotary knob ⟳
and press the following keys:

[1 pqrs] [G / n dBµV]

All other required parameters are configured in the Preset settings.

There are several ways to initiate the sweep measurement, two of which are shown below:

Method A

Step 1.	**Step 2.**
Press the SETUP key	Press the SETUP key
Select **Diagram…** with the rotary knob	Select **Start Cont…** with the rotary knob
and press it .	and press it .
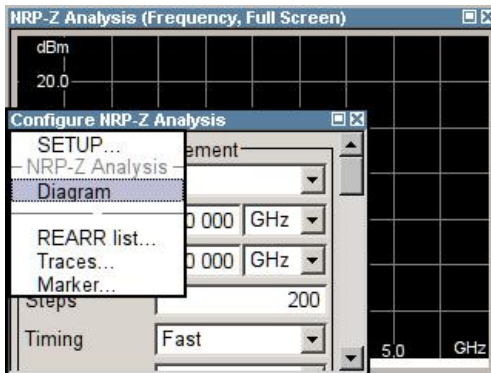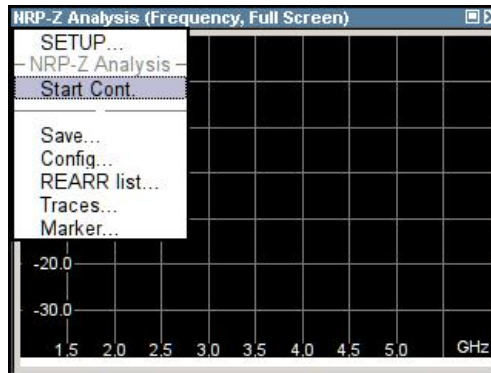
Method B

Step 1.	**Step 2.**
Press the ESC CLOSE key	Press the ON/OFF TOGGLE key
Closes the **Configure NRP-Z Analysis** window	Initiates the sweep measurement

The DUT will be continuously measured.
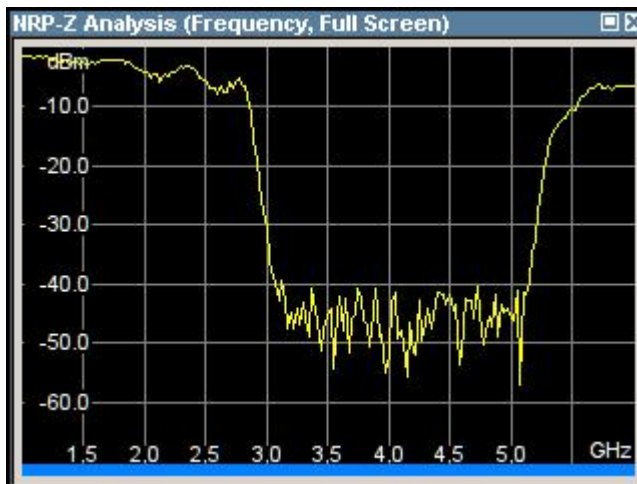
Note:

Press the [ON/OFF TOGGLE] key to stop the sweep measurement.

Remote Control via GPIB , USB , LAN

Using the NRP-Z81

Required SCPI Commands (After Transmitting *rst)

Ideal timeout setting is 10 seconds (relevant only in case of errors)

*rst
*cls
// -----------------------------------
// set power level and output state
// -----------------------------------
POWer 0dbm
OUTPut:STATe on
// -----------------------------------
// sweep setting and start sweep
//
// These settings also control the generator frequency.
// -----------------------------------
SENSe:POWer:SWEep:FREQuency:STARt 1E9
SENSe:POWer:SWEep:FREQuency:STOP 6E9
SENSe:POWer:SWEep:RMODe SINGle

SENSe:POWer:SWEep:INITiate
// -----------------------------------
// wait for end of sweep
// -----------------------------------
*opc?
Loop until reading is **1**, reply to query ***opc?** is always 1, never 0.
(timeout reading will be blank)
// -----------------------------------
// readout of complete dataset, x and y values are separate
// -----------------------------------
TRACe:POWer:SWEep:DATA:XVALues?
Store all x values

TRACe:POWer:SWEep:DATA:YVALues?
Store all y values

// -----------------------------------
// representation of readings with external graph program
// -----------------------------------
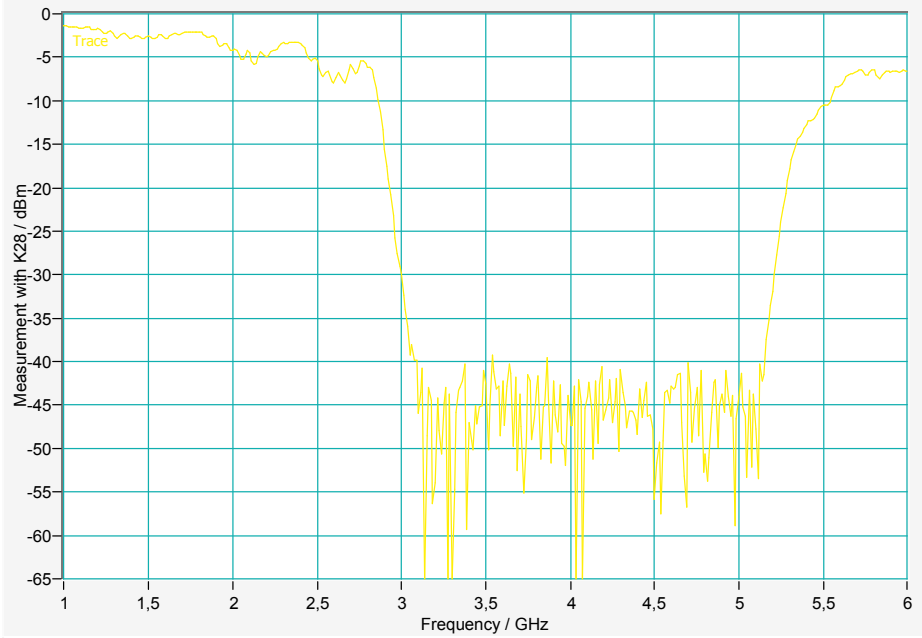
Using the NRP-Z81 Sensor

Using Additional SCPI Commands

Ideal timeout setting is 10 seconds (relevant only in case of errors)


```
// ------------------------------------
// make sure the NRP-Z81 sensor is
// plugged into the round NRP connector on the generator
// ------------------------------------
```


SENSe:TYPe?

Expected reply: **NRP-Z81**

*cls
```
// ------------------------------------
// set power level and output state, some modulation set to OFF
// ------------------------------------
```
POWer 0dbm
OUTPut:STATe ON

CORRection:STATe OFF
MODulation:STATe OFF
```
// ------------------------------------
// switch off of other sensors and/or traces if activated
//
// measurement configuration using Trace 2
// state command is sent after the feed command
// ------------------------------------
```
TRACe1:POWer:SWEep:STATe OFF
TRACe3:POWer:SWEep:STATe OFF

TRACe2:POWer:SWEep:FEED SENSor1// Round Connector (is sens1) -> trace 2
TRACe2:POWer:SWEep:STATe ON

TRACe2:POWer:SWEep:COLor BLUE
```
// ------------------------------------
// sweep setting and start sweep
// ------------------------------------
```
SENSe:POWer:SWEep:MODE FREQuency

SENSe:POWer:SWEep:FREQuency:STARt 1E9
SENSe:POWer:SWEep:FREQuency:STOP 6E9

SENSe:POWer:SWEep:FREQuency:STEP 400
SENSe:POWer:SWEep:RMODe SINGle

SENSe:POWer:SWEep:FREQuency:TIMing:MODE NORMal

SENSe:POWer:SWEep:INITiate
```
// ------------------------------------
// wait for end of sweep
// ------------------------------------
```

*opc?
Loop until reading is **1**, reply to query ***opc?** is always 1, never 0.
(timeout reading will be blank)
// -----------------------------------
// readout of complete dataset, x and y values are separate
// readout of trace color
// -----------------------------------
TRACe2:POWer:SWEep:DATA:XVALues?
Store all x values

TRACe2:POWer:SWEep:DATA:YVALues?
Store all y values

TRACe2:POWer:SWEep:COLor?
Store trace color

// -----------------------------------
// representation of readings with external graph program
// -----------------------------------
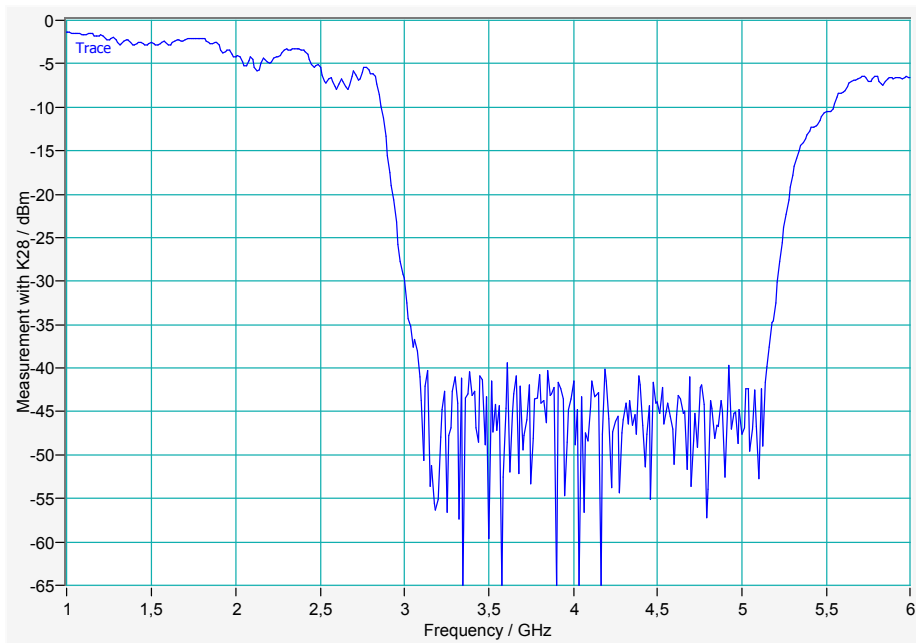
Sensor and Generator Settings for Frequency Measurements

All required generator settings are automatically configured with the exception of the power level.

The frequency sweep measurements are executed with the power level setting of the generator.

The frequency sweep settings are transferred to the sensor in order to automatically calculate the correct measurement value for each frequency point.

Note:

Active modulations are **not** switched off when sweep measurements are started.

Adaptations to DUT-Specific Requirements (e.g. Mixers)

With frequency sweep measurements, the frequency settings of the sensor can be configured differently than the generator settings.
This can be done in the sensor section of the SMA-K28 configuration menu.
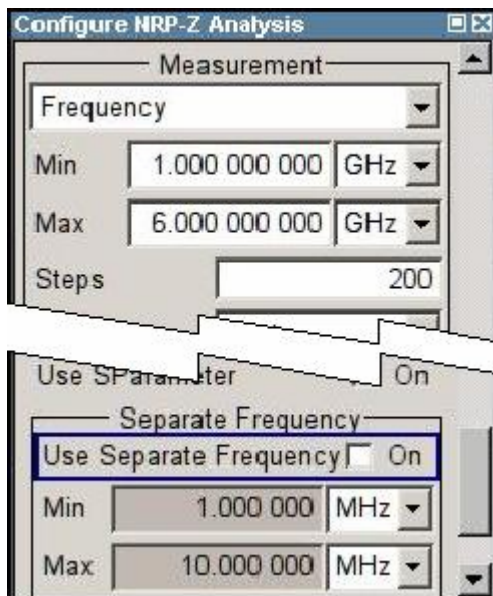
User Correction in Combination with Frequency Sweep Measurements

User correction can be used in combination with NRP-Z Analysis frequency sweep measurements and power sweep measurements (current generator frequency correction).
However, this is a *generator setup* and the user correction will be taken into account by setting the generators output level.

This setup is therefore valid for *all* connected sensors.

Comments on Measurement Accuracy

Measurement accuracy depends primarily on the NRP sensors that are used and the SMA100A signal generator.
The SMA-K28 power analysis option can have a minor impact on accuracy due to display noise or when the power level is stepped.

Power changes:

Every sensor is designed to handle power changes in 20 dB steps with almost no dynamic errors.

Display noise (2σ):

The value specified in the data sheet is valid for an integration time of 10.24 s or a multiple of a given sampling window time (aperture time).

For other integration times the display noise value can be calculated with the following formula:

Given value for 10.24s $* \sqrt{\dfrac{10.24s}{Integration\,Time}}$

Integration time = aperture time x averaging factor x 2 (x 2 due to chopped AD conversion)

> e.g. NRP-Z21

Power level: e.g. 0 dBm(Path 2 @ NRP-Z21)

Display noise[14]		values in []: 8 GHz to 18 GHz	Extract from NRP data sheet
15°C to 35°C	Path 1	<60 pW [64 pW] (40 pW typ.)	
	Path 2	<5.6 nW [6.0 nW] (3.6 nW typ.)	
	Path 3	<0.56 µW [0.60 µW] (0.36 µW typ.)	
0°C to 50°C	Path 1	<65 pW [69 pW]	
	Path 2	<6.3 nW [6.6 nW]	
	Path 3	<0.63 µW [0.66 µW]	

Timing mode:	FAST	NORMAL
->	aperture time: 2 ms averaging factor 1	20 ms 1

Display noise:

$$6nW * \sqrt{\frac{10.24s}{2ms*1*2}} = 304 \text{ nW} \qquad 6nW * \sqrt{\frac{10.24s}{20ms*1*2}} = 96 \text{ nW}$$

e.g. NRP-Z81

Noise [2,3] Typical values in ( )	measurement function Continuous Average Trace / Statistics	(<200,110) pW sampling window set to 10 µs [4]	Extract from NRP-Z81 datasheet

Timing mode:	FAST	NORMAL

->	aperture time:	10 µs	10 µs
	averaging factor	256	2048

Display noise:

$$200\,pW * \sqrt{\frac{10.24s}{10\mu s * 256 * 2}} = 9 \text{ nW} \qquad 200\,pW * \sqrt{\frac{10.24s}{10\mu s * 2048 * 2}} = 3 \text{ nW}$$

5 Power Sweep Mode

This mode is similar to frequency sweep mode except that instead of the frequency, the power level is stepped.

Power sweep measurements are executed using the frequency settings of the generator.

This frequency is transmitted to the sensor in order to automatically calculate the correct measurement value.

Alternatively, the sensor can be adjusted to a frequency different from the generator. Refer to the sensor section of the SMA-K28 configuration dialog for further information.
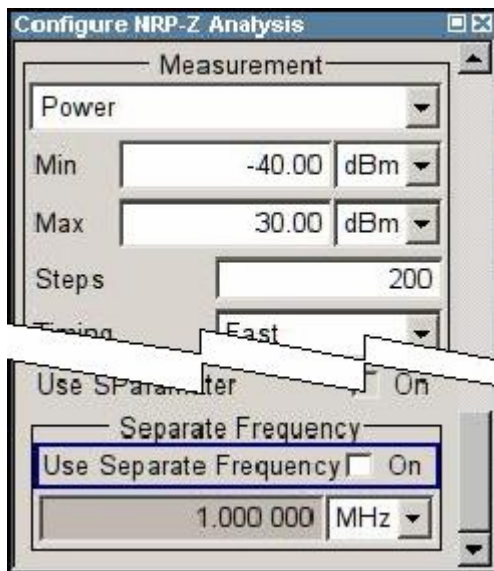
Comments on Running Power Sweep Measurements

To simplify the NRP-Z power analysis user interface and to account for differences in the generators, **Continuous** mode is permitted only if the attenuator is set to **Fixed** (attenuator range). This will prevent damage to mechanical attenuator switches.

If the attenuator is **not** set to **Fixed** when in **Continuous** mode, the sweep automatically stops after one run and an error message is then displayed.

This behavior allows sweeping across the full power range of the generator regardless of the attenuator switches being used.

6 Time Mode

This chapter describes time trace measurements using a pulse-modulated signal to measure power as a function of time.

The first step is to configure the basic settings for the NRP-Z power analysis, followed by the generator's pulse modulation settings and then modification of the trigger level to obtain stable measurements.

Manual Settings Using Front Panel Keys

Using the NRP-Z81

Set up the instrument as outlined in chapter *Setup*.

Connect the RF plug of the NRP-Z81 sensor to the RF output of the generator.

The NRP-Z81 is a wideband power sensor and is the preferred sensor for measuring short pulses or fast pulse rise and fall times.

When using other sensors such as the NRP-Z21, different settings are required.

Refer to chapter *Using the NRP-Z21 Sensor*.

This chapter demonstrates how to configure the NRP-Z Power Analysis settings in standard view mode.

Initial display:
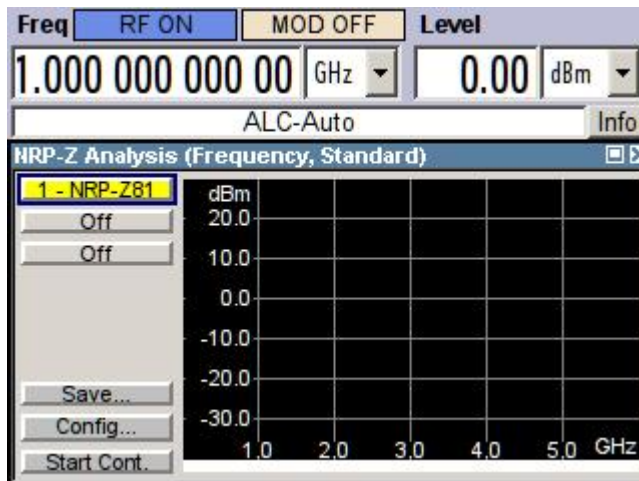
Use the rotary knob ⟳ to select **Config…** and then press it 🔼.
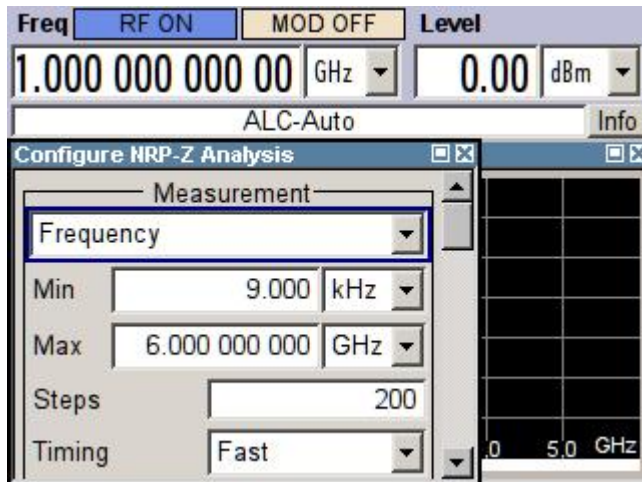
Select **Time** instead of **Frequency**.
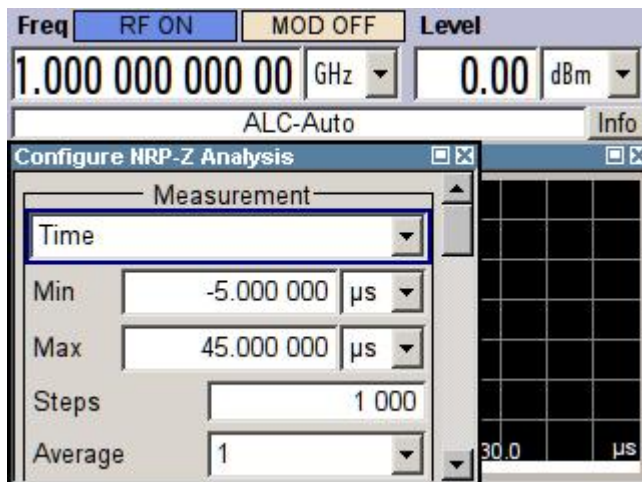
Refer to chapter *7* for other Min/Max Time settings with the NRP-Z21.

The wanted signal is a pulse-modulated RF signal. It is represented as a video pulse trace (waveform envelope).

Press the   [DIAGRAM]   key to show the diagram display of the generator.

Select the Modulation block with the rotary knob 🔘 and then press it 🔘 to activate the

corresponding menu. Select **Pulse Mod…** from the menu with the rotary knob 🔘
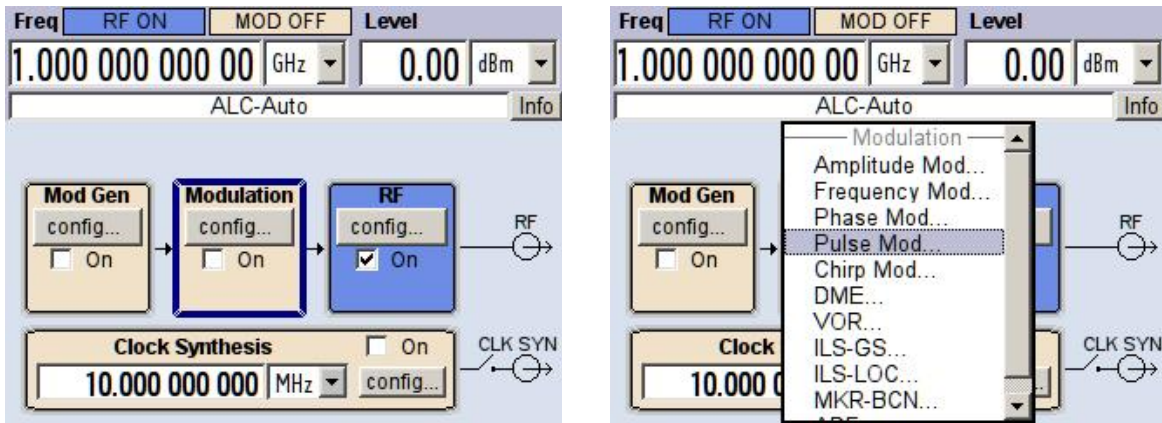
and press it again. This activates the Pulse Modulation control panel.

Press the rotary knob again to activate the modulation.
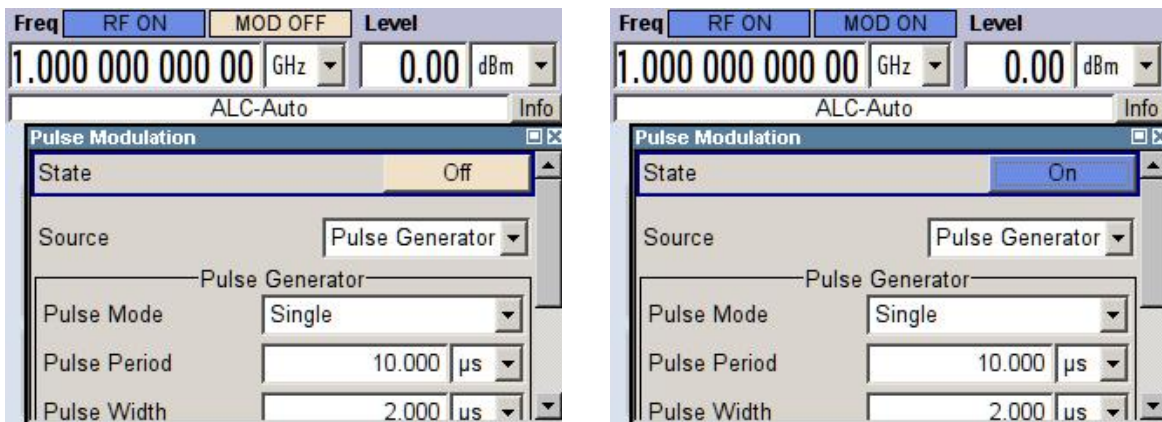
Refer to chapter *Using the NRP-Z21 Sensor* for other Pulse Period/Width settings with the NRP-Z21.

Close the Pulse Modulation dialog box by pressing the [ESC CLOSE] key.

Press the [WINBAR] key to show the graph analysis window again.

Press the [ON/OFF TOGGLE] key to start the measurement.
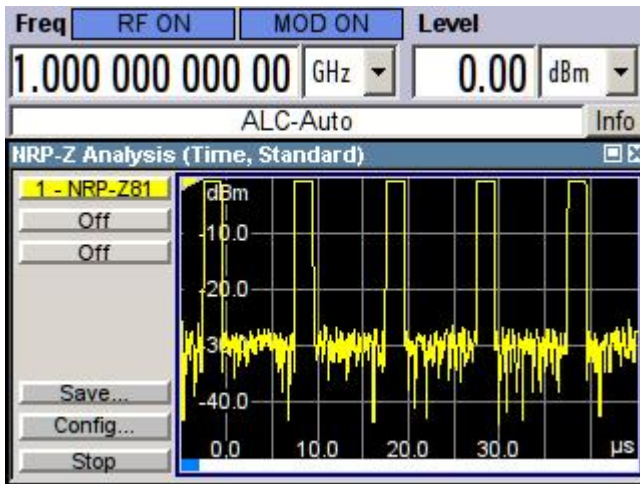
The displayed signal is clearly unstable. This is caused by the current trigger level setting (marked with the ▶ symbol).

To change the trigger level (focus is on the graph within the blue border) press the rotary knob ⟳ ⟳ twice.
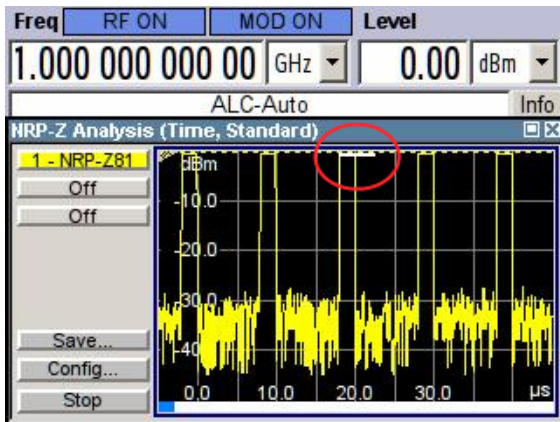
1. Press   2. Press
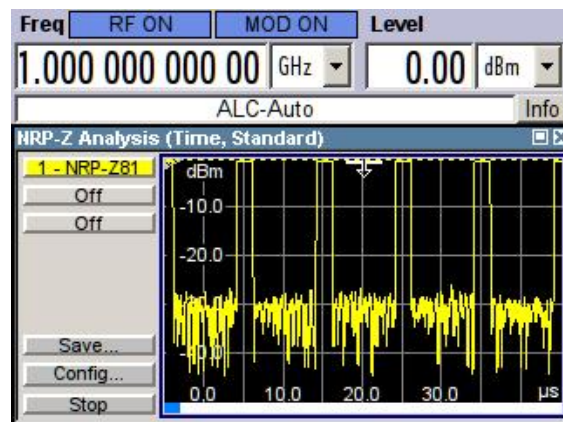
Simply move the trigger line into the signal area using the rotary knob ⟳ .

The displayed signal is now stable and has low noise (except for the noise floor)
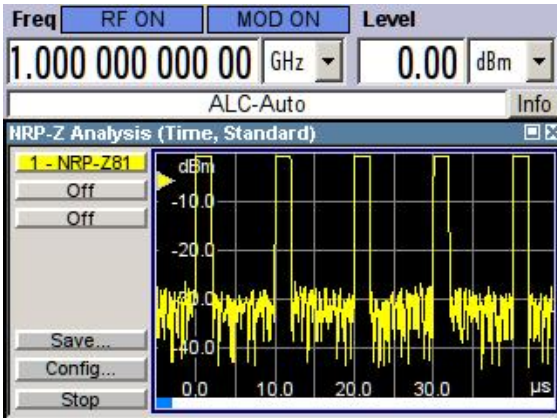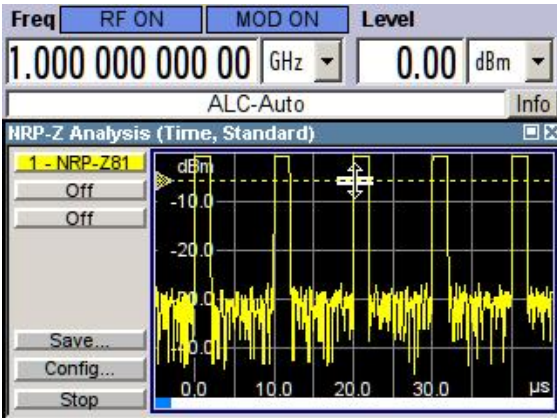
Press the [ESC CLOSE] [ESC CLOSE] key two times to remove trigger line (right graph).

Note :

Press the [ESC CLOSE] *key to close the window !*

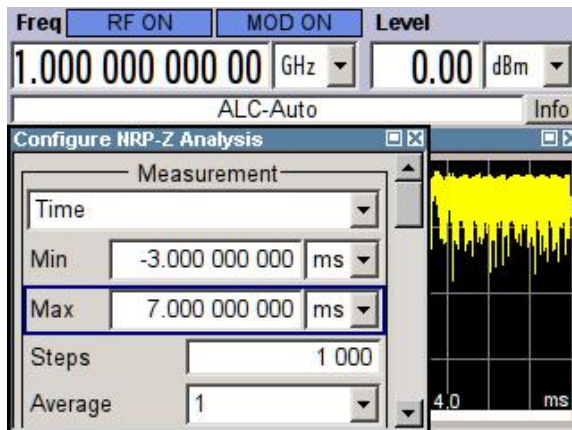Go to chapter *Measuring Pulse Parameters with NRP-Z81 Sensors*.

Go to chapter *Gate Mode*.

Using the NRP-Z21 Sensor

Connect the RF plug of the NRP-Z21 sensor to the RF output of the generator.

Press the [ON/OFF TOGGLE] key to start the measurement.

Recommended Settings for Measurements and Graph Display

Select **Config…** with the rotary knob and press it.

Select **Min** with the rotary knob

[+/- A↔a] [3 wxyz] [k/m mV]   Enter – 3 m (s)

Select **Max** with the rotary knob

[7] [k/m mV]   Enter 7 m (s)

Press the [ESC CLOSE] key to close the dialog box.
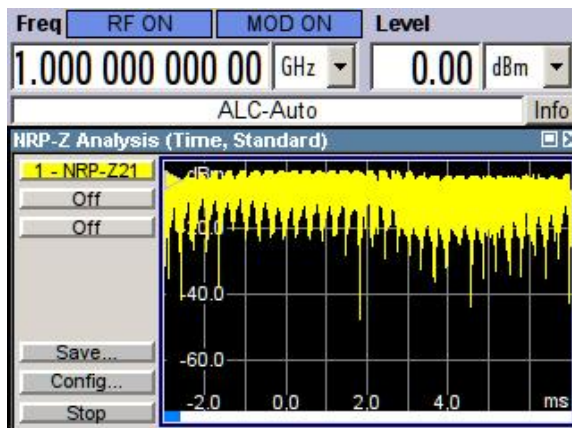
The above display shows how the measured signal appears under the current settings. This is because in contrast to the NRP-Z81, the NRP-Z21 cannot measure short pulses. The pulse modulator therefore needs to be reconfigured.

Recommended Settings for Pulse Modulation

To open the Pulse Modulation/Generator dialog box:

Press the [DIAGRAM] key to display the diagram of the generator.

Select the Modulation block with the rotary knob ⊙ and press it 🔼 to active the corresponding

menu. Select **Pulse Mod…** from the menu with the rotary knob ⊙

and press it 🔼 again. This activates the Pulse Modulation/Generator control panel.

Select **Pulse Period** with the rotary knob ⊙.

[4 ghi] [k / m mV]   Enter 4 m (s)

Select **Pulse Width** with the rotary knob ⊙.

[1 pqrs] [. *…#] [5 jkl] [k / m mV]   Enter 1.5 m (s)

Freq	RF ON		MOD ON	Level	
1.000 000 000 00	GHz ▾			0.00	dBm ▾

ALC-Auto	Info

Pulse Modulation	▢☒
State	On ▲

Source	Pulse Generator ▾

Pulse Generator	
Pulse Mode	Single ▾
Pulse Period	4.000 000	ms ▾
Pulse Width	1.500 000	ms ▾
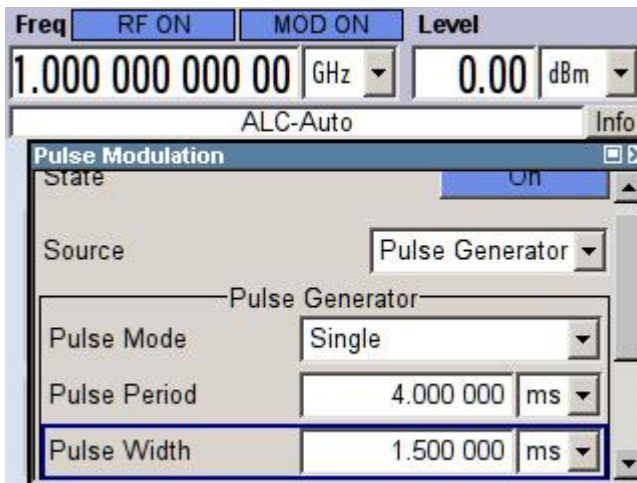
Note :

Press the   [WINBAR]   **key to toggle between the open dialog boxes.**

Press the [WINBAR] key until the diagram box appears.
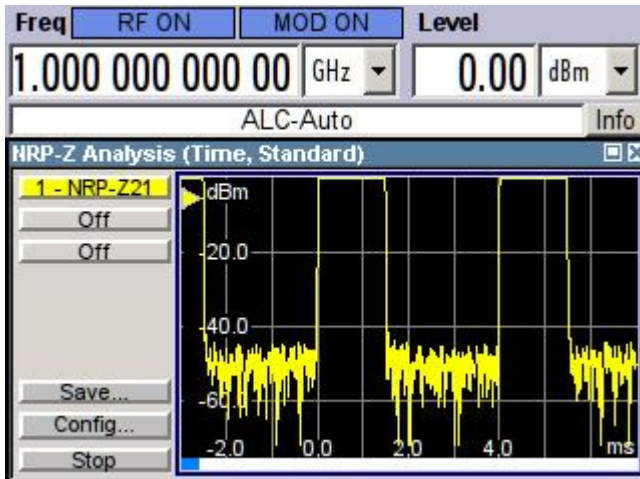
To enlarge the diagram, press the [REARR] key four times.

The generator steps through all of the SMA-K28 graphs.
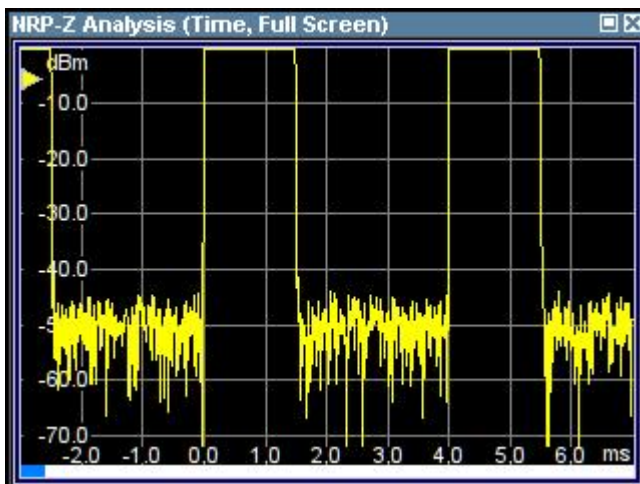
Note :

To eliminate specific views, configure the viewing mode as outlined in chapter *Configuring the Viewing Modes*.

Go to chapter *Gate Mode* (Time gated peak and average power values).

Remote Control via GPIB , USB , LAN

Using the NRP-Z81 Sensor

Required SCPI Commands (After Transmitting *rst)

Ideal timeout setting is 10 seconds (relevant only in case of errors)

*rst
*cls
// ------------------------------------
// set power level and output state
//
// switch on pulse modulation
// ------------------------------------
POWer 0dbm
OUTPut:STATe ON

:SOURce:PULM:STATe ON
// ------------------------------------
// sweep setting (time mode)
//
// set trigger level -5dBm
//
// start sweep
// ------------------------------------
SENSe:POWer:SWEep:MODE TIME

SENSe:POWer:SWEep:TIME:STARt -0.02E-3s
SENSe:POWer:SWEep:TIME:STOP 0.04E-3s

SENSe:POWer:SWEep:TIME:TRIGger:LEVel -5.0dBm

SENSe:POWer:SWEep:INITiate
// ------------------------------------
// wait for end of sweep
// ------------------------------------
*opc?
Loop until reading is **1**, reply to query ***opc?** is always 1, never 0.
(timeout reading will be blank)
// ------------------------------------
// readout of complete dataset, x and y values are separate
// ------------------------------------
TRACe:POWer:SWEep:DATA:XVALues?
Store all x values

TRACe:POWer:SWEep:DATA:YVALues?
Store all y values

Note:
It is not necessary to transfer the current frequency of the generator to the sensor. This is automatically performed by the generator firmware.
// ------------------------------------
// readings displayed with external graph program
// ------------------------------------
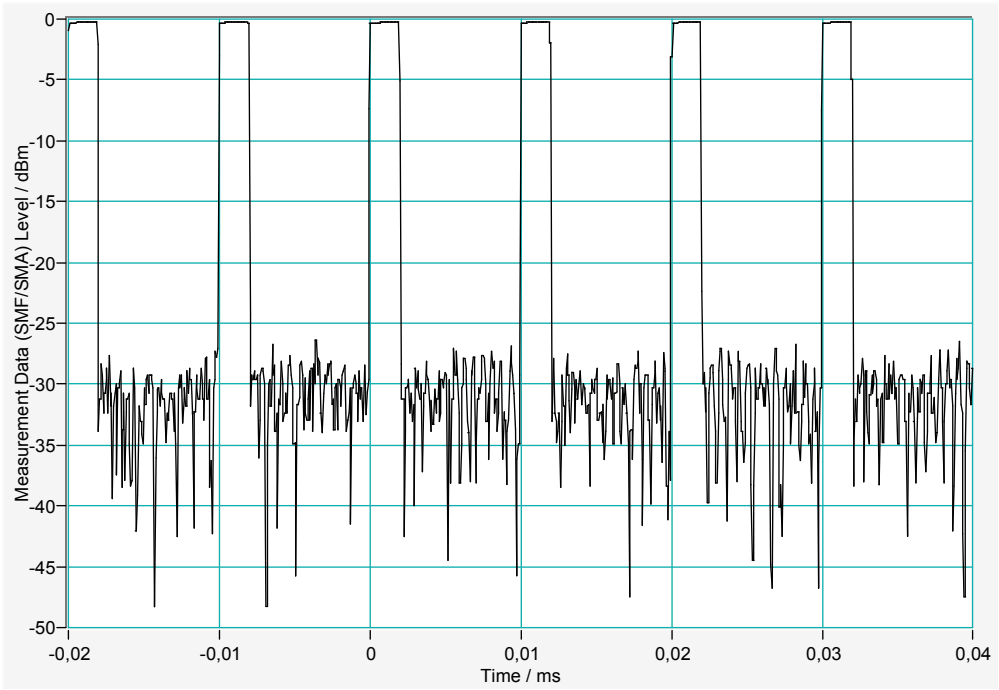
Using the NRP-Z21 Sensor

Additional SCPI Commands

Ideal timeout setting is 10 seconds (relevant only in case of errors)


```
// -----------------------------------
// make sure the NRP-Z21 sensor is
// plugged into the standard USB connector on the generator
// (NRP-Z3 or NRP-Z4 adapter is used)
// -----------------------------------
```

SENSe2:TYPe?

Expected reply: **NRP-Z21**

*rst
*cls
```
// -----------------------------------
// set power level and output state
//
// switch on pulse modulation, pulse generator setup for NRP-Z21
// -----------------------------------
```
POWer 0dbm
OUTPut:STATe ON

:SOURce:PULM:STATe ON

:SOURce:PULM:PERiod 4MS
:SOURce:PULM:WIDTh 1.5MS
```
// -----------------------------------
// sweep setting (time mode)
//
// set trigger level -5dBm (sensor dependent ! -> SENSe2)
//
// start sweep
// -----------------------------------
```
SENSe:POWer:SWEep:MODE TIME

SENSe:POWer:SWEep:TIME:STARt -3.0E-3s
SENSe:POWer:SWEep:TIME:STOP 7.0E-3s

SENSe2:POWer:SWEep:TIME:TRIGger:LEVel -5.0dbm
```
// -----------------------------------
// switch off of sensors/traces that are not required
//
// measurement configuration using Trace 3
//
// use index 3 to read result
// state command is to be sent after the feed command
// -----------------------------------
```

TRACe1:POWer:SWEep:STATe OFF
TRACe2:POWer:SWEep:STATe OFF
TRACe3:POWer:SWEep:FEED SENSor2// sensor in USB connector (2) -> trace 3
TRACe3:POWer:SWEep:STATe ON
TRACe3:POWer:SWEep:COLor BLUE// set trace color to blue
// ------------------------------------
// start sweep
// ------------------------------------
SENSe:POWer:SWEep:INITiate
// ------------------------------------
// wait for end of sweep
// ------------------------------------
*opc?
Loop until reading is **1**, reply to query ***opc?** is always 1, never 0.
(timeout reading will be blank)
// ------------------------------------
// readout of complete dataset, x and y values are separate
// ------------------------------------
TRACe3:POWer:SWEep:DATA:XVALues?
Store all x values

TRACe3:POWer:SWEep:DATA:YVALues?
Store all y values

// ------------------------------------
// readings displayed with external graph program
// ------------------------------------
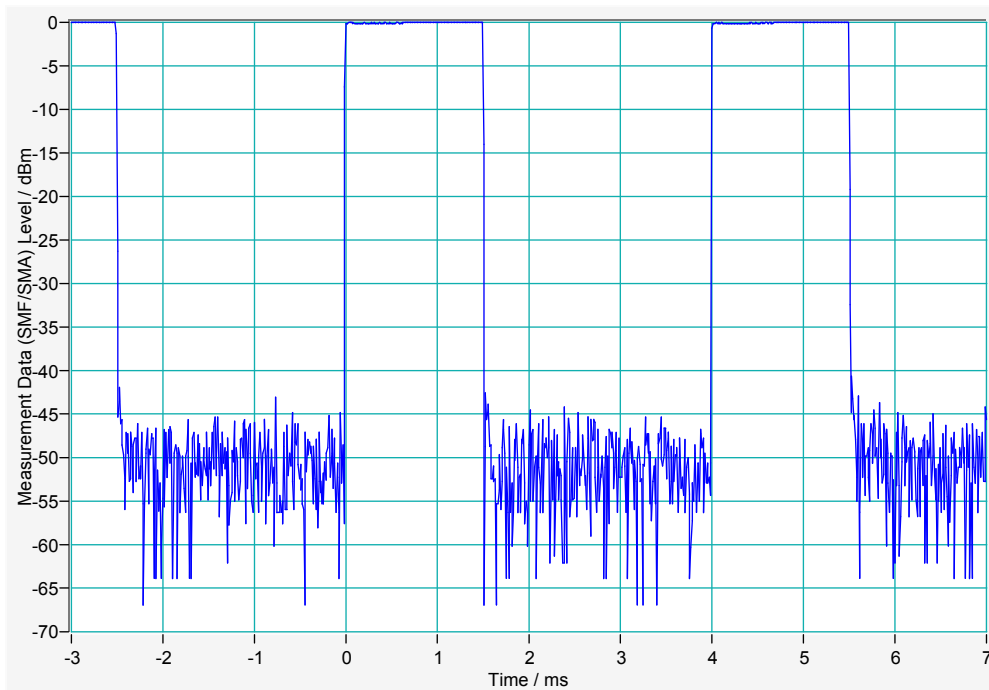
```
// -----------------------------------
// Readout of measurement data as a hardcopy
//
//  Reset (recalculate) scaling (measurement mode dependent, time)
//
// Read data into a file (e.g.hardcopy.bmp)
// Purge file from binary header  #6921654, see Chapter 0.4
// Execute a bitmap viewer
//
// This hardcopy can be executed in any user interface state.
// There is no need to explicitly show it on the generator.
// -----------------------------------
```

SENSe:POWer:SWEep:time:YSCale:AUTO:RESet

:SENSe:POWer:SWEep:HCOPy:DEVice:LANGuage BMP;*wai;:SENSe:POWer:SWEep:HCOPy:DATA?

```
// -----------------------------------
// Display of the hardcopy file (hardcopy.bmp)
// -----------------------------------
```
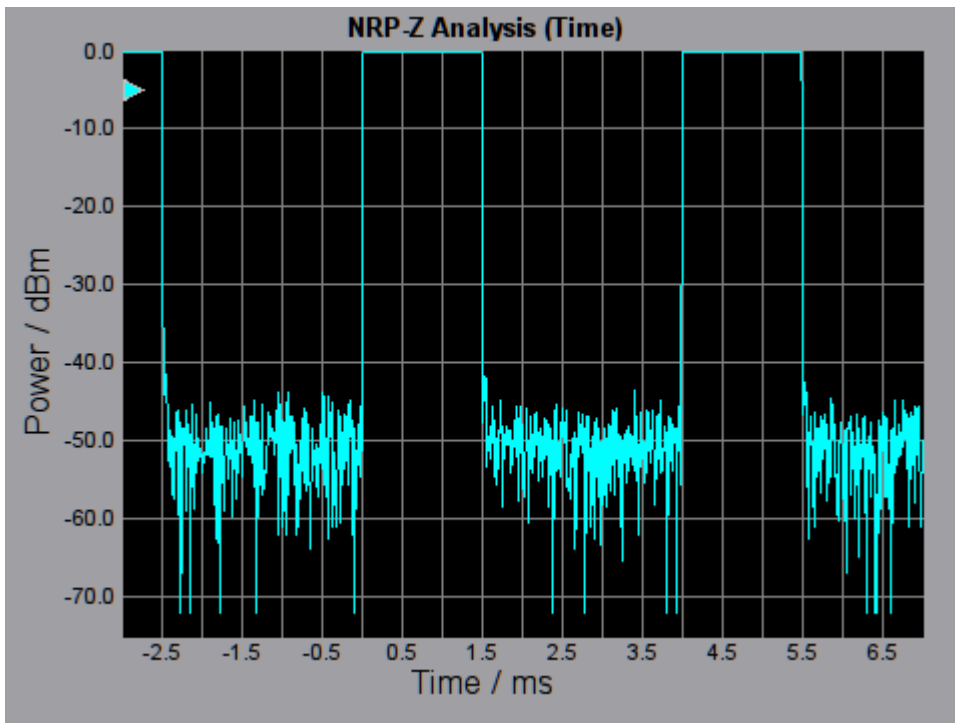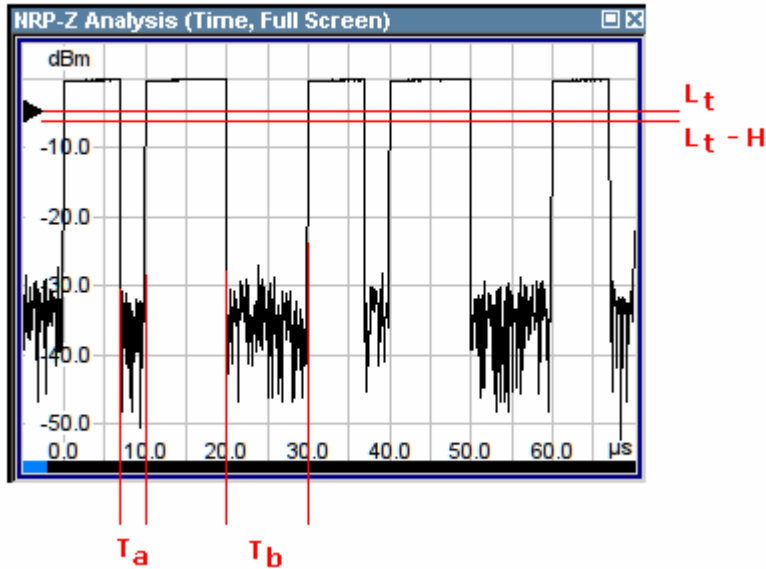
Stable Triggering Using the Dropout Time Parameter

(NRP-Z81 used, measuring double pulses, can be generated only with the SMA-K23 option.)

Dropout time can be set to allow stable triggering of double or multipulse signals without signal jitter.

Setting the dropout time T_d

L_t = Trigger Level , $L_t - H$ = Trigger Level – Trigger Hysteresis , T_a und T_b = Signal Gaps

Pulse generator setup for wanted signal	Trigger setup using SMA-K28

=> T_a = 3 µs , T_b = 10 µs

The following conditions must be met for correct and stable triggering of the signal:

$T_d > T_a$ and $T_d < T_b$ or$T_a < T_d < T_b$

=> T_d = 5 µs

T_a and T_b are calculated from double pulse generator settings as follows:

T_a = Double Pulse Delay – Pulse Width
T_b = Pulse Period – Double Pulse Width – Double Pulse Delay

With SMA-K28, the signal is always triggered by using the positive edge of the signal. Therefore the signal level has to be below the trigger level $L_t – H$ for a given time T_d, before the next trigger event is executed.

Note :

The **Auto Set** key in the Trigger NRP-Z Analysis menu is used to set **Hysteresis** to a fixed value of **0.5 dB** and **Drop Out Time** to a fixed value of **200 ns**.

The **Level** parameter value will be measured and calculated by the sensor depending on the measured signal.

Time Resolution – NRP-Z2x and NRP-Z8x Sensors

Time resolution is usually defined as follows:

Time span = Max time – Min time

Display resolution/point = Time span/Steps

Max. time resolution:

NRP-Z2x: 10 µs

NRP-Z8x: 12.5 ns

2 ns   (High resolution: if resolution/point is less 12.5 ns,
a periodic signal required. One trace is measured 32 times.
Please note that this behavior extends the measuring time
and therefore reduces the display refresh rate.)

The generator will initiate an error message if these limits are exceeded.

Adaptations to DUT-Specific Requirements

As with frequency or power sweep measurements, the sensor can be adjusted to a frequency different from the generator when performing time trace measurements.

This can be set in the **Separate Frequency** button in the SMA-K28 configuration dialog box.
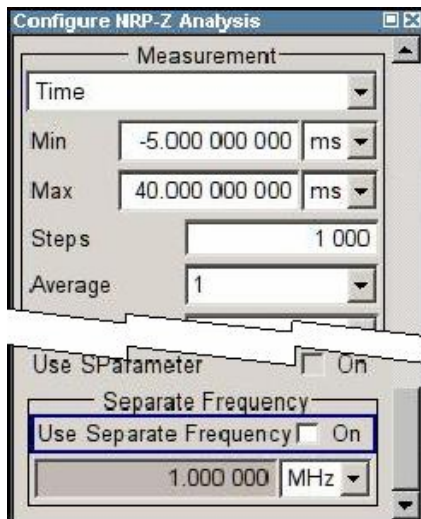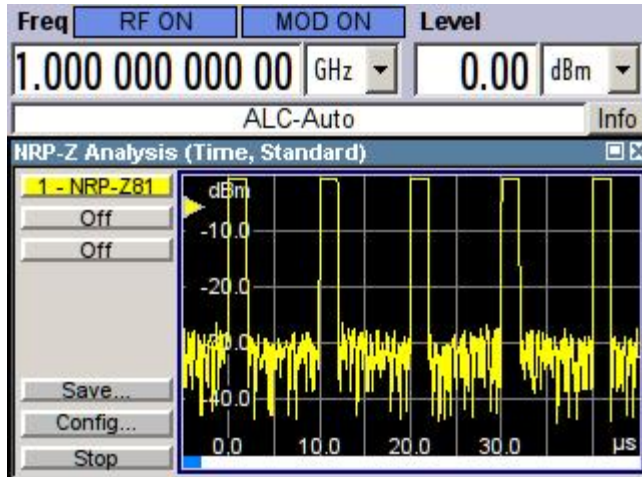
7 Measuring Pulse Parameters with NRP-Z81 Sensors

Manual settings Using Front Panel Keys

Carry out time trace measurements as outlined in chapter *Time Mode*.
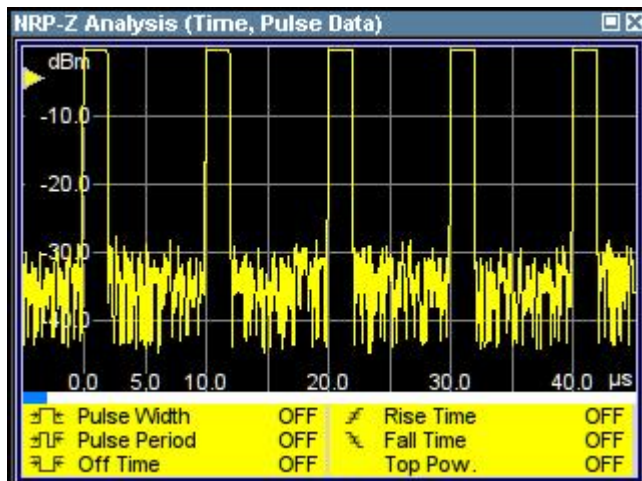
The following generator screen will appear:

To display the pulse data view, press the [REARR] key three times.
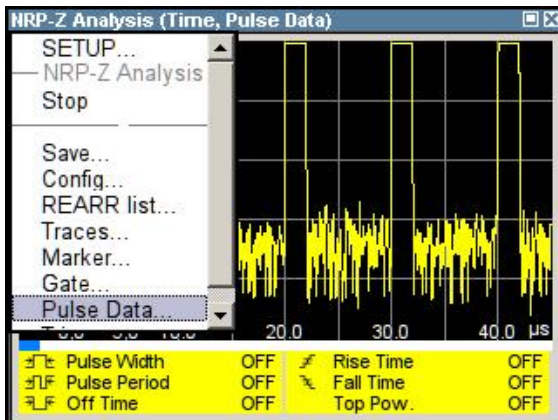
The generator screen now looks like this:

OFF indicates that pulse measurement is currently switched off.

Press the [SETUP] key to configure the generator for pulse data measurements.

Select **Pulse Data…** from the menu with the rotary knob ⟳ and press it ⬆ .

Press the [REARR] key to enlarge the dialog window.
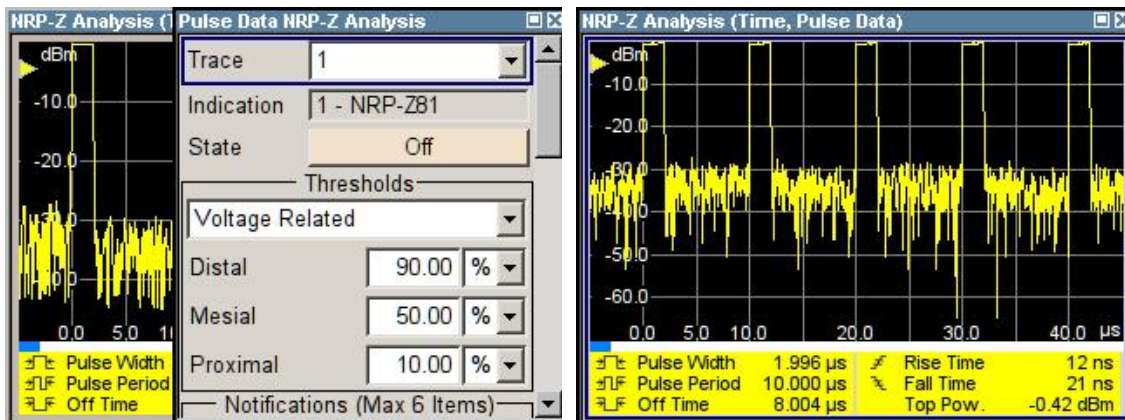
Select the **State** button with the rotary knob ⟳ press it ⬆ to activate the pulse data measurement.

Up to 6 items can be selected for display in the pulse data measurement graph screen by scrolling down the dialog window.

Press the [ESC CLOSE] key to close the settings dialog window and return to the graph screen.

Note:

The scaling of the graph on the right-hand side is modified due to a different noise floor.
(For best results, the internal sensor measurement is sampled with higher resolution while measuring pulse data.)

Remote Control via GPIB, USB, LAN

Using Additional SCPI Commands

Ideal timeout setting is 10 seconds (relevant only in case of errors).

```
// -----------------------------------
// make sure the NRP-Z81 sensor is plugged
// into the round NRP connector on the generator
// -----------------------------------
```

SENSe:TYPe?

Expected reply: **NRP-Z81**

*rst
*cls
```
// -----------------------------------
// set power level and output state
//
// switch on pulse modulation (default values)
// -----------------------------------
```
pow 0dbm
outp:stat on

:SOURe:PULM:STATe ON
```
// -----------------------------------
// sweep setting (time mode)
//
// set average count of the sensor
//
// switch on pulse data measurement
//
// set trigger level -5 dBm (sensor dependent)
//
// start sweep
// -----------------------------------
```
SENSe:POWer:SWEep:MODE TIME

SENSe:POWer:SWEep:TIME:AVERage:COUNt 64

SENSe:POWer:SWEep:TIME:SENSor:PULSe:STATe ON

SENSe:POWer:SWEep:TIME:STARt -0.02E-3s
SENSe:POWer:SWEep:TIME:STOP 0.04E-3s

SENSe:POWer:SWEep:TIME:TRIGger:LEVel -5.0dBm
```
// -----------------------------------
// switch off sensors/traces that are not required
//
// use trace 2 for indication
// state command is to be sent after the feed command
// -----------------------------------
```

TRACe1:POWer:SWEep:STATe OFF
TRACe3:POWer:SWEep:STATe OFF
TRACe2:POWer:SWEep:FEED SENSor1// Round Connector (is sens1) -> trace 2
TRACe2:POWer:SWEep:STATe ON

// -------------------------------------
// start sweep
// -------------------------------------
SENSe:POWer:SWEep:INIT
// -------------------------------------
// wait for end of sweep
// -------------------------------------
*opc
Loop until reading is **1**, reply to query ***opc?** is always 1, never 0.
(timeout reading will be blank)
// -------------------------------------
// readout of complete dataset, x and y values are separate if desired
// -------------------------------------
TRACe2:POWer:SWEep:DATA:XVALues?
Store all x values

TRACe2:POWer:SWEep:DATA:YVALues?
Store all y values

// -------------------------------------
// representation of readings with external graph program
// -------------------------------------
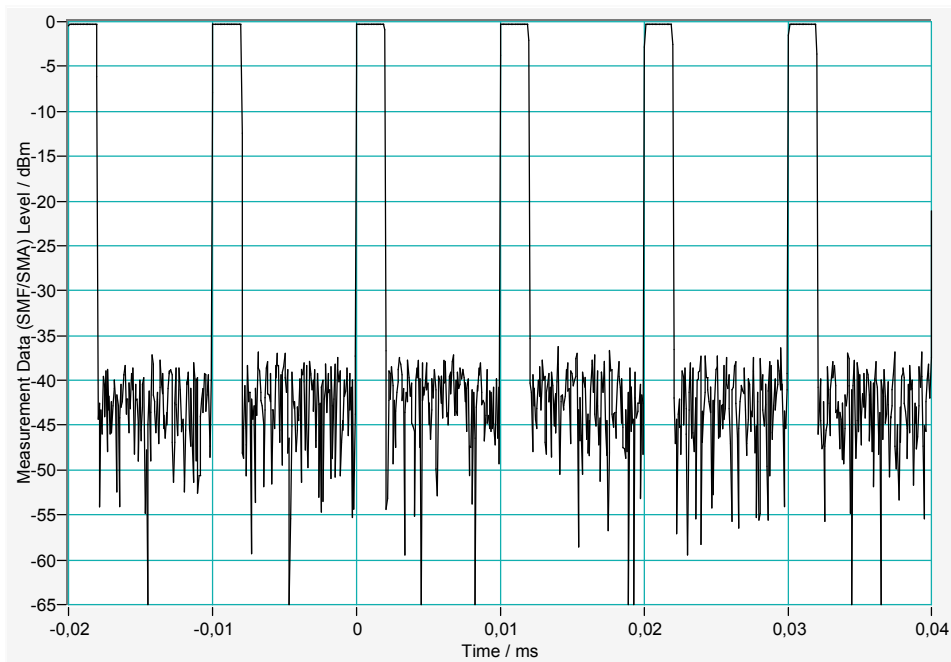
// -------------------------------------
// readout of selected pulse data values if desired
// all values are readable
// -------------------------------------

TRACe2:POWer:SWEep:MEASurement:POWer:PULSe:TOP?
TRACe2:POWer:SWEep:MEASurement:PULSe:DURation?
TRACe2:POWer:SWEep:MEASurement:PULSe:PERiod?
TRACe2:POWer:SWEep:MEASurement:TRANsition:POSitive:DURation?
TRACe2:POWer:SWEep:MEASurement:TRANsition:NEGative:DURation?

```
// ----------------------------------
// representation of readings, formatted
// ----------------------------------

//
// Pulse data :
//
//    Pulse width       : 1.999 µs
//
//    Pulse period      : 10.000 µs
//
//    Pulse rise time   : 23.9 ns
//
//    Pulse fall time   : 21.3 ns
//
//    Pulse top level   : -0.29 dBm
//
```

// ----------------------------------
// Readout of measurement data as a hardcopy if desired
//
// Read data into a file (e.g. hardcopy.bmp)
// Purge file from binary header #6518463, see Chapter 0.4
// Execute a bitmap viewer
//
// This hardcopy can be executed in any user interface state.
// There is no need to explicitly show the graphical dialog on the generator display.
// ----------------------------------

// ----------------------------------
// Disable all possible pulse data indication for all traces
// since by default for trace 1 some values for indication are enabled
// The first six enabled values (across all traces) for indication are usable
// It is thus possible to define the desired value for indication freely
// ----------------------------------
:TRACe1:POWer:SWEep:MEASurement:PULSe:ALL:DISPlay:ANNotation:STATe OFF
:TRACe2:POWer:SWEep:MEASurement:PULSe:ALL:DISPlay:ANNotation:STATe OFF
:TRACe3:POWer:SWEep:MEASurement:PULSe:ALL:DISPlay:ANNotation:STATe OFF
// ----------------------------------
// Select the desired values for indication (max. six items)
// ----------------------------------
TRACe2:POWer:SWEep:MEASurement:PULSe:DCYCle:DISPlay:ANNotation 1
TRACe2:POWer:SWEep:MEASurement:PULSe:DURation:DISPlay:ANNotation 1
TRACe2:POWer:SWEep:MEASurement:PULSe:PERiod:DISPlay:ANNotation 1

TRACe2:POWer:SWEep:MEASurement:POWer:PULSe:TOP:DISPlay:ANNotation 1
TRACe2:POWer:SWEep:MEASurement:TRANsition:POSitive:DURation:DISPlay:ANNotation 1
TRACe2:POWer:SWEep:MEASurement:TRANsition:NEGative:DURation:DISPlay:ANNotation 1

// ----------------------------------
// Switch on Pulse Data screen
// ----------------------------------

:TRACe2:POWer:SWEep:MEASurement:PULSe:DISPlay:ANNotation:STATe ON

// -----------------------------------
// Reset (recalculate) scaling (measurement mode dependent, time)
// -----------------------------------
SENSe:POWer:SWEep:time:YSCale:AUTO:RESet
:SENSe:POWer:SWEep:HCOPy:DEVice:LANGuage BMP;*wai;:SENSe:POWer:SWEep:HCOPy:DATA?
// -----------------------------------
// Read data into a file (e.g. hardcopy.bmp)
// Purge file from binary header #6518463, see Chapter 0.4
// Execute a bitmap viewer
// -----------------------------------

// -----------------------------------
// Display of the hardcopy file (hardcopy.bmp)
// -----------------------------------
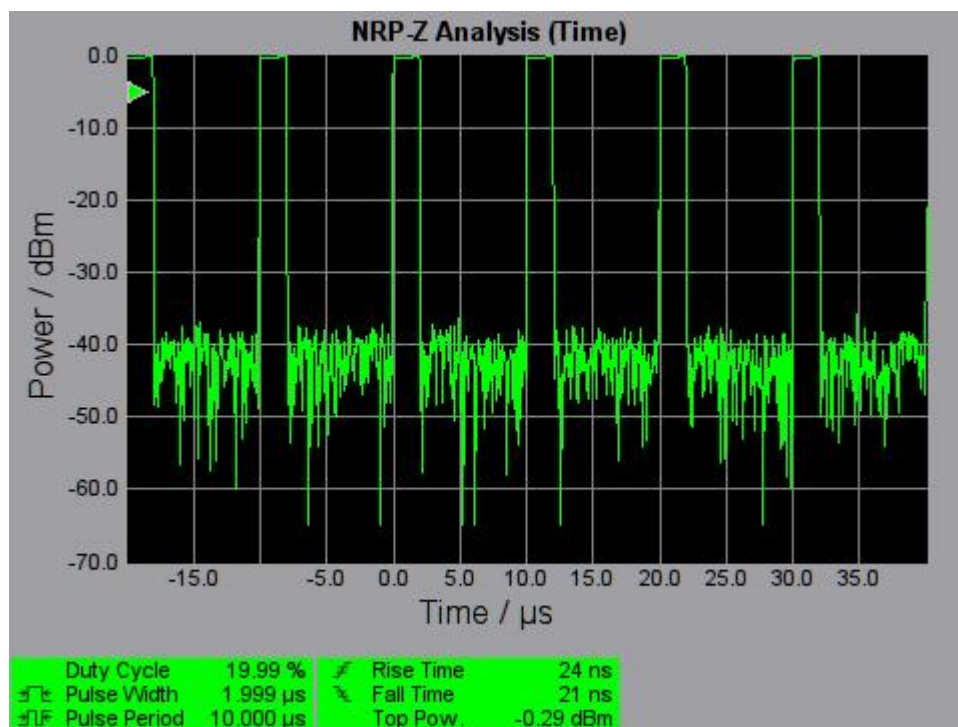
Measured Pulse Data Values

These values are measured/calculated over the displayed (or set) time range. This time range is the basis for calculating the pulse data values. Therefore, varying the time range may modify some of the values. Keep this mind when interpreting the values.

Thresholds Values

Because measurements such as rise/fall time and pulse width are usually represented as a function of **Voltage** (Vt) and not **Power** (Pt), the values displayed as "Voltage related" represent the normal case.

To get the same results for the measured values using the "Power related" setting, the given values for the "Voltage related" settings must be converted (squared).

Example:
	Distal	Mesial	Proximal
Voltage related:	90 %	50 %	10 %
Power related:	81 %	25 %	1 %

log. scale (e.g.): -0.9 dB -6 dB -20 dB [*]

[*] (approx. difference between top and base power > 30 dB)

Time Resolution of the Measured Pulse Data

(Refer to Chapter 6.4)

If possible, the signal should be internally measured at a higher resolution by calculating the ratio between time span and steps. Multiple internal measurement points therefore form a single display point.

This behavior depends on the time span and steps settings and cannot be influenced by the user.

Time span = Max time – Min time

Display resolution/point = Time span/Steps

Maximal achievable resolution for measuring pulse data:
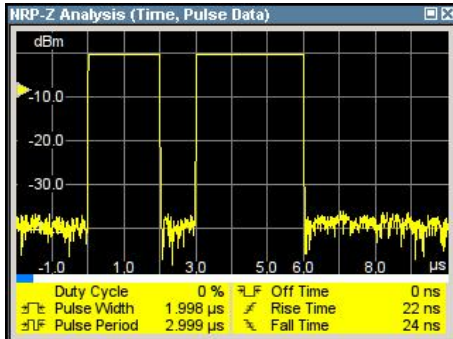
Resolution/point >= 12.5 ns   ->   Max. resolution = 12.5 ns

Resolution/point < 12.5 ns   ->   Max. resolution = 2 ns
(Periodic signal required, one trace is measured 32 times.
Please note that this behavior extends the measuring time
and therefore reduces the display refresh rate.)

Keep this resolution in mind when interpreting the values being displayed.
(See example in Chapter 7.6)

How to Measure the Different Pulses of a Signal

All pulse data values are measured from (or are related to) the initial pulse:

Time resolution = 12.5 µs / 1000 = 12.5 ns

Please note that in this case the value for Pulse Period is interpreted as the pulse distance.
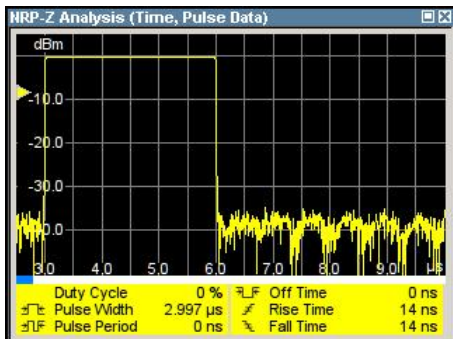
Measurement data from the first pulse of a double pulse signal.

Since this is a double pulse, refer to Chapter 6.3 for correct and stable triggering.

To measure the second pulse, the signal has to be shifted to the left. This can be done by setting the Min Time in the Configure NRP-Z Analysis menu to 2.5 µs.
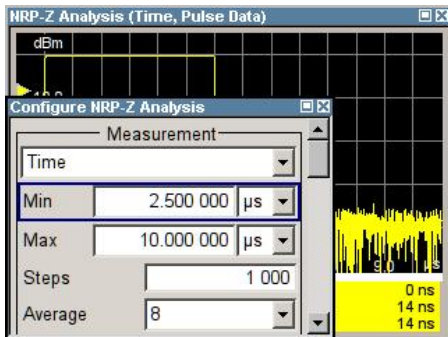
The measurement data for the second pulse is displayed:

Time resolution = 7.5 µs/1000 = 7.5 ns

The pulse appears wider because only the Min Time parameter was changed.

Note that the Pulse Width value has changed.

Rise/Fall Time values are different due to the time resolution, which was changed to a high resolution (2 ns).

Measurement data from second pulse of the double pulse signal.

Note that the Rise/Fall Time values lie within the range of the time resolution.

Explanation of the Values

Refer to the sensor specifications to determine the accuracy of the measurement data.

All values are calculated in line with IEC469.

The descriptions are based on a DME pulse, which can be generated with SMA-K26.

Basic Signal Times

Note:

As a result of the current generator settings, the distance of the double pulses is shown as Pulse Period.

DME pulses are double pulses with a different (larger) pulse period as indicated below.

Pulse Period is the distance between one rising edge of the pulse and the next. If the Duty Cycle shows 0 % and/or if Off Time is 0 ns, this value can be interpreted as pulse distance.
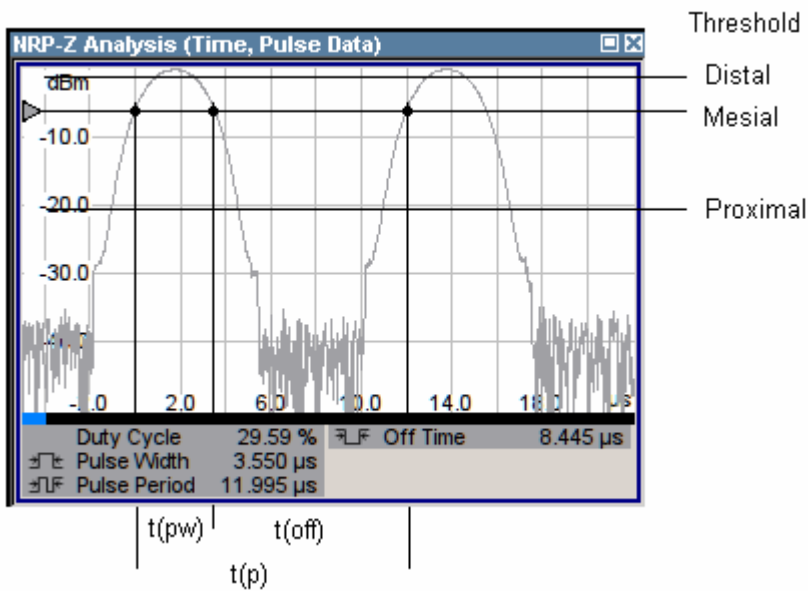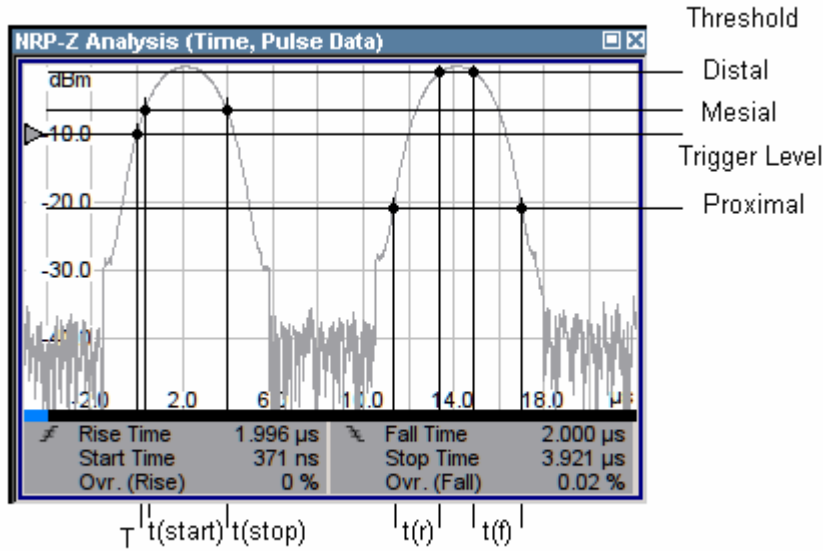
$$DC = \frac{t(pw)}{t(p)} * 100 \ [\%]$$

t(pw) [s]

t(p) [s]

t(off) [s]

These values are measured at the defined mesial threshold level.

Transition Times

For better graphical representation, the rise and fall time of the second pulse is shown, but measurements are always based on the first pulse.

To measure the **rise and fall time of the second pulse in detail**, the signal has to be shifted to the left. This can be done by setting the Min Time in the Configure NRP-Z Analysis menu to 9 µs (in this example). (Refer to Chapter 7.6)

t(r) [s] ❶

t(start) [s]
time from trigger point T to mesial point of pos. slope

❸

t(f) [s] ❷

t(stop) [s]
time from trigger point T to mesial point of neg. slope

❹

❶Rise Time is measured from defined proximal to defined distal threshold level.

❷Fall Time is measured from defined distal to defined proximal threshold level.

❸Overshoot (Rising Edge) = $\dfrac{local\ \max imum - pulse\ top\ level}{pulse\ amplitude}$ * 100 [%]

❹Overshoot (Falling Edge) = $\dfrac{pulse\ base\ level - local\ \min imum}{pulse\ amplitude}$ * 100 [%]

(pulse amplitude = pulse top level – pulse base level)

Signal Power
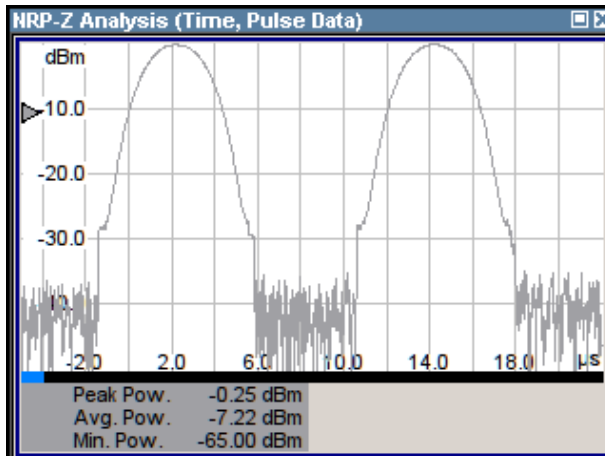
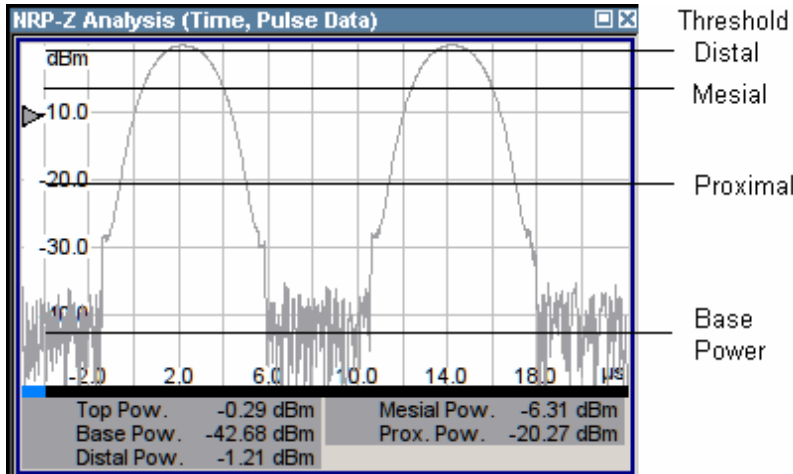Absolute max. level of the measured signal
Average level of the measured signal
(calculated over the set time range, refer to Chapter 6.3)

Absolute min. level of the measured signal

Pulse Power

Max. level of the measured signal (without glitches)

Min. level of the measured signal (without noise)

Level according to defined distal threshold value (refer to Chapter 6.4)

Level according to defined mesial threshold value (refer to Chapter 6.4)

Level according to defined proximal threshold value (refer to Chapter 6.4)

8 Gate Mode

Gate mode allows time gated measurements of peak and average power. This function can be carried out using sensors from the NRP-Z2x and NRP-Z8x family.

The difference between the sensor families in this case is the minimal resolution (due to different bandwidth of the sensors) in measuring a signal.

Since these values are calculated from the displayed data, the accuracy depends on, among other things, the number of measured points.

Manual Settings Using Front Panel Keys

It is assumed that the generator has been set up as outlined in chapter *Time Mode*.
(There is no need to activate the pulse data measurement.)

The following generator screen will appear (set up for the NRP-Z81):
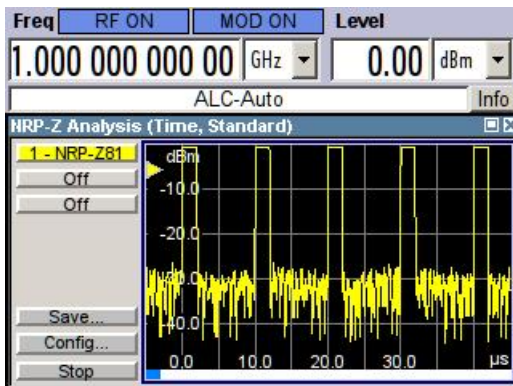
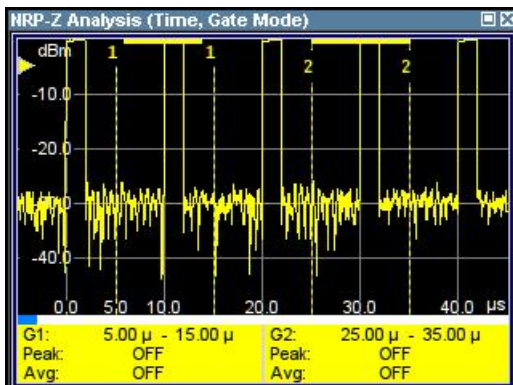To display the gate mode view, press the   [REARR]   key twice

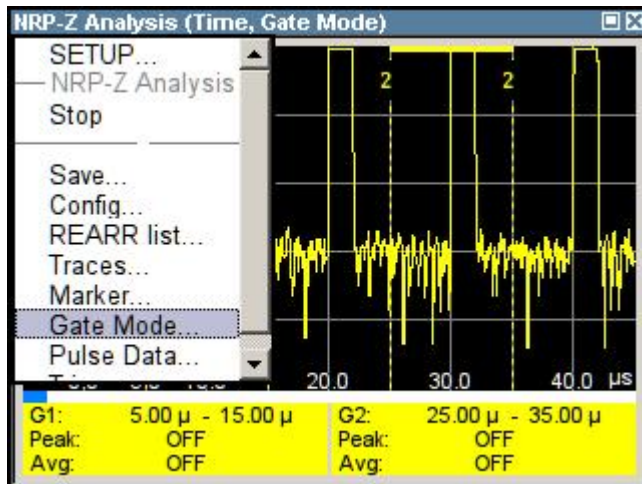The generator screen now looks like this:

OFF indicates that calculation of the power values is currently switched off.

To enable calculation of the values, press the   [SETUP]   key

and select **Gate Mode…** from the menu with the rotary knob and press it.

Press the ⬚REARR⬚ key to enlarge the dialog.

Select **State** button with the rotary knob and press it to switch on the gated power level calculation.

This dialog box can be used to define the gate limits for calculating the peak and average value for the two gates.
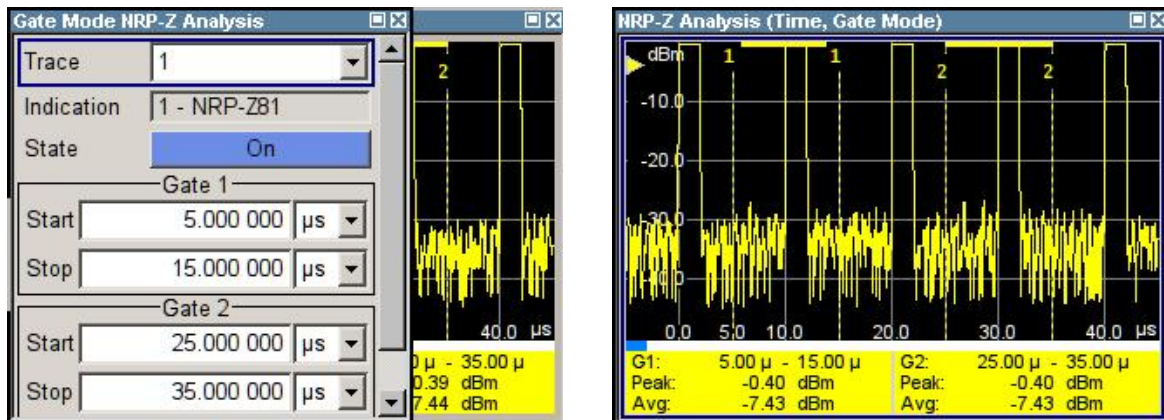
Note:

The two gates can only be assigned to the same trace.

Press the ⬚ESC CLOSE⬚ key to close the setting dialog and return to the graph.

The gate limits can also be defined by moving the displayed gate limitation line with the rotary knob.

To select a gate limitation line, press the rotary knob once. The trigger level line or a gate limitation line should be marked as shown in the next screen:
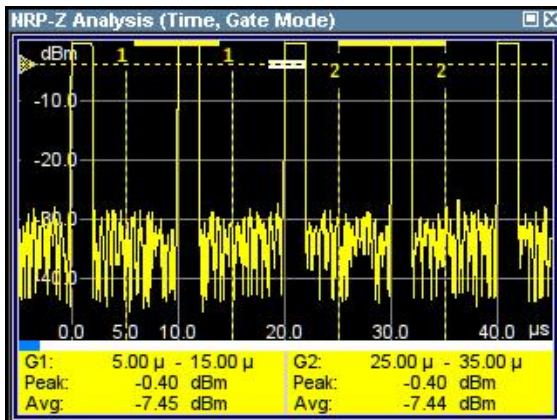
The rotary knob can be used to select any gate limitation line.

Pressing the rotary knob activates the gate limitation line so it can be moved.
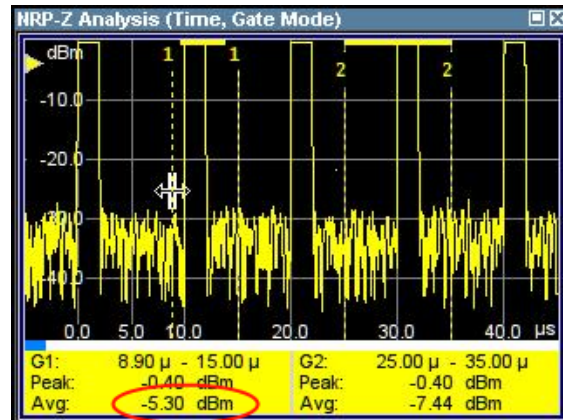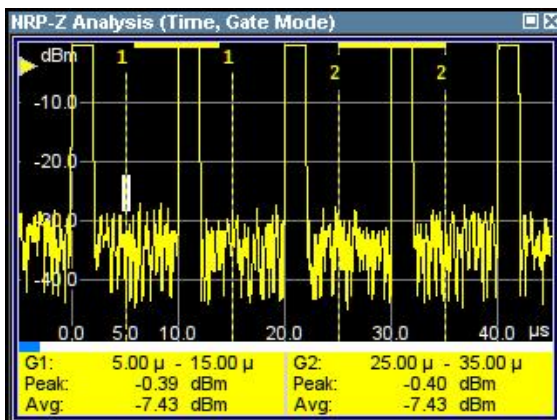
Please note that the average value (Avg.) has changed because the time span for calculating this value is less or different than the length of the indicated signal.

To deselect the gate limitation line, press the [ESC CLOSE] key once.

Select another gate limitation line with the rotary knob and press it to activate the selected line to be moved.

Press the [ESC CLOSE] key to deselect and/or return to the graph screen.

Remote Control via GPIB, USB, LAN

Using Additional SCPI Commands

Ideal timeout setting is 10 seconds (relevant only in case of errors).

```
// -----------------------------------
// make sure the NRP-Z81 sensor is plugged
// into the round NRP connector on the generator
// -----------------------------------
```

SENSe:TYPe?

Expected reply: **NRP-Z81**

*rst
*cls
```
// -----------------------------------
// set power level and output state
//
// switch on pulse modulation (default values)
// -----------------------------------
```
pow 0dbm
outp:stat on

:SOURe:PULM:STATe ON
```
// -----------------------------------
// sweep setting (time mode)
//
// set average count of the sensor
//
// switch on pulse data measurement
//
// set trigger level -5 dBm (sensor dependent)
//
// start sweep
// -----------------------------------
```
SENSe:POWer:SWEep:MODE TIME

SENSe:POWer:SWEep:TIME:AVERage:COUNt 64
```
//
// There is no need to switch on pulse data measurements in the sensor
//
// This only shows the possibility to combine this measurement with the
// Gate Mode data calculation
//
```
SENSe:POWer:SWEep:TIME:SENSor:PULSe:STATe ON

SENSe:POWer:SWEep:TIME:STARt -0.02E-3s
SENSe:POWer:SWEep:TIME:STOP 0.04E-3s

SENSe:POWer:SWEep:TIME:TRIGger:LEVel -5.0dBm

// -----------------------------------
// switch off sensors/traces that are not required
//
// use trace 2 for indication
// state command is to be sent after the feed command
// -----------------------------------
TRACe1:POWer:SWEep:STATe OFF
TRACe3:POWer:SWEep:STATe OFF

TRACe2:POWer:SWEep:FEED SENSor1// Round Connector (is sens1) -> trace 2
TRACe2:POWer:SWEep:STATe ON

// -----------------------------------
// start sweep
// -----------------------------------
SENSe:POWer:SWEep:INIT
// -----------------------------------
// wait for end of sweep
// -----------------------------------
*opc?
Loop until reading is **1**, reply to query ***opc?** is always 1, never 0.
(timeout reading will be blank)

```
// -----------------------------------
// setup gate mode
// assign gate mode to desired trace
// calculate gate mode data values
// read data
// -----------------------------------
```

CALCulate:POWer:SWEep:TIME:GATE1:FEED TRACe2

CALCulate:POWer:SWEep:TIME:GATE1:STARt 8E-6
CALCulate:POWer:SWEep:TIME:GATE1:STOP 12.5E-6

CALCulate:POWer:SWEep:TIME:GATE1:STATe on// on for both gates

CALCulate:POWer:SWEep:TIME:GATE1:AVERage?
CALCulate:POWer:SWEep:TIME:GATE1:MAXimum?
CALCulate:POWer:SWEep:TIME:GATE2:AVERage?
CALCulate:POWer:SWEep:TIME:GATE2:MAXimum?

CALCulate:POWer:SWEep:TIME:GATE1:STARt?
CALCulate:POWer:SWEep:TIME:GATE1:STOP?
CALCulate:POWer:SWEep:TIME:GATE2:STARt?
CALCulate:POWer:SWEep:TIME:GATE2:STOP?

```
// -----------------------------------
// representation of readings, formatted
// -----------------------------------

//
// Gate Mode data :
//
//
//    Gate 1               : 8.00 µs to 12.50 µs
//
//    Gate 1 average   : -3.84 dBm
//
//    Gate 1 maximum   : -0.26 dBm
//
//    Gate 2               : 25.00 µs to 35.00 µs
//
//    Gate 2 average   : -7.33 dBm
//
//    Gate 2 maximum   : -0.26 dBm
//
```

// ------------------------------------
// Readout of measurement data as a hardcopy, if desired
//
// Read data into a file (e.g. hardcopy.jpg)
// Purge file from binary header #536975, see Chapter 0.4
// Execute a bitmap viewer
//
// This hardcopy can be executed in any state of user interface.
// There is no need to show the graphical dialog on the generator display explicitly.
//
// Switch on gate mode screen
// ------------------------------------
:TRACe:POWer:SWEep:MEASurement:GATE:DISPlay:ANNotation:STATe ON

// ------------------------------------
// Reset (recalculate) scaling (measurement mode dependent, time)
// ------------------------------------
SENSe:POWer:SWEep:time:YSCale:AUTO:RESet

:SENSe:POWer:SWEep:HCOPy:DEVice:LANGuage JPG;*wai;:SENSe:POWer:SWEep:HCOPy:DATA?
// ------------------------------------
// Read data into a file (e.g.: hardcopy.jpg)
// Purge file from binary header #536975, see Chapter 0.4
// Execute a bitmap viewer
// ------------------------------------

// ------------------------------------
// Display of the hardcopy file (hardcopy.bmp)
// ------------------------------------
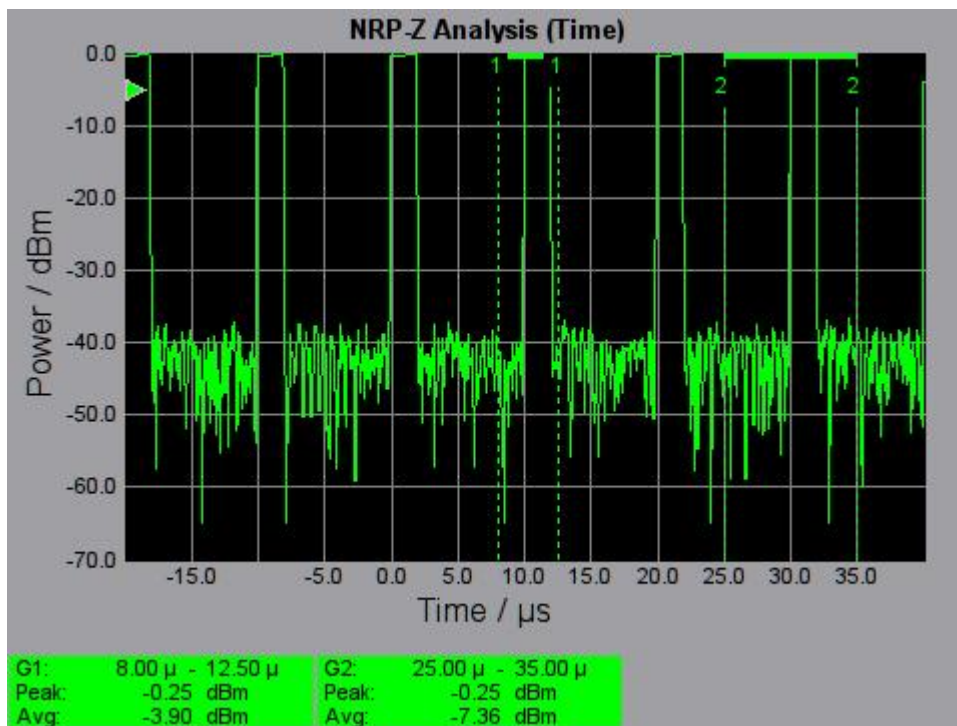
9 Configuring the Viewing Modes

Manual Settings Using Front Panel Keys

Three to five viewing modes are available depending on the sensor.

Press the [REARR] key to toggle between the viewing modes.

This behavior can be changed by disabling unwanted modes.

To do this, press the [SETUP] key
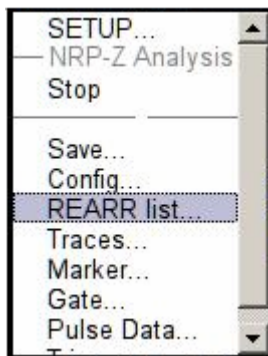
and select **REARR lis**t… from the menu.

Depending on the measurement mode (frequency or level sweep, time trace), a slightly modified control panel will appear.

Frequency or level sweep:
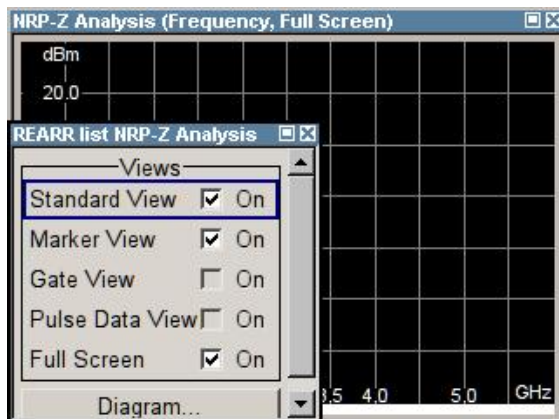
Time trace measurement:
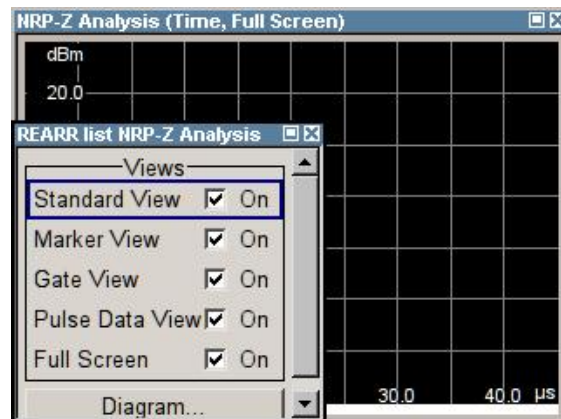
All unwanted viewing modes can be removed from the list by toggling with the [REARR] key.

At least one viewing mode has to be selected.

Remote Control via GPIB, USB, LAN

Impact on the NRP-Z Analysis Hardcopy

All viewing modes can be controlled by remote commands:

```
:TRACe[:POWer]:SWEep:MEASurement:STANard:DISPlay:ANNotation[:STATe]      ON | OFF
:TRACe[:POWer]:SWEep:MEASurement:MARKer:DISPlay:ANNotation[:STATe]       ON | OFF
:TRACe[:POWer]:SWEep:MEASurement:GATE:DISPlay:ANNotation[:STATe]         ON | OFF
:TRACe[:POWer]:SWEep:MEASurement:PULSe:DISPlay:ANNotation[:STATe]        ON | OFF
:TRACe[:POWer]:SWEep:MEASurement:FULLscreen:DISPlay:ANNotation[:STATe]   ON | OFF
```

If a desired viewing mode is not available for the current measurement mode, the viewing mode command is ignored.

Even if the diagram is not visible on the generator screen, these commands can be used to switch the virtual diagram to the desired configuration for a screenshot of the NRP-Z Analysis.
Refer to the programming examples in Chapter 7.2 (Measuring Pulse Data) and Chapter 8.2 (Gate Mode).

Marker View

This view is available (if not deselected) for all measurement modes.
Up to four markers can be used to display the current power according to the position of the marker. The value(s) are displayed at the bottom of the window below the graph.

There are no corresponding remote control commands for this viewing mode.

Examples:
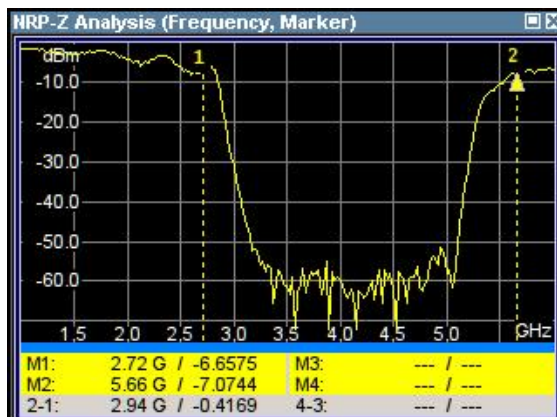
Frequency or level sweep   Time trace measurement
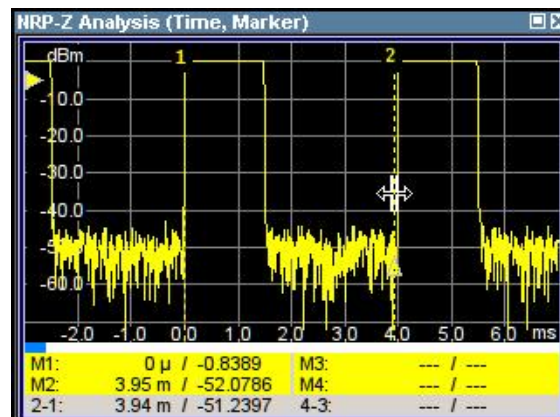
Due to space restrictions on the screen, the values are displayed with the first letter of the measurement unit (G = GHz, m = ms).

The power values are displayed without the "dBm."

The marker lines can be moved only with the rotary knob.

Press the rotary knob to activate the selection mechanism. Select the desired marker with the

rotary knob and press it again to move the marker line with the rotary knob.

The marker lines and display of the corresponding values can only be enabled or disabled via a control panel:

Press the   SETUP   key
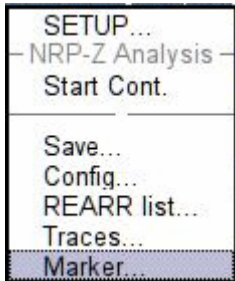
and select **Marker…** from the menu.
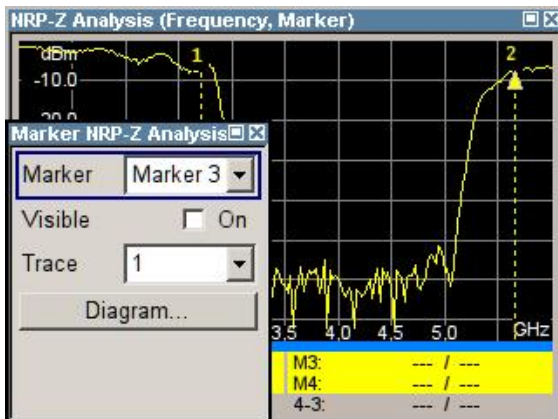
Use this control panel to enable or disable the marker indication.

Each marker can be assigned to a different trace if desired. The color of the trace matches the background color of the corresponding value(s) for easy reference.

Example:
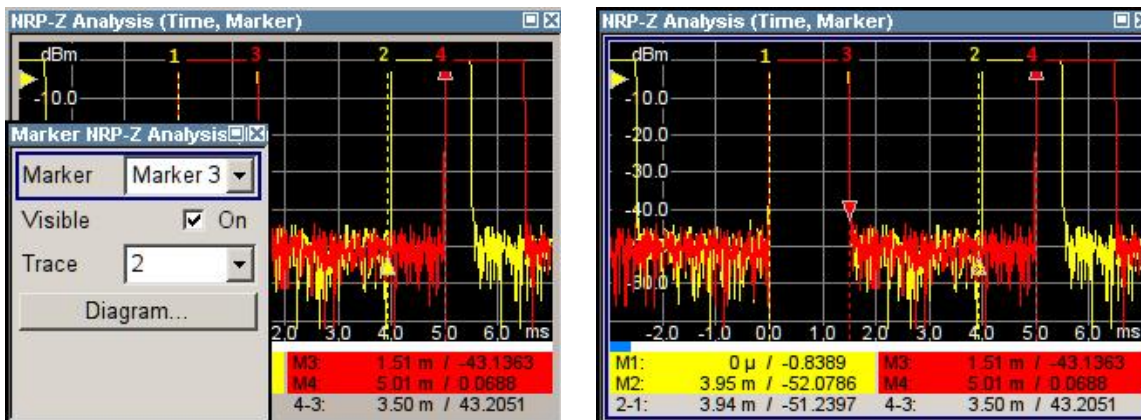
Error Notification

If a full-screen viewing mode is selected, the normal info manager display is hidden. If an error has occurred, an exclamation mark symbol

← error notification
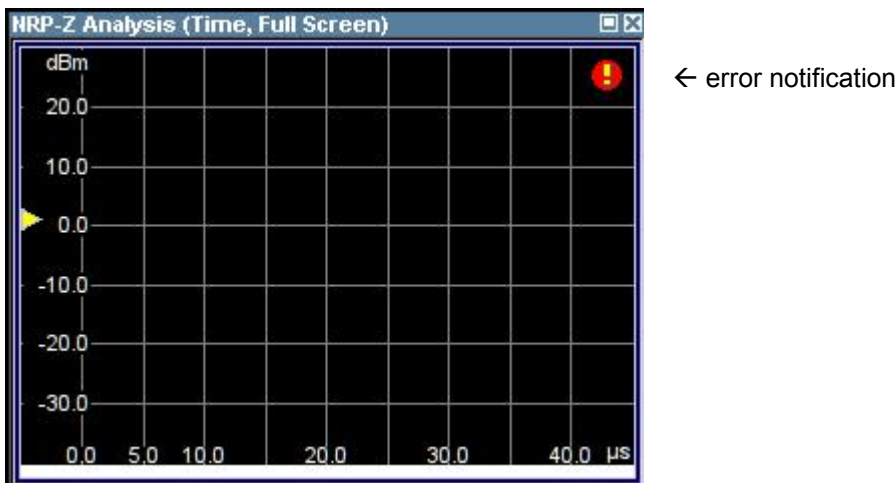
is displayed in the upper right corner of the screen to notify the user.

Press the [INFO] key to determine the cause of the error.

Press the [INFO] key again to return to the NRP-Z Analysis screen.

10 Hardcopy of the NRP-Z Power Analysis

Manual Settings Using Front Panel Keys

There are two ways to create a hardcopy with the SMA-K28 option.

Screencopy of the Active Generator Screen

Since the SMA signal generator does not feature a hardcopy button, a direct screencopy can only be created by pressing **CTRL-Y** on an external keyboard or via a remote control command.

CTRL-Y opens a control panel with the preview of the current screencopy:
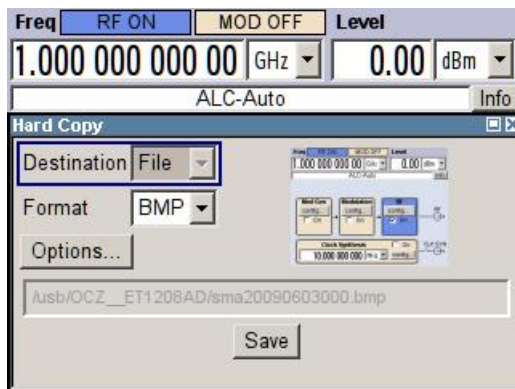
A bitmap image (file name = sma20090603000.bmp) is written directly to a USB memory stick when the **Save** button is pressed.

Hardcopy examples (screenshots):
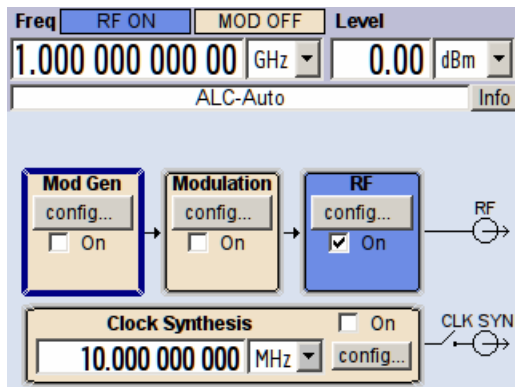
    Generator diagram view   NRP-Z Analysis diagram (full screen)
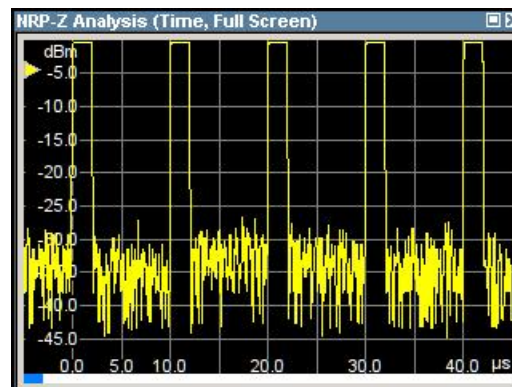
Screenshots can be saved in four different formats: BMP, JPG, XPM, PNG.

No modifications are required in the **Save NRP-Z Analysis Options** control panel.
Refer to Chapter 10.2 for remote commands.

NRP-Z Power Analysis Hardcopy

This hardcopy can be generated whenever the diagram window of the NRP-Z Power Analysis is displayed. Press the **Save…** button in the standard view mode
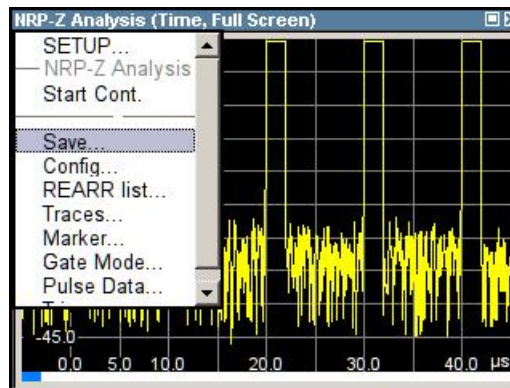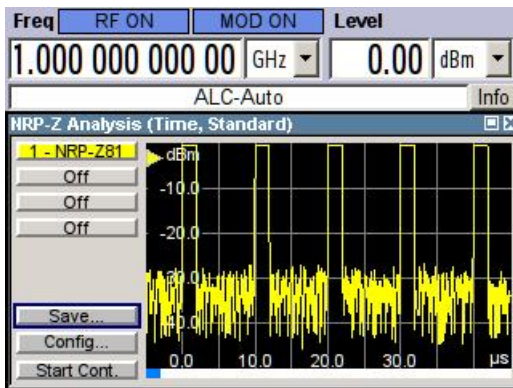
or press the [SETUP] key and select **Save…** from the menu.

In both cases the **Save NRP-Z Analysis** control panel will be opened.
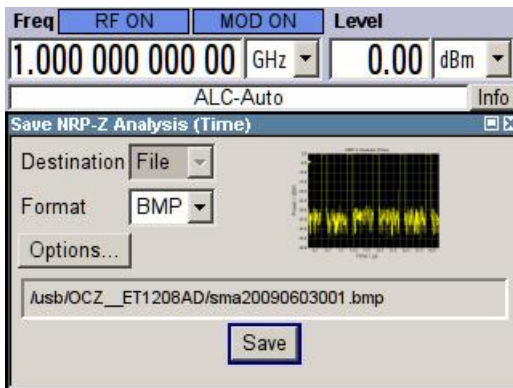
A bitmap image (file name = sma20090603001.bmp) is written directly to a USB memory stick when the **Save** button is pressed.

This is the resulting
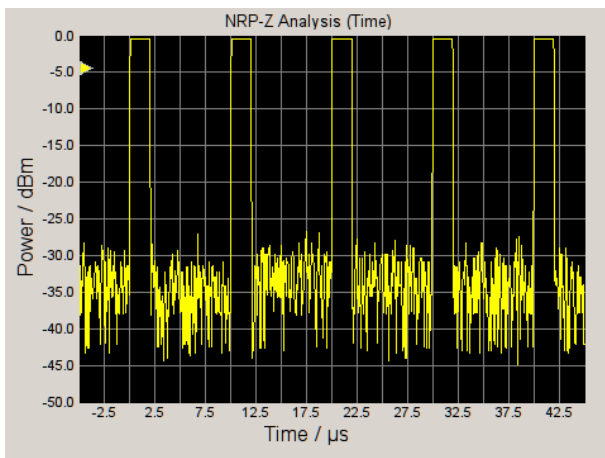
image.

Excel Support in CSV Format

Apart from the four image formats, the measurement data can also be saved in numerical format (CSV) and imported into MS Excel for instance.
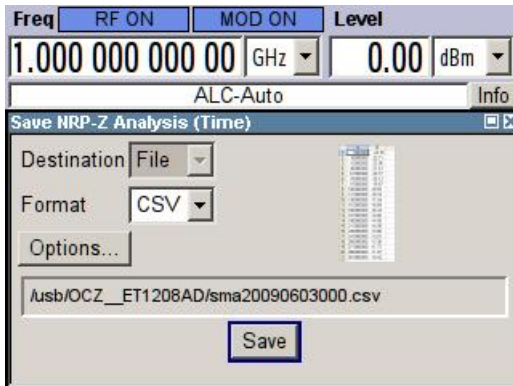
Use the **Save NRP-Z Analysis Options** control panel to modify file settings when necessary (e.g. to adapt the decimal point to the corresponding language settings):
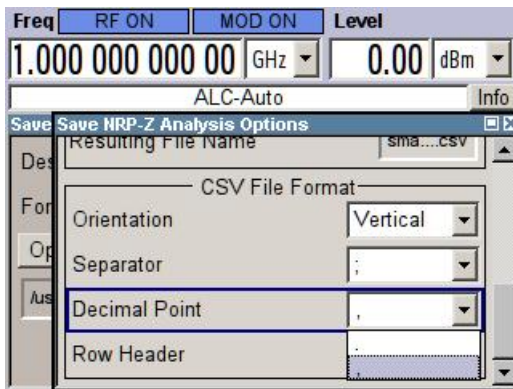
The decimal point is set to ','.

The figure below shows the data imported into MS Excel and displayed as an x/y chart:
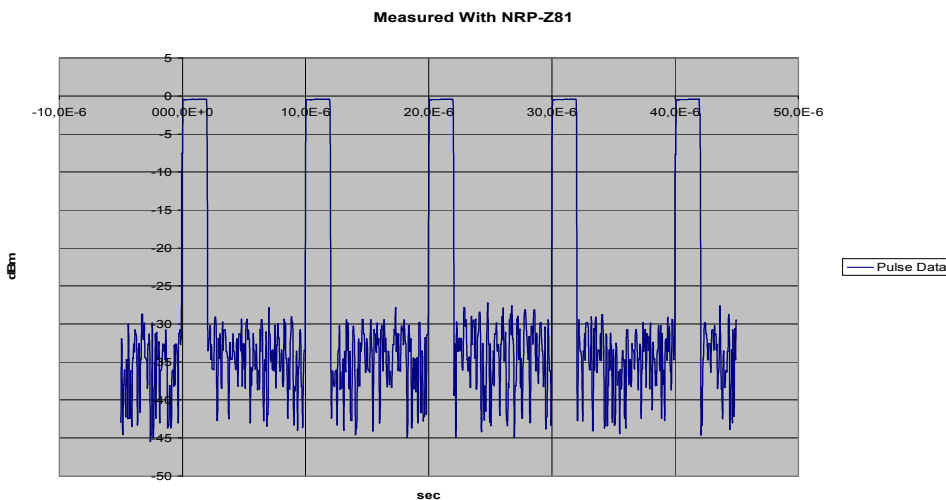
Remote Control via GPIB, USB, LAN

In previous remote control programming examples, the NRP-Z Power Analysis hardcopy was generated as a part of the program. Chapter 9.2 describes how to set up a special viewing configuration for an NRP-Z Power Analysis hardcopy.

Generating a Screencopy File of the NRP-Z Power Analysis via Remote Control

Save data in a file with a standard name

```
:HCOPy:DEVice:LANGuage JPG

:HCOPy:FILE:NAME:AUTO:STATe OFF
:HCOPy:FILE:NAME "/var/user/screencopy"

:HCOPy:EXECute
```

or

save data in a file with automatic renaming of individual files

```
:HCOPy:DEVice:LANGuage JPG

:HCOPy:FILE:NAME:AUTO:STATe ON
:HCOPy:FILE:NAME:AUTO:DIRectory "/var/user"

:HCOPy:EXECute
```

Below is an example of the "/var/user" file directory after executing the commands:

The file **screencopy.jpg** exists only once, since this is a fixed file name. In the second example, **sma20090603000.jpg** is automatically saved and then renamed by incrementing the last digit each time the command is executed.

Generating a Hardcopy File of the NRP-Z Power Analysis via Remote Control

```
:SENSe:POWer:SWEep:HCOPy:DEVice:LANGuage JPG

:SENSe:POWer:SWEep:HCOPy:FILE:NAME:AUTO:STATe ON
:SENSe:POWer:SWEep:HCOPy:FILE:NAME:AUTO:DIRectory "/var/user"

:TRACe:POWer:SWEep:MEASurement:GATE:DISPlay:ANNotation:STATe ON
:SENSe:POWer:SWEep:HCOPy:EXECute

:TRACe:POWer:SWEep:MEASurement:PULSe:DISPlay:ANNotation:STATe ON
:SENSe:POWer:SWEep:HCOPy:EXECute

:TRACe:POWer:SWEep:MEASurement:FULLscreen:DISPlay:ANNotation:STATe ON
:SENSe:POWer:SWEep:HCOPy:EXECute
```

Below is an example of the "/var/user" file directory after executing the commands:

/var/user		
Name	Info	Size
.	DIR	
..	DIR	
share	DIR	
screencopy.jpg		25739
sma20090603000.jpg		25739
sma20090603001.jpg		25739
sma20090603002.jpg		25739
sma20090603003.jpg		44434
sma20090603004.jpg		43817
sma20090603005.jpg		40330

The three files **sma20090603003.jpg**, **sma20090603004.jpg** and **sma20090603005.jpg** contain three different NRP-Z Analysis hardcopies as illustrated in the examples below:
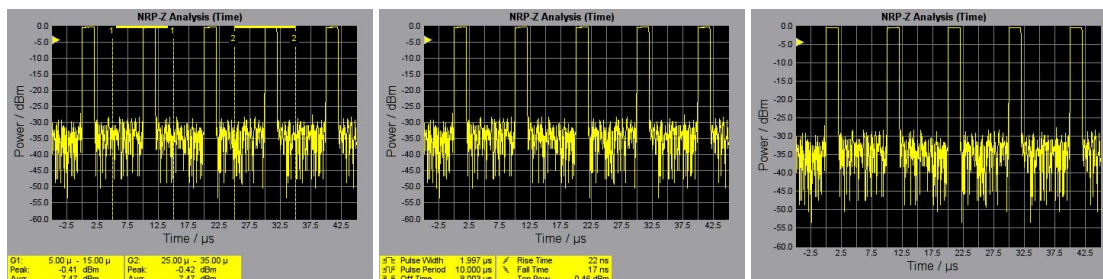
Gate Mode View   Pulse Data View   Full Screen View

Reading a Hardcopy File of the NRP-Z Power Analysis via Remote Control

`:SENSe:POWer:SWEep:HCOPy:DEVice:LANGuage JPG`

`:TRACe:POWer:SWEep:MEASurement:FULLscreen:DISPlay:ANNotation:STATe ON`
`:SENSe:POWer:SWEep:HCOPy:DATA?`

With this command the data is not stored in a file on the generators hard drive, but read directly into a program on a computer or stored on the computer's hard drive.

The data is provided with a binary header (e.g. #525739, see Chapter 0.4) that must be removed in order to process the actual numerical or image data. This also applies to data saved in the CSV format. Consequently, all data can be handled in the same manner.

Note:

If the **language** command and **read** command are combined into a single command line, use **wai.**

Example:

`:SENS:POW:SWE:HCOP:DEV:LANG BMP;*wai;:SENS:POW:SWE:HCOP:DATA?`

11 Summary of SMA-K28 SCPI Commands

1 | 0 can be sent instead of **ON | OFF**

<CH> 1…4 (3 with current firmware version 2.10.001.26)
<TR> 1…4 (3 with current firmware version 2.10.001.26)
<GT> 1…2

Common Commands for All Measurement Modes

Sensor detection

<CH> 1…4

```
:SENSe<CH>[:POWer]:STATus[:DEVice]?
:SENSe<CH>[:POWer]:SNUMber?
:SENSe<CH>[:POWer]:TYPE?
```

Measurement mode

```
:SENSe[:POWer]:SWEep:MODE                              FREQ | POW | TIME

:SENSe[:POWer]:SWEep:RMODe                             SINGle | CONTinuous
```

Start/stop measurement

```
:SENSe[:POWer]:SWEep:INITiate

:SENSe[:POWer]:SWEep:ABORt
```

Measurement Commands

Frequency Commands

```
:SENSe[:POWer]:SWEep:FREQuency:STARt              <value> [HZ | KHZ | MHZ | GHZ]
:SENSe[:POWer]:SWEep:FREQuency:STOP               <value> [HZ | KHZ | MHZ | GHZ]


:SENSe[:POWer]:SWEep:FREQuency:STEPs              <value>


:SENSe[:POWer]:SWEep:FREQuency:TIMing[:MODE]      FAST | NORMal
:SENSe[:POWer]:SWEep:FREQuency:SPACing[:MODE]     LINear | LOGarithmic


:SENSe[:POWer]:SWEep:FREQuency:YSCale:AUTO        OFF | CEXPanding | FEXPanding | CFLoating | FFLoating
:SENSe[:POWer]:SWEep:FREQuency:YSCale:AUTO:RESet
:SENSe[:POWer]:SWEep:FREQuency:YSCale:MINimum     <value>
:SENSe[:POWer]:SWEep:FREQuency:YSCale:MAXimum     <value>
```

Frequency Sweep, Sensor Commands

\<CH\> 1…4

```
:SENSe<CH>[:POWer]:SWEep:FREQuency[:SENSor]:SRANge[:STATe] ON | OFF
:SENSe<CH>[:POWer]:SWEep:FREQuency[:SENSor]:SRANge:STARt   <value> [HZ | KHZ | MHZ | GHZ]
:SENSe<CH>[:POWer]:SWEep:FREQuency[:SENSor]:SRANge:STOP    <value> [HZ | KHZ | MHZ | GHZ]
```

Power Sweep Commands

```
:SENSe[:POWer]:SWEep:POWer:STARt                    <value> [dBm]
:SENSe[:POWer]:SWEep:POWer:STOP                     <value> [dBm]
:SENSe[:POWer]:SWEep:POWer:STEPs                    <value>

:SENSe[:POWer]:SWEep:POWer:SPACing[:MODE]           LINear

:SENSe[:POWer]:SWEep:POWer:YSCale:AUTO              OFF | CEXPanding | FEXPanding | CFLoating | FFLoating
:SENSe[:POWer]:SWEep:POWer:YSCale:AUTO:RESet
:SENSe[:POWer]:SWEep:POWer:YSCale:MINimum           <value>
:SENSe[:POWer]:SWEep:POWer:YSCale:MAXimum           <value>
```

Power Sweep, Sensor Commands

<CH> 1…4

```
:SENSe<CH>[:POWer]:SWEep:POWer[:SENSor]:SFRequency:STATe   ON | OFF
:SENSe<CH>[:POWer]:SWEep:POWer[:SENSor]:SFRequency         <value> [HZ | KHZ | MHZ | GHZ]
```

Time Measurement Commands

```
:SENSe[:POWer]:SWEep:TIME:STARt                    <value> [s | ms | us ]
:SENSe[:POWer]:SWEep:TIME:STOP                     <value> [s | ms | us ]

:SENSe[:POWer]:SWEep:TIME:STEPs                    <value>

:SENSe[:POWer]:SWEep:TIME:AVERage[:COUNt]          1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 |1024

:SENSe[:POWer]:SWEep:TIME:SPACing[:MODE]           LINear

:SENSe[:POWer]:SWEep:TIME:YSCale:AUTO              OFF | CEXPanding | FEXPanding | CFLoating | FFLoating
:SENSe[:POWer]:SWEep:TIME:YSCale:AUTO:RESet
:SENSe[:POWer]:SWEep:TIME:YSCale:MINimum           <value> [dBm]
:SENSe[:POWer]:SWEep:TIME:YSCale:MAXimum           <value> [dBm]
```

Time Measurement, Sensor Commands

<CH> 1…4

```
:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:SFRequency:STATe    ON | OFF
:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:SFRequency          <value> [HZ | KHZ | MHZ | GHZ]

:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:TRIGger:SOURce      FREE | AUTO | EXTernal

:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:TRIGger:LEVel       <value> [dBm]
:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:TRIGger:DTIMe       <value> [s | ms | us ]
:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:TRIGger:HYSTeresis  <value> [dB]

:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:TRIGger:AUTO        ONCE
```

Pulse data measurement configuration

<CH> 1…4

```
:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:PULSe:STATe                            ON | OFF
:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:PULSe:THReshold:BASE                   VOLTage | POWer
:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:PULSe:THReshold:POWer:REFerence       <value> [PCT]
:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:PULSe:THReshold:POWer:LREFerence      <value> [PCT]
:SENSe<CH>[:POWer]:SWEep:TIME[:SENSor]:PULSe:THReshold:POWer:HREFerence      <value> [PCT]
```

Trace Commands

REARR list

```
:TRACe[:POWer]:SWEep:MEASurement:STANard:DISPlay:ANNotation[:STATe]          ON | OFF
:TRACe[:POWer]:SWEep:MEASurement:MARKer:DISPlay:ANNotation[:STATe]           ON | OFF
:TRACe[:POWer]:SWEep:MEASurement:GATE:DISPlay:ANNotation[:STATe]             ON | OFF
:TRACe[:POWer]:SWEep:MEASurement:PULSe:DISPlay:ANNotation[:STATe]            ON | OFF
:TRACe[:POWer]:SWEep:MEASurement:FULLscreen:DISPlay:ANNotation[:STATe]       ON | OFF
```

Configuration

<TR> 1…4

```
:TRACe<TR>[:POWer]:SWEep:COLor              INVers | GRAY | YELLow | BLUE | GREen | RED | MAGenta

:TRACe<TR>[:POWer]:SWEep:STATe              OFF | ON | HOLD
:TRACe<TR>[:POWer]:SWEep:FEED               SENSor1 | SENSor2 | SENSor3 | REFerence | NONE
```

Measurement data (query)

`<TR>` 1…4

```
:TRACe<TR>[:POWer]:SWEep:DATA:POINts?
:TRACe<TR>[:POWer]:SWEep:DATA:XVALues?
:TRACe<TR>[:POWer]:SWEep:DATA:YVALues?

:TRACe<TR>[:POWer]:SWEep:COPY                          REFerence
```

Pulse data measurement configuration (also for HOLD or REF traces)

`<TR>` 1…4

```
:TRACe<TR>[:POWer]:SWEep:PULSe:THReshold:BASE?
:TRACe<TR>[:POWer]:SWEep:PULSe:THReshold:POWer:REFerence?
:TRACe<TR>[:POWer]:SWEep:PULSe:THReshold:POWer:LREFerence?
:TRACe<TR>[:POWer]:SWEep:PULSe:THReshold:POWer:HREFerence?
```

Pulse data annotation

<TR> 1…4

```
:TRACe<TR>[:POWer]:SWEep:MEASurement:PULSe:ALL:DISPlay:ANNotation[:STATe]                                    ON | OFF

:TRACE<TR>[:POWer]:SWEep:MEASurement:PULSe:DCYCle:DISPlay:ANNotation[:STATe]                                 ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:PULSe:DURation:DISPlay:ANNotation[:STATe]                               ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:PULSe:SEParation:DISPlay:ANNotation[:STATe]                             ON | OFF

:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:POSitive:DURation:DISPlay:ANNotation[:STATe]                 ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:POSitive:OCCurrence:DISPlay:ANNotation[:STATe]              ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:POSitive:OVERshoot:DISPlay:ANNotation[:STATe]               ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:NEGative:DURation:DISPlay:ANNotation[:STATe]                 ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:NEGative:OCCurrence:DISPlay:ANNotation[:STATe]              ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:NEGative:OVERshoot:DISPlay:ANNotation[:STATe]               ON | OFF

:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:MINimum:DISPlay:ANNotation[:STATe]                                ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:MAXimum:DISPlay:ANNotation[:STATe]                                ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:AVERage:DISPlay:ANNotation[:STATe]                                ON | OFF

:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:PULSe:TOP:DISPlay:ANNotation[:STATe]                              ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:PULSe:BASE:DISPlay:ANNotation[:STATe]                             ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:REFerence:DISPlay:ANNotation[:STATe]                              ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:LREFerence:DISPlay:ANNotation[:STATe]                             ON | OFF
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:HREFerence:DISPlay:ANNotation[:STATe]                             ON | OFF
```

Pulse data query

\<TR\> 1…4

```
:TRACe<TR>[:POWer]:SWEep:MEASurement:PULSe:DCYCle?
:TRACe<TR>[:POWer]:SWEep:MEASurement:PULSe:DURation?
:TRACe<TR>[:POWer]:SWEep:MEASurement:PULSe:PERiod?
:TRACe<TR>[:POWer]:SWEep:MEASurement:PULSe:SEParation?

:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:POSitive:DURation?
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:POSitive:OCCurrence?
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:POSitive:OVERshoot?
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:NEGative:DURation?
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:NEGative:OCCurrence?
:TRACE<TR>[:POWer]:SWEep:MEASurement:TRANsition:NEGative:OVERshoot?

:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:MINimum?
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:MAXimum?
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:AVERage?

:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:PULSe:TOP?
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:PULSe:BASE?

:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:REFerence?
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:LREFerence?
:TRACE<TR>[:POWer]:SWEep:MEASurement:POWer:HREFerence?
```

Display Commands

```
:DISPlay[:WINDow][:POWer]:SWEep:BACKground:COLor        BLACk | WHITe
:DISPlay[:WINDow][:POWer]:SWEep:GRID:STATe              ON | OFF
```

Calculate Commands

<GT> 1…2

```
:CALCulate[:POWer]:SWEep:TIME:GATE<GT>:FEED        TRACe1 | TRACe2 | TRACe3
:CALCulate[:POWer]:SWEep:TIME:GATE<GT>:STATe       ON | OFF

:CALCulate[:POWer]:SWEep:TIME:GATE<GT>:STARt       <value> [s | ms | us ]
:CALCulate[:POWer]:SWEep:TIME:GATE<GT>:STOP        <value> [s | ms | us ]

:CALCulate[:POWer]:SWEep:TIME:GATE<GT>:AVERage?
:CALCulate[:POWer]:SWEep:TIME:GATE<GT>:MAXimum?
```

Hardcopy Commands

Refer to the operating manual for a full list of all hardcopy commands.
(listed below are the most essential commands, user files have to be stored as **/var/user/…**)

Default settings after RESET are typed in **bold** characters.

Screenshots

```
:HCOPy:DEVice:LANGuage                          BMP | JPG | XPM | PNG

:HCOPy:FILE[:NAME]:AUTO:STATe                   ON | OFF
:HCOPy:FILE[:NAME]                              /var/user/file_name
:HCOPy:FILE[:NAME]:AUTO:DIRectory               /var/user

:HCOPy[:EXECute]

:HCOPy:DATA?
```

NRP-Z Analysis diagram

```
:SENSe[:POWer]:SWEep:HCOPy:DEVice:LANGuage                      BMP | JPG | XPM | PNG | CSV

:SENSe[:POWer]:SWEep:HCOPy:DEVice:LANGuage:CSV:DPOint           DOT | COMMA
:SENSe[:POWer]:SWEep:HCOPy:DEVice:LANGuage:CSV[:COLumn]:SEParator   TABulator | SEMicolon | COMMa | BLANk

:SENSe[:POWer]:SWEep:HCOPy:FILE[:NAME]:AUTO:STATe              ON | OFF
:SENSe[:POWer]:SWEep:HCOPy:FILE[:NAME]                         /var/user/file_name
:SENSe[:POWer]:SWEep:HCOPy:FILE[:NAME]:AUTO:DIRectory          /var/user

:SENSe[:POWer]:SWEep:HCOPy[:EXECute]

:SENSe[:POWer]:SWEep:HCOPy:DATA?
```