



ROHDE & SCHWARZ

SERVICE MANUAL



Test System Versatile Platform

R&S® CompactTSVP TS-PCA3

R&S® PowerTSVP TS-PWA3

Service Manual
for ROHDE & SCHWARZ Test System Versatile Platform
R&S CompactTSVP / R&S PowerTSVP

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Basic Safety Instructions

Always read through and comply with the following safety instructions!

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







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

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

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





Symbols and safety labels

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

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

Tags and their meaning

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

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

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

Operating states and operating positions

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

1. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products: predefined operating position is always with the housing floor facing down, IP protection 2X, pollution severity 2, overvoltage category 2, use only indoors, max. operating altitude 2000 m above sea level, max. transport altitude 4500 m above sea level. A tolerance of $\pm 10\%$ shall apply to the nominal voltage and $\pm 5\%$ 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 $V_{\text{rms}} > 30 \text{ V}$, 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.

Basic Safety Instructions

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.

Informaciones elementales de seguridad

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	Advertencia: superficie caliente	Conexión a conductor de protección	Conexión a tierra	Conexión a masa	Aviso: Cuidado en el manejo de dispositivos sensibles a la electrostática (ESD)

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

Palabras de señal y su significado

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



PELIGRO identifica un peligro inminente con riesgo elevado que provocará muerte o lesiones graves si no se evita.



ADVERTENCIA identifica un posible peligro con riesgo medio de provocar muerte o lesiones (graves) si no se evita.



ATENCIÓN identifica un peligro con riesgo reducido de provocar lesiones leves o moderadas si no se evita.



AVISO indica la posibilidad de utilizar mal el producto y, como consecuencia, dañarlo.

En la documentación del producto se emplea de forma sinónima el término CUIDADO.

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

Estados operativos y posiciones de funcionamiento

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

1. Si no se convino de otra manera, es para los productos Rohde & Schwarz válido lo que sigue: como posición de funcionamiento se define por principio la posición con el suelo de la caja para abajo, modo de protección IP 2X, grado de suciedad 2, categoría de sobrecarga eléctrica 2, uso solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar, transporte hasta 4500 m sobre el nivel del mar. Se aplicará una tolerancia de $\pm 10\%$ sobre el voltaje nominal y de $\pm 5\%$ 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 $U_{\text{eff}} > 30 \text{ V}$ se deberán tomar las medidas apropiadas para impedir cualquier peligro (p. ej. medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
10. Para la conexión con dispositivos informáticos como un PC o un ordenador industrial, debe comprobarse que éstos cumplan los estándares IEC60950-1/EN60950-1 o IEC61010-1/EN 61010-1 válidos en cada caso.
11. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. Esto pone a descubierto los cables y componentes eléctricos y puede causar lesiones, fuego o daños en el producto.

Informaciones elementales de seguridad

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 señalar 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.

Informaciones elementales de seguridad

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 (polveros 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.

Additional safety instructions:

- Any alteration to the basic equipment is prohibited, unless carried out by R&S authorized persons.
- In case that a module is inserted which is specified for an analog bus operation < 60 VDC, then this limit is also restrictively valid for the total system.
- The voltage limits for exposed voltage-carrying parts under DIN EN61010-1/6.3 must on no account be exceeded.
If the use of higher voltages is required, this may be done only after consultation with R&S.
- The total power which may be drawn from the secondary side depends on the format of the relevant backplane segment (typically 250VA).
- When installing in racks, the ventilation of the system must be such that the specified data sheet values of 0 ... 50 °C are adhered to.

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 ISO9001 und ISO14001 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 ISO9001 and ISO14001.

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 ISO9001 et ISO14001.

Engagement écologique

- ▮ Produits à efficience énergétique
- ▮ Amélioration continue de la durabilité environnementale
- ▮ Système de gestion de l'environnement certifié selon ISO 14001

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Customer Support

Technical support – where and when you need it

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

Up-to-date information and upgrades

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

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Content

1	User Information	1-1
1.1	Purpose of the Handbook	1-1
1.2	Important User Notes	1-2
1.3	Explanation of symbols	1-3
1.4	Glossary	1-4
2	Customer Service	2-1
2.1	Service Addresses	2-1
2.1.1	Technical Support	2-1
2.1.2	Ordering Spare Parts	2-1
2.2	Service Questionnaire	2-2
2.2.1	Configuration Information	2-5
2.2.1.1	PCitree (example)	2-5
2.2.1.2	Windows System Information	2-5
3	Safety	3-1
3.1	General	3-1
3.2	Safety Instructions	3-1
4	Self Test	4-1
4.1	Function	4-1
4.1.1	System overview	4-1
4.1.2	Concept of Execution	4-2
4.1.3	Self Test Sequence	4-3
4.1.4	R&S CompactTSVP / R&S PowerTSVP Self Test	4-4
4.2	Hardware Required	4-5
4.3	Starting and Performance	4-6
4.4	Configuration	4-12
4.5	Basic Tests	4-15
4.6	Self Test of Plug-In Cards	4-16
4.6.1	Power Switch Module R&S TS-PSM1	4-16
4.6.2	Matrix Module B R&S TS-PMB	4-23
4.6.2.1	Initialization	4-23
4.6.2.1.1	Description	4-23
4.6.2.1.2	Sequence	4-23
4.6.2.2	Configuration	4-23



4.6.2.2.1	Description	4-23
4.6.2.2.2	Sequence	4-23
4.6.2.3	Device Self Test	4-23
4.6.2.3.1	Description	4-23
4.6.2.3.2	Sequence	4-23
4.6.2.4	External Voltage	4-24
4.6.2.4.1	Description	4-24
4.6.2.4.2	Sequence	4-24
4.6.2.5	Bus Isolation	4-24
4.6.2.5.1	Description	4-24
4.6.2.5.2	Sequence	4-25
4.6.2.6	Coupling Relays	4-25
4.6.2.6.1	Description	4-25
4.6.2.6.2	Sequence	4-25
4.6.2.7	P Matrix Relays	4-26
4.6.2.7.1	Description	4-26
4.6.2.7.2	Sequence	4-26
4.6.2.8	IL Matrix Relays	4-27
4.6.2.9	Sense Relays	4-28
4.6.2.9.1	Description	4-28
4.6.2.9.2	Sequence	4-28
4.6.2.10	Front Connector	4-28
4.6.2.10.1	Description	4-28
4.6.2.10.2	Sequence	4-29
4.6.2.11	Ground Relay	4-29
4.6.2.11.1	Description	4-29
4.6.2.11.2	Sequence	4-29
4.6.3	Source and Measurement Module R&S TS-PSAM	4-30
4.6.4	Arbitrary Function Generator Module R&S TS-PFG	4-45
4.6.5	InCircuit Test Module R&S TS-PICT	4-49
4.6.6	Digital Functional Test Module R&S TS-PDFT	4-55
4.6.7	Analyzer Module R&S TS-PAM	4-60
4.6.7.1	Initialization	4-60
4.6.7.1.1	Description	4-60
4.6.7.1.2	Sequence	4-60
4.6.7.2	Configuration	4-60
4.6.7.2.1	Description	4-60
4.6.7.2.2	Sequence	4-60
4.6.7.3	Device Self Test	4-60
4.6.7.3.1	Description	4-60
4.6.7.3.2	Sequence	4-60
4.6.7.4	External Voltage	4-61
4.6.7.4.1	Description	4-61
4.6.7.4.2	Sequence	4-61
4.6.7.5	Bus Isolation	4-61
4.6.7.5.1	Description	4-61
4.6.7.5.2	Sequence	4-62
4.6.7.6	Coupling Relays Bus Lines A, B	4-62
4.6.7.6.1	Description	4-62
4.6.7.6.2	Sequence	4-62
4.6.7.7	Coupling Relays Bus Lines C, D	4-63
4.6.7.8	Matrix Relays Bus Lines A, B	4-63
4.6.7.8.1	Description	4-63
4.6.7.8.2	Sequence	4-64

4.6.7.9	Matrix Relays Bus Lines C, D	4-64
4.6.7.10	Ground Relays	4-65
4.6.7.10.1	Description	4-65
4.6.7.10.2	Sequence	4-65
4.6.7.11	CHx_LO to CHxy_HI Relays	4-66
4.6.7.11.1	Description	4-66
4.6.7.11.2	Sequence	4-67
4.6.7.12	Amplifier Offset	4-68
4.6.7.12.1	Description	4-68
4.6.7.12.2	Sequence	4-68
4.6.7.13	Amplifier Gain	4-69
4.6.7.13.1	Description	4-69
4.6.7.13.2	Sequence	4-69
4.6.7.14	Scanner Offset	4-70
4.6.7.14.1	Description	4-70
4.6.7.14.2	Sequence	4-70
4.6.7.15	Scanner Gain	4-71
4.6.7.15.1	Description	4-71
4.6.7.15.2	Sequence	4-72
4.6.7.16	Filter DC	4-72
4.6.7.16.1	Description	4-72
4.6.7.16.2	Sequence	4-74
4.6.7.17	DAC	4-75
4.6.7.17.1	Description	4-75
4.6.7.17.2	Sequence	4-75
4.6.7.18	DAC Multi Channel	4-76
4.6.7.18.1	Description	4-76
4.6.7.18.2	Sequence	4-76
4.6.7.19	Trigger Bus Input	4-77
4.6.7.19.1	Description	4-77
4.6.7.19.2	Sequence	4-77
4.6.7.20	Trigger Bus Output	4-78
4.6.7.20.1	Description	4-78
4.6.7.20.2	Sequence	4-78
4.6.7.21	Analog Trigger	4-79
4.6.7.21.1	Description	4-79
4.6.7.21.2	Sequence	4-80
4.6.7.22	External Trigger In / Out	4-81
4.6.7.22.1	Description	4-81
4.6.7.22.2	Sequence	4-81
4.6.7.23	Channel Multiplexer	4-82
4.6.7.23.1	Description	4-82
4.6.7.23.2	Sequence	4-83
4.6.7.24	CHx_LO to CHx_LO1 Relay	4-83
4.6.7.24.1	Description	4-83
4.6.7.24.2	Sequence	4-85
4.6.8	System Module R&S TS-PSYS1 and R&S TS-PSYS2	4-86
4.6.9	Power Supply/Load Module R&S TS-PSU	4-87
4.6.9.1	Initialisation	4-87
4.6.9.1.1	Description	4-87
4.6.9.1.2	Sequence	4-87
4.6.9.2	Configuration	4-87
4.6.9.2.1	Description	4-87
4.6.9.2.2	Sequence	4-87
4.6.9.3	Device self-test	4-87



4.6.9.3.1	Description	4-87
4.6.9.3.2	Sequence	4-87
4.6.9.4	External voltage	4-88
4.6.9.4.1	Description	4-88
4.6.9.4.2	Sequence	4-88
4.6.9.5	Bus isolation	4-88
4.6.9.5.1	Description	4-88
4.6.9.5.2	Sequence	4-89
4.6.9.6	Coupling relays - bus lines A, B	4-89
4.6.9.6.1	Description	4-89
4.6.9.6.2	Sequence	4-89
4.6.9.7	Coupling Relays Bus Lines C, D	4-90
4.6.9.8	Matrix relays - bus lines A, B	4-90
4.6.9.8.1	Description	4-90
4.6.9.8.2	Sequence	4-91
4.6.9.9	Matrix Relays Bus Lines C, D	4-91
4.6.9.10	Ground relays	4-92
4.6.9.10.1	Description	4-92
4.6.9.10.2	Sequence	4-92
4.6.9.11	Voltage setting	4-93
4.6.9.11.1	Description	4-93
4.6.9.11.2	Sequence	4-93
4.6.9.12	Current setting	4-93
4.6.9.12.1	Description	4-93
4.6.9.12.2	Sequence	4-94
4.6.9.13	PAC control	4-94
4.6.9.13.1	Description	4-94
4.6.9.13.2	Sequence	4-94
4.6.9.14	Measurement of voltage force	4-95
4.6.9.14.1	Description	4-95
4.6.9.14.2	Sequence	4-95
4.6.9.15	Measurement of voltage sense	4-95
4.6.9.15.1	Description	4-95
4.6.9.15.2	Sequence	4-96
4.6.9.16	Measurement current	4-96
4.6.9.16.1	Description	4-96
4.6.9.16.2	Sequence	4-97
4.6.9.17	Trigger bus input	4-97
4.6.9.17.1	Description	4-97
4.6.9.17.2	Sequence	4-97
4.6.9.18	Trigger bus output	4-98
4.6.9.18.1	Description	4-98
4.6.9.18.2	Sequence	4-98
4.6.9.19	External trigger In / Out	4-98
4.6.9.19.1	Description	4-98
4.6.9.19.2	Sequence	4-98
4.6.9.20	Monitor output	4-99
4.6.9.20.1	Description	4-99
4.6.9.20.2	Sequence	4-99
4.6.9.21	High current	4-100
4.6.9.21.1	Description	4-100
4.6.9.21.2	Sequence	4-101
4.6.9.22	External sensing	4-101
4.6.9.22.1	Description	4-101
4.6.9.22.2	Sequence	4-102
4.6.9.23	Sense protection	4-103

4.6.9.23.1	Description	4-103
4.6.9.23.2	Sequence	4-103
4.6.9.24	Sense relays	4-104
4.6.9.24.1	Description	4-104
4.6.9.24.2	Sequence	4-104
4.6.9.25	Force relays	4-105
4.6.9.25.1	Description	4-105
4.6.9.25.2	Sequence	4-106
4.6.9.26	Sink mode	4-106
4.6.9.26.1	Description	4-106
4.6.9.26.2	Sequence	4-107
4.6.10	Switch/Multiplex Module 2 R&S TS-PSM2	4-108
4.6.10.1	Initialisation	4-108
4.6.10.1.1	Description	4-108
4.6.10.1.2	Sequence	4-108
4.6.10.2	Configuration	4-108
4.6.10.2.1	Description	4-108
4.6.10.2.2	Sequence	4-108
4.6.10.3	Device self-test	4-108
4.6.10.3.1	Description	4-108
4.6.10.3.2	Sequence	4-108
4.6.10.4	External voltage	4-109
4.6.10.4.1	Description	4-109
4.6.10.4.2	Sequence	4-109
4.6.10.5	Bus isolation	4-110
4.6.10.5.1	Description	4-110
4.6.10.5.2	Sequence	4-111
4.6.10.6	Matrix relays LABa1, LABa2	4-111
4.6.10.6.1	Description	4-111
4.6.10.6.2	Sequence	4-111
4.6.10.7	Matrix relays LABb1, LABb2	4-112
4.6.10.8	Matrix relays LABc1, LABc2	4-112
4.6.10.9	Matrix relays LABd1, LABd2	4-112
4.6.10.10	Coupling relays	4-112
4.6.10.10.1	Description	4-112
4.6.10.10.2	Sequence	4-113
4.6.10.11	Local power bus relays	4-114
4.6.10.11.1	Description	4-114
4.6.10.11.2	Sequence	4-114
4.6.10.12	Shunt resistor path	4-115
4.6.10.12.1	Description	4-115
4.6.10.12.2	Sequence	4-117
4.6.10.13	Multiplexer relays	4-117
4.6.10.13.1	Description	4-117
4.6.10.13.2	Sequence	4-118
4.6.10.14	Sense relays	4-119
4.6.10.14.1	Description	4-119
4.6.10.14.2	Sequence	4-121
4.6.11	Analog/Digital IO Module 2 R&S TS-PIO2	4-122
4.6.11.1	Initialisation	4-122
4.6.11.1.1	Description	4-122
4.6.11.1.2	Sequence	4-122
4.6.11.2	Configuration	4-122
4.6.11.2.1	Description	4-122
4.6.11.2.2	Sequence	4-122



4.6.11.3	Device self-test	4-122
4.6.11.3.1	Description	4-122
4.6.11.3.2	Sequence	4-122
4.6.11.4	Supply Voltages	4-123
4.6.11.4.1	Description	4-123
4.6.11.4.2	Sequence	4-123
4.6.11.5	Temperatures	4-123
4.6.11.5.1	Description	4-123
4.6.11.5.2	Sequence	4-123
4.6.11.6	Correction Data	4-123
4.6.11.6.1	Description	4-123
4.6.11.6.2	Sequence	4-123
4.6.11.7	External voltage	4-124
4.6.11.7.1	Description	4-124
4.6.11.7.2	Sequence	4-124
4.6.11.8	Bus isolation	4-124
4.6.11.8.1	Description	4-124
4.6.11.8.2	Sequence	4-125
4.6.11.9	Matrix relays LABa1, LABa2	4-125
4.6.11.9.1	Description	4-125
4.6.11.9.2	Sequence	4-125
4.6.11.10	Matrix relays LABb1, LABb2	4-126
4.6.11.11	Matrix relays LABc1, LABc2	4-126
4.6.11.12	Matrix relays LABd1, LABd2	4-126
4.6.11.13	Coupling relays	4-127
4.6.11.13.1	Description	4-127
4.6.11.13.2	Sequence	4-127
4.6.11.14	Ground Relay	4-128
4.6.11.14.1	Description	4-128
4.6.11.14.2	Sequence	4-129
4.6.11.15	AGND to LAB Relays	4-130
4.6.11.15.1	Description	4-130
4.6.11.15.2	Sequence	4-130
4.6.11.16	Loop Back Relays	4-131
4.6.11.16.1	Description	4-131
4.6.11.16.2	Sequence	4-131
4.6.11.17	100 Ohm reference	4-132
4.6.11.17.1	Description	4-132
4.6.11.17.2	Sequence	4-133
4.6.11.18	5 V reference	4-133
4.6.11.18.1	Description	4-133
4.6.11.18.2	Sequence	4-133
4.6.11.19	Reference Relay	4-134
4.6.11.20	Analog Input	4-134
4.6.11.20.1	Description	4-134
4.6.11.20.2	Sequence	4-134
4.6.11.21	Analog Output	4-135
4.6.11.21.1	Description	4-135
4.6.11.21.2	Sequence	4-135
4.6.11.22	Output Current	4-135
4.6.11.22.1	Description	4-135
4.6.11.22.2	Sequence	4-135
4.6.11.23	Digital Output	4-136
4.6.11.23.1	Description	4-136
4.6.11.23.2	Sequence	4-136
4.6.11.24	Current Limit	4-137

4.6.11.24.1	Description	4-137
4.6.11.24.2	Sequence	4-137
4.6.11.25	Digital Input	4-138
4.6.11.25.1	Description	4-138
4.6.11.25.2	Sequence	4-138
4.6.11.26	Square Wave	4-139
4.6.11.26.1	Description	4-139
4.6.11.26.2	Sequence	4-139
4.6.11.27	Trigger bus input	4-140
4.6.11.27.1	Description	4-140
4.6.11.27.2	Sequence	4-140
4.6.11.28	Trigger bus output	4-140
4.6.11.28.1	Description	4-140
4.6.11.28.2	Sequence	4-140
4.6.11.29	Noise Input	4-141
4.6.11.29.1	Description	4-141
4.6.11.29.2	Sequence	4-141
4.6.11.30	Noise Output	4-141
4.6.11.30.1	Description	4-141
4.6.11.30.2	Sequence	4-141
4.6.11.31	Noise Current Limit	4-142
4.6.11.31.1	Description	4-142
4.6.11.31.2	Sequence	4-142
4.6.11.32	Input Multiplexer	4-143
4.6.11.32.1	Description	4-143
4.6.11.32.2	Sequence	4-143
4.6.11.33	LO Relay	4-144
4.6.11.34	Output Standard Channel	4-145
4.6.11.34.1	Description	4-145
4.6.11.34.2	Sequence	4-145
4.6.11.35	Output Extended Channel	4-146
4.6.11.35.1	Description	4-146
4.6.11.35.2	Sequence	4-146
4.6.11.36	5 V Reference Load Test	4-147
4.6.11.36.1	Description	4-147
4.6.11.36.2	Sequence	4-147
4.6.11.37	External Trigger	4-148
4.6.11.37.1	Description	4-148
4.6.11.37.2	Sequence	4-148
4.6.12	High-Speed Digital Test Module R&S TS-PHDT	4-149
4.6.12.1	Initialisation	4-149
4.6.12.1.1	Description	4-149
4.6.12.1.2	Sequence	4-149
4.6.12.2	Configuration	4-149
4.6.12.2.1	Description	4-149
4.6.12.2.2	Sequence	4-149
4.6.12.3	Device self-test	4-149
4.6.12.3.1	Description	4-149
4.6.12.3.2	Sequence	4-149
4.6.12.4	Output Voltages	4-150
4.6.12.4.1	Description	4-150
4.6.12.4.2	Sequence	4-150
4.6.12.5	Output Current Limit	4-151
4.6.12.5.1	Description	4-151
4.6.12.5.2	Sequence	4-151



4.6.12.6	Thresholds	4-151
4.6.12.6.1	Description	4-151
4.6.12.6.2	Sequence	4-152
4.6.12.7	Dynamic	4-152
4.6.12.7.1	Description	4-152
4.6.12.7.2	Sequence	4-152
4.6.12.8	Trigger bus input	4-152
4.6.12.8.1	Description	4-152
4.6.12.8.2	Sequence	4-153
4.6.12.9	Trigger bus output	4-153
4.6.12.9.1	Description	4-153
4.6.12.9.2	Sequence	4-153
4.6.12.10	Thresholds via X10	4-153
4.6.12.10.1	Description	4-153
4.6.12.11	Dynamic via X10	4-154
4.6.12.11.1	Description	4-154
4.6.12.12	External Trigger	4-154
4.6.12.12.1	Description	4-154
4.6.12.12.2	Sequence	4-154
4.6.13	Calibration module 2 R&S RS-PCAL2	4-155
4.6.13.1	Initialisation	4-155
4.6.13.1.1	Description	4-155
4.6.13.1.2	Sequence	4-155
4.6.13.2	Configuration	4-155
4.6.13.2.1	Description	4-155
4.6.13.2.2	Sequence	4-155
4.6.13.3	Temperatures	4-155
4.6.13.3.1	Description	4-155
4.6.13.3.2	Sequence	4-155
4.6.13.4	Correction data	4-156
4.6.13.4.1	Description	4-156
4.6.13.4.2	Sequence	4-156
4.6.13.5	Device self test	4-156
4.6.13.5.1	Description	4-156
4.6.13.5.2	Sequence	4-156
4.6.13.6	Measurement Unit / Open	4-157
4.6.13.6.1	Description	4-157
4.6.13.6.2	Sequence	4-157
4.6.13.7	Measurement Unit / 5V Reference	4-157
4.6.13.7.1	Description	4-157
4.6.13.7.2	Sequence	4-157
4.6.13.8	Measurement Unit / Voltage Source	4-158
4.6.13.8.1	Description	4-158
4.6.13.8.2	Sequence	4-158
4.6.13.9	Measurement Unit / Current Source	4-159
4.6.13.9.1	Description	4-159
4.6.13.9.2	Sequence	4-159
4.6.13.10	LAB Relay Tests	4-160
4.6.13.10.1	Description	4-160
4.6.13.10.2	Sequence	4-160
4.6.13.11	Reference Resistors Tests	4-161
4.6.13.11.1	Description	4-161
4.6.13.11.2	Sequence	4-161
4.6.13.12	ADS DC Voltage Tests	4-162
4.6.13.12.1	Description	4-162

4.6.13.12.2	Sequence	4-162
4.6.13.13	ADS AC Voltage Tests	4-163
4.6.13.13.1	Description	4-163
4.6.13.13.2	Sequence	4-163
4.6.13.14	AGND Relay Test	4-164
4.6.13.14.1	Description	4-164
4.6.13.14.2	Sequence	4-164
4.6.13.15	Current Source Test	4-165
4.6.13.15.1	Description	4-165
4.6.13.15.2	Sequence	4-165
4.6.13.16	GND Relay Test	4-166
4.6.13.16.1	Description	4-166
4.6.13.16.2	Sequence	4-166
4.6.14	Power Supply/Load Module 12V R&S TS-PSU12	4-167
4.6.15	Digital IO Module 3B R&S TS-PIO3B	4-167
4.6.15.1	Initialization	4-167
4.6.15.1.1	Description	4-167
4.6.15.1.2	Sequence	4-167
4.6.15.2	Configuration	4-167
4.6.15.2.1	Description	4-167
4.6.15.2.2	Sequence	4-168
4.6.15.3	Device Self-Test	4-168
4.6.15.3.1	Description	4-168
4.6.15.3.2	Sequence	4-168
4.6.15.4	Fuse Test	4-168
4.6.15.4.1	Description	4-168
4.6.15.4.2	Sequence	4-168
4.7	Self Test Report	4-169
5	Manual Fault Finding	5-1
5.1	Visual Inspection	5-1
5.2	Supply Voltages	5-1
5.3	Fans	5-2
6	Removal / Installation of Modules	6-1
6.1	Important User Notes	6-1
6.1.1	Anti-Static Work Station	6-2
6.1.2	Tools	6-2
6.2	Removal	6-3
6.2.1	Removing Standard cPCI/PXI Plug-in Cards	6-3
6.2.2	Removing ROHDE & SCHWARZ specific Plug-in Cards	6-4
6.2.3	Removing Power Supply	6-4
6.2.4	Removing Fans	6-4
6.3	Installation	6-6
6.4	Packaging, Shipment and Storage	6-6



7	Spare Parts List	7-1
7.1	Spare Parts List R&S CompactTSVP TS-PCA3	7-1
7.2	Spare Parts List R&S PowerTSVP TS-PWA3	7-1
7.3	Spare Parts Modules	7-2
7.3.1	R&S TS-PAM	7-2
7.3.2	R&S TS-PDC	7-2
7.3.3	R&S TS-PDFT	7-2
7.3.4	R&S TS-PFG	7-2
7.3.5	R&S TS-PICT	7-3
7.3.6	R&S TS-PMB	7-3
7.3.7	R&S TS-PSAM	7-3
7.3.8	R&S TS-PSC0	7-4
7.3.9	R&S TS-PSC3	7-4
7.3.10	R&S TS-PSC4	7-4
7.3.11	R&S TS-PSC5	7-4
7.3.12	R&S TS-PSM1	7-5
7.3.13	R&S TS-PSM2	7-5
7.3.14	R&S TS-PSU	7-5
7.3.15	R&S TS-PIO2	7-6
7.3.16	R&S TS-PHDT	7-6
7.3.17	R&S TS-ISC	7-6
7.3.18	R&S TS-PIO3B	7-6
7.3.19	R&S TS-PTR	7-7
7.3.20	R&S TS-PTRF	7-7
7.3.21	R&S TS-PRIO4	7-7
7.3.22	R&S TS-PXM1	7-7
7.3.23	Spare Parts for several Modules	7-8
8	Service Documents	8-1
8.1	Interface Description	8-1
8.1.1	Interface Description R&S CompactTSVP TS-PCA3	8-1
8.1.2	Interface Description R&S PowerTSVP TS-PWA3	8-1
8.2	Plug-In Cards	8-2
8.2.1	Analyzer Module R&S TS-PAM	8-2
8.2.2	Digital Functional Test Module R&S TS-PDFT	8-2
8.2.3	Arbitrary Function Generator Module R&S TS-PFG	8-2
8.2.4	InCircuit Test Module R&S TS-PICT	8-2
8.2.5	Matrix Module B R&S TS-PMB	8-2
8.2.6	Source and Measurement Module R&S TS-PSAM	8-2
8.2.7	Power Switch Module R&S TS-PSM1	8-2

R&S CompactTSVP / R&S PowerTSVP		Content
8.2.8	Switch/Multiplex Module 2 R&S TS-PSM2	8-2
8.2.9	Power Supply/Load Module R&S TS-PSU	8-3
8.2.10	Analog/Digital IO Module 2 R&S TS-PIO2	8-3
8.2.11	High-Speed Digital Test Module R&S TS-PHDT	8-3
8.2.12	Calibration Module (Rear IO-Module) R&S TS-PCAL2	8-3
A	Appendix	A-1
A.1	SFT Report Example	A-1



Figures

Figure 2-1	System Information	2-5
Figure 4-1	SFT Software Overview	4-1
Figure 4-2	Self Test Sequence	4-3
Figure 4-3	Connection of R&S TS-PSAM to Analog Bus	4-5
Figure 4-4	Self Test Start Screen.....	4-6
Figure 4-5	Self Test Parts and Options.....	4-7
Figure 4-6	Self Test in Progress	4-9
Figure 4-7	Self Test Result Passed	4-10
Figure 4-8	Self Test Result Failed	4-10
Figure 4-9	Shunt resistor path.....	4-115
Figure 6-1	R&S CompactTSVP / R&S PowerTSVP Rear View	6-5



Tables

Table 5-1	Display elements on the Plug-In Cards	5-1
Table 7-1	Spare Parts List TS-PCA3	7-1
Table 7-2	Spare Parts List TS-PWA3	7-1
Table 7-3	Spare Parts List R&S TS-PAM	7-2
Table 7-4	Spare Parts List R&S TS-PDC	7-2
Table 7-5	Spare Parts List R&S TS-PDFT	7-2
Table 7-6	Spare Parts List R&S TS-PFG	7-2
Table 7-7	Spare Parts List R&S TS-PICT	7-3
Table 7-8	Spare Parts List R&S TS-PMB	7-3
Table 7-9	Spare Parts List R&S TS-PSAM	7-3
Table 7-10	Spare Parts List R&S TS-PSC0	7-4
Table 7-11	Spare Parts List R&S TS-PSC3	7-4
Table 7-12	Spare Parts List R&S TS-PSC4	7-4
Table 7-13	Spare Parts List R&S TS-PSC5	7-4
Table 7-14	Spare Parts List R&S TS-PSM1	7-5
Table 7-15	Spare Parts List R&S TS-PSM2	7-5
Table 7-16	Spare Parts List R&S TS-PSU	7-5
Table 7-17	Spare Parts List R&S TS-PIO2	7-6
Table 7-18	Spare Parts List R&S TS-PHDT	7-6
Table 7-19	Spare Parts List R&S TS-ISC	7-6
Table 7-20	Spare Parts List R&S TS-PIO3B	7-6
Table 7-21	Spare Parts List R&S TS-PTR	7-7
Table 7-22	Spare Parts List R&S TS-PTRF	7-7
Table 7-23	Spare Parts List R&S TS-PRIO4	7-7
Table 7-24	Spare Parts List R&S TS-PXM1	7-7
Table 7-25	Spare Parts List for several Modules	7-8



1 User Information

1.1 Purpose of the Handbook

The Service Handbook provides the information necessary for

- Faultfinding and
- Fault rectification

on the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP .

The Service Handbook must be read carefully by the operator / service engineer tasked with working on the R&S CompactTSVP / R&S PowerTSVP prior to performing service tasks.

Apart from the Service Handbook, the Operating Instructions, the health and safety regulations applicable in the place where the unit is used, as well as the applicable technical standards and regulations on safety and correct working are to be observed.

The service instructions must always be available in the place where the R&S CompactTSVP / R&S PowerTSVP is used.

The operating organisation is to extend the service instructions, as necessary, with information on national health and safety regulations, and environmental regulations .

1.2 Important User Notes

**NOTE:**

This Service Manual is intended for use with the following products:

- **Test System Versatile Platform R&S CompactTSVP TS-PCA3**
- **Test System Versatile Platform R&S PowerTSVP TS-PWA3**

The contents of this manual apply to both products. Any differences are highlighted in the text.

**NOTE:**

When working with the Service Handbook, the information from the “Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP” Operating Instructions is to be observed.

**NOTE:**

To perform service tasks, in particular to run the self test, knowledge of the WINDOWS 2000 operating system is required.

1.3 Explanation of symbols

The Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP has been manufactured in accordance with generally recognised technical regulations and the current state of the art in science and engineering.

Nevertheless, there are risks associated with the unit that cannot be avoided by design.

To provide adequate safety for the personnel working with the R&S CompactTSVP / R&S PowerTSVP , additional safety instructions are given.

A satisfactory level of safety when using the Test System Versatile Platform cannot be guaranteed unless these instructions are followed.

Certain sections of text are specially highlighted. These sections have the following meaning:



DANGER!

Failure to follow instructions can result in personal injury!



ELECTROCUTION HAZARD!

Failure to follow instructions can result in personal injury!



WARNING!

Failure to follow instructions can result in damage to the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP .



NOTE:

Highlights important details to which special attention must be paid and that make work easier.



1.4 Glossary

CPCI	Compact PCI
DCS	DC Source
DMM	Digital Multimeter
EGTSL	Enhanced Generic Test Software Library.
GTSL	Generic Test Software Library
MU	Measurement Unit
Overall Self Test	Self test of a non-standard test system or a test system with customer-specific modifications, including the TSVP self test, the system self test and customer-specific additions and/or modifications.
PSW	"Prüfsoftware - (test software)", a software used in the production test field at Rohde & Schwarz.
PXI	PCI eXtension for Instrumentation
Self Test	Software module, which verifies the functionality of a specific hardware component or a combination of components. In case of a failure, a diagnostic message is generated which identifies the defective component(s).
SFT	Abbreviation for Self Test
System Self Test	Self Test of a standard test system built on the TSVP platform (e.g. TS7100) including the self test of the TSVP and tests of the external devices and cabling.
TSVP Module Self Test	Self test for a single module (CPCI card) inside the TSVP frame.
TSVP Self Test	Self Test of the TSVP frame (power supply, backplanes) and the CPCI cards inside the frame.
UUT	Unit Under Test, Device Under Test

2 Customer Service

2.1 Service Addresses

2.1.1 Technical Support

If you have any technical queries about this Rohde & Schwarz equipment, our Hotline at the Support Center of Rohde & Schwarz Sales-GmbH will be glad to help.

Our team will discuss your queries and look for solutions to your problems.

The Hotline is open Mondays to Fridays from 08.00 to 17.00 hrs. For queries outside office hours, you can leave a message or send a note via fax or email. We will then get back to you as soon as possible.

Telephone

Europe: +49 180 512 42 42

Telephone

worldwide: +49 89 4129 13774

Fax: +49 89 4129 13777

e-mail: customersupport@rohde-schwarz.com

2.1.2 Ordering Spare Parts

The spare parts required for the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP can be ordered from the following address:

Spare Parts Express Service

Phone: +49 89 4129 - 12465

Fax: +49 89 4129 - 13306

e-mail: customersupport@rohde-schwarz.com



2.2 Service Questionnaire

To be able to process technical questions or orders for spare parts as quickly as possible, we request you to complete the following service questionnaire. We request you to include the completed service questionnaire with all letters and parcels sent to ROHDE & SCHWARZ . In the case of telephone queries, we also request you to complete the service questionnaire and keep it at hand such that the necessary information is available.

Please use the service questionnaire printed on the following two pages as a master.

A Service Questionnaire form is in a separate PDF-file.

(A) CUSTOMER INFORMATION

Name of Customer:	
Customer Address:	
Contact Person:	
Telephone :	
Fax:	
eMail:	
Project No:	
R&S CompactTSVP / R&S PowerTSVP Identification No:	

(B) R&S CompactTSVP / R&S PowerTSVP EQUIPMENT LISTS

Identification of Equipment	Quantity

(C) R&S CompactTSVP / R&S PowerTSVP CONFIGURATION

R&S CompactTSVP / R&S PowerTSVP Frame Serial Number:	
R&S CompactTSVP / R&S PowerTSVP Configuration Type:	

Configuration of CPCI/PXI Cards		
Slot Number	Identification of CPCI/PXI Card	Serial Number



Configuration of CPCI/PXI Cards		

Version of Software Utilities :	
--	--

Please see the attached reports generated by a PCI Software Tool and Windows System Information in chapter 2.2.1.1 and 2.2.1.2 .

(D) OPERATIONAL HOUR

No. of operating hour per day		hrs
--------------------------------------	--	-----

(D) REPLACEMENT OF FAULTY COMPONENTS (IF ANY)

S/No	Faulty Component(s)	Remedial Actions / Fault Analysis
1		
2		
3		

(E) REMARKS

1	
2	
3	

Location of Recording / Testing:

Recorded By:

Date:

2.2.1 Configuration Information

Further information on the configuration of the Test System Versatile Platform R&S CompactTSVP can be found in the utilities like “PCItree” (or similar software tools) and “Windows System Information”. A print out of the information from these two utilities is to be included with the service questionnaire.

2.2.1.1 PCitree (example)

“PCItree” is a shareware program and displays all the PCIbus devices in a tree structure.

For further information and downloads, visit:

<http://www.pcitree.de>

2.2.1.2 Windows System Information

Start the utility “Windows System Information” as follows:

1. Select **Start -> Programs -> Accessories -> System Tools -> System Information** .

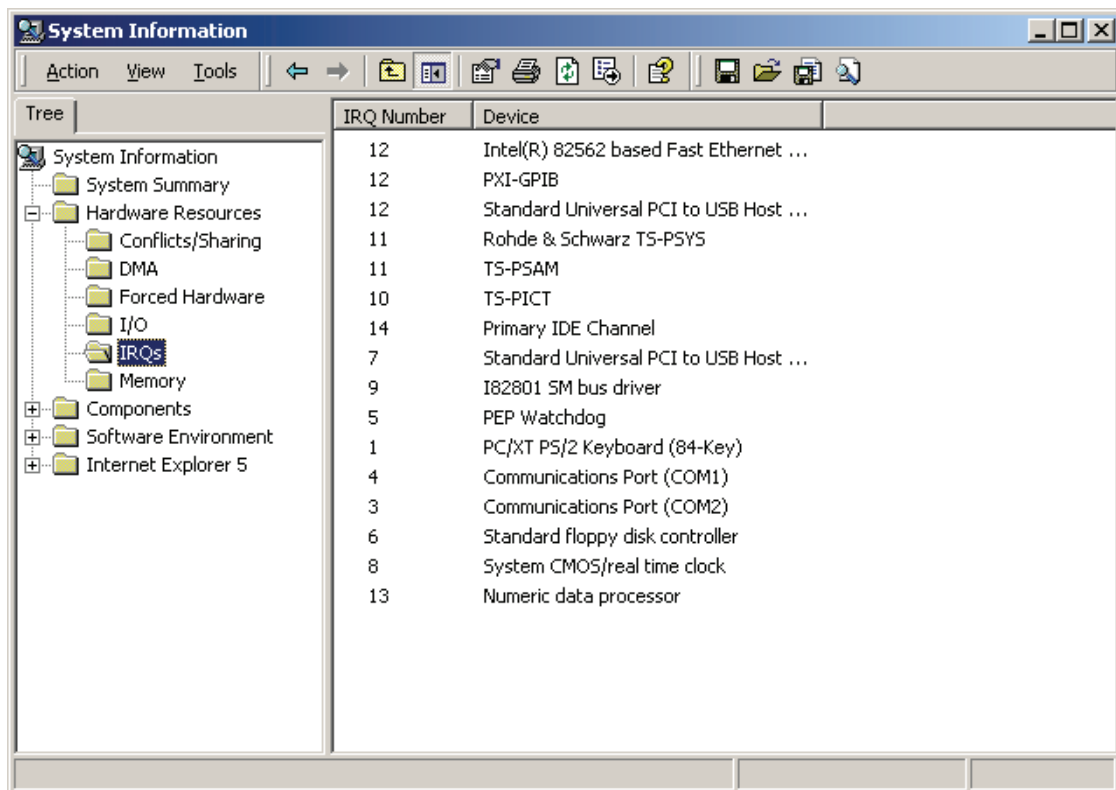


Figure 2-1 System Information



2. The menu option **Action** -> **Save As System Information File** can be used to save an MSInfo.Document (Filename.nfo). All system-relevant information is stored in this document.

3 Safety

3.1 General

During service work on the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP, the safety regulations applicable in the country of use must be observed.



NOTE:

If, during service work on the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP the applicable service regulations are ignored, ROHDE & SCHWARZ GmbH & Co. KG is not liable in the case of damage and any right to make a claim under the warranty against is void.

3.2 Safety Instructions



ELECTROCUTION HAZARD!

The Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP is only permitted to be opened by appropriately trained specialist personnel! The appropriate regulations for work on electrical equipment must be observed.

Prior to working on the R&S CompactTSVP / R&S PowerTSVP, it is to be isolated from the mains power supply.



WARNING!

Do not bridge defective fuses. Defective fuses are only permitted to be replaced with fuses of the same rating.

The electrical equipment in the R&S CompactTSVP / R&S PowerTSVP is to be checked at regular intervals. Defects, such as loose connections, or chaffed cables must be rectified immediately.

The safety instructions on the safety sheet included are to be observed.



4 Self Test

4.1 Function

4.1.1 System overview

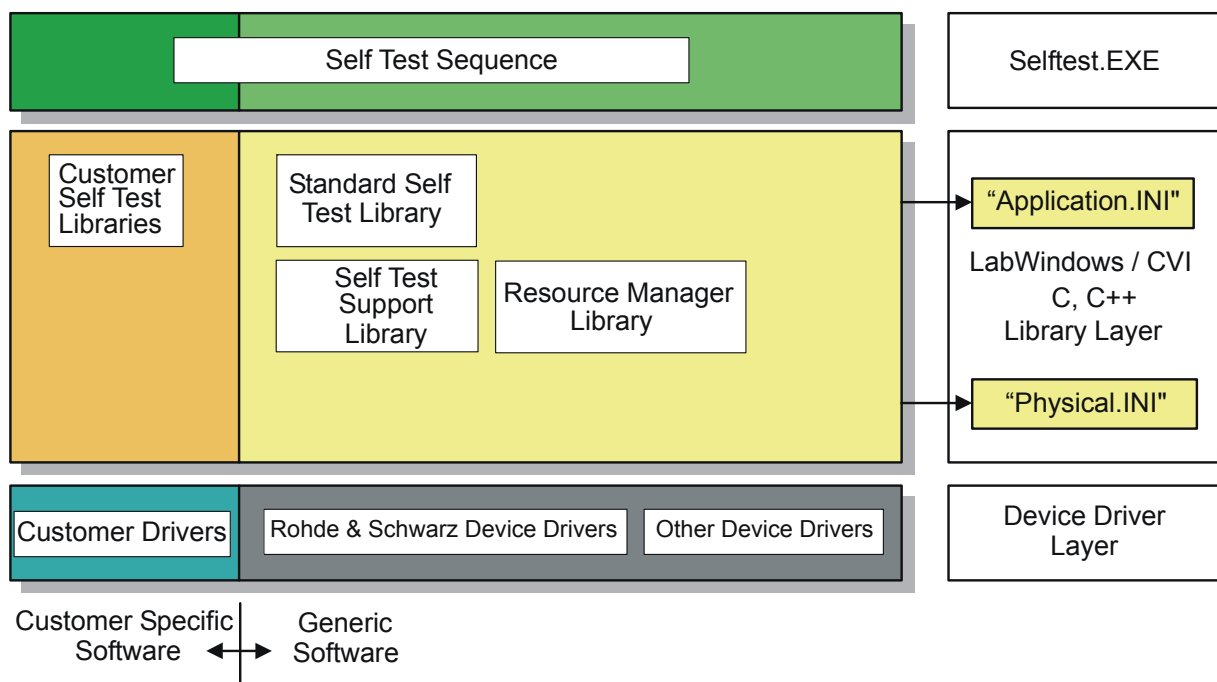


Figure 4-1 SFT Software Overview

The software for the self test consists of four main parts:

- The Self Test Sequence, which combines the R&S CompactTSVP / R&S PowerTSVP internal part, the standard system part and the user-defined part of the self test.
- The Standard Self Test Libraries. One is responsible for the self test of the R&S CompactTSVP / R&S PowerTSVP frame and the built-in cards. Other libraries contain self test functions for external devices in standard systems.
- The Customer Self Test Libraries, which are responsible for the self test of customer specific external devices, the fixture and the cabling between the R&S CompactTSVP / R&S PowerTSVP and these parts.
- The Self Test Support Library which provides generic SFT support functions like report generation, user communication etc.


NOTE:

Further information on the software implementation of the self test is given in the software description “Generic Test Software Library GTSL”.

4.1.2 Concept of Execution

The basic self test concept is not very different from any other test application. There is the Resource Manager which coordinates the actions and there are the device drivers which connect the software to the devices. This makes it easy for the user, since there is no difference between loading and running a test program and running the self test. It makes it easy for the programmer, since the self test libraries are written the same way as the high-level test libraries.

The self test is configured by entries in the Resource Manager's physical and application INI files. The physical layer describes the devices, the application layer contains information about self test benches, options and test cases.

The `selftest.exe` program starts functions from the libraries described above. Customer-specific self tests can be added to the source code. Sequence Editors like TestStand can also be used to launch self test functions from the DLLs.

The program `selftest.exe` starts the self test for the R&S CompactTSVP frame. Enter the name of the application and physical ini file in the start dialog. A sample application and physical ini file is provided in the `\configuration` directory:

- `SFT_CompactTSVP_application.ini`
- `CompactTSVP_physical.ini`


NOTE:

You can use the specimen INI files that are supplied as templates for the `SFT_application.ini` and `physical.ini` files. The specimen INI files should not be overwritten.

The source code for this self test program is provided in the directory `\develop\tools\selftest`.

4.1.3 Self Test Sequence

The self test sequence calls functions from the standard and customer self test libraries:

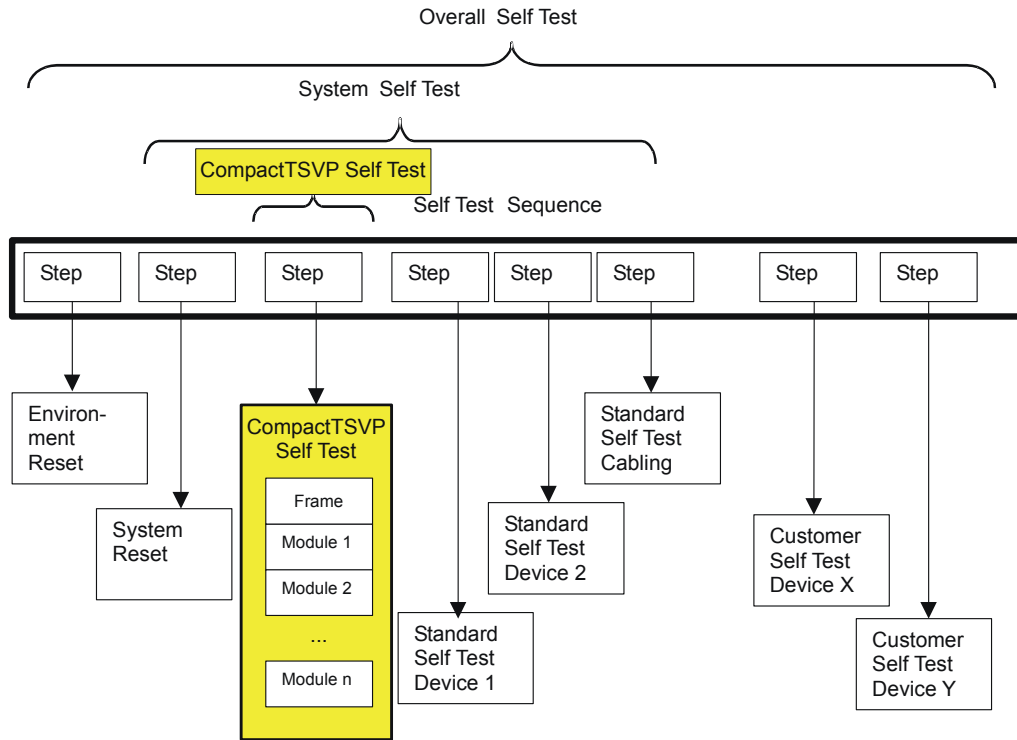


Figure 4-2 Self Test Sequence

Note that the complete R&S CompactTSVP / R&S PowerTSVP self test is done in only one test step inside the R&S CompactTSVP / R&S PowerTSVP SFT library. The system/overall self test is split into many test steps calling functions from the standard and customer SFT libraries.

The complexity of the sequence grows with the complexity of the system. If the system is just a R&S CompactTSVP / R&S PowerTSVP frame with some cards in it, the self test sequence consists only of one step.



4.1.4 R&S CompactTSVP / R&S PowerTSVP Self Test

The R&S CompactTSVP / R&S PowerTSVP self test consists of the R&S CompactTSVP / R&S PowerTSVP Self Test Frame and a R&S CompactTSVP / R&S PowerTSVP Module Self Test for each type of hardware module. The R&S CompactTSVP / R&S PowerTSVP SFT frame reads the configuration information from the resource manager and activates the self test for each testable module

4.2 Hardware Required

The Source and Measurement Module R&S TS-PSAM is needed to carry out the self test on the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP. The R&S TS-PSAM performs the necessary measurements on the analog bus of the R&S CompactTSVP / R&S PowerTSVP. Figure 4-3 shows the connection of the R&S TS-PSAM to the analog bus.

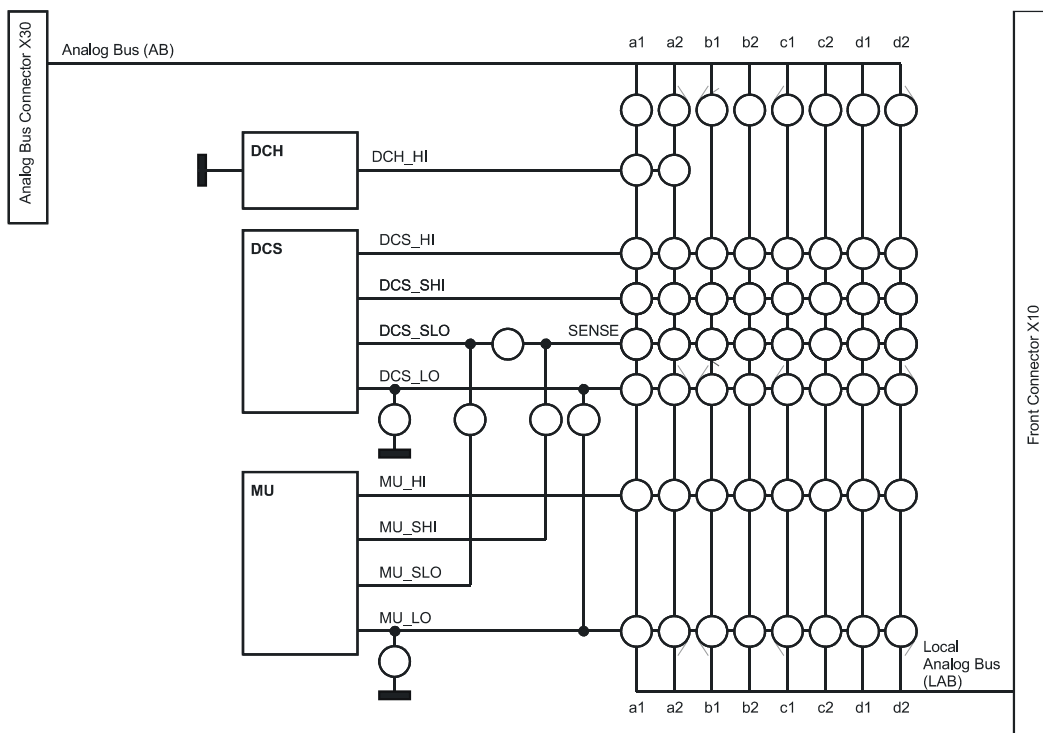


Figure 4-3 Connection of R&S TS-PSAM to Analog Bus

4.3 Starting and Performance

The self test of the R&S CompactTSVP / R&S PowerTSVP is started as a test sequence. As the R&S CompactTSVP / R&S PowerTSVP is always part of a test system, the self test of the R&S CompactTSVP / R&S PowerTSVP is always part of a more comprehensive self test sequence. The self test or the test sequence of the self test of the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP is a self-contained executable program (EXE file).

To run the self test, proceed as follows:

1. Start the self test file `Selftest.exe`.

The self test created and supplied by ROHDE & SCHWARZ is stored in the default directory `C:\Program Files\GTSL\Bin`. If a different directory was specified when the software was installed, then you will find the self test in that directory (`...\Bin`).

You can also start the self test by selecting **Start -> Programs -> Rohde & Schwarz GTSL -> TSVP Self Test**.

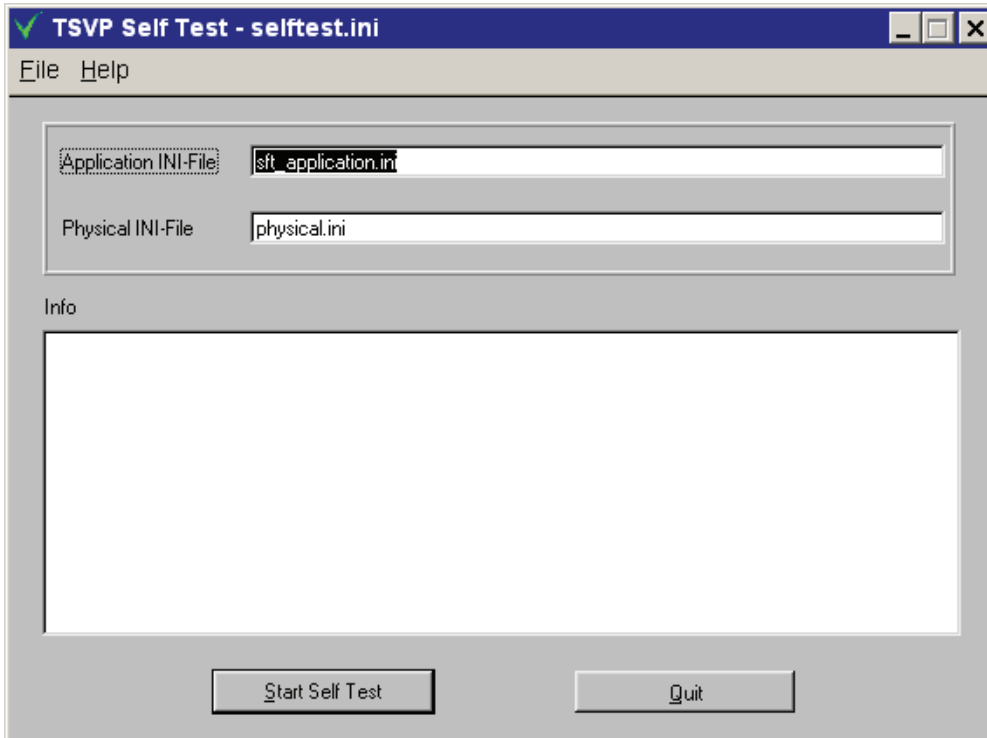


Figure 4-4 Self Test Start Screen

Application INI-File Enter the name of the Application INI file that is needed for the self test in this window.

Physical INI-File

Enter the name of the Physical INI file that is needed for the self test in this window.

Info

Displays status messages while the self test is running.

Starts the automatic self test routine.



Stops the self test.



2. In the **Self Test Parts and Options** dialog box, settings can be made on the way in which the self test sequence is performed (see Figure 4-5). The dialog box is opened automatically by the SFT_Setup function. Default values for the settings in the dialog box can be defined in the INI file (see Section 4.4: Configuration).

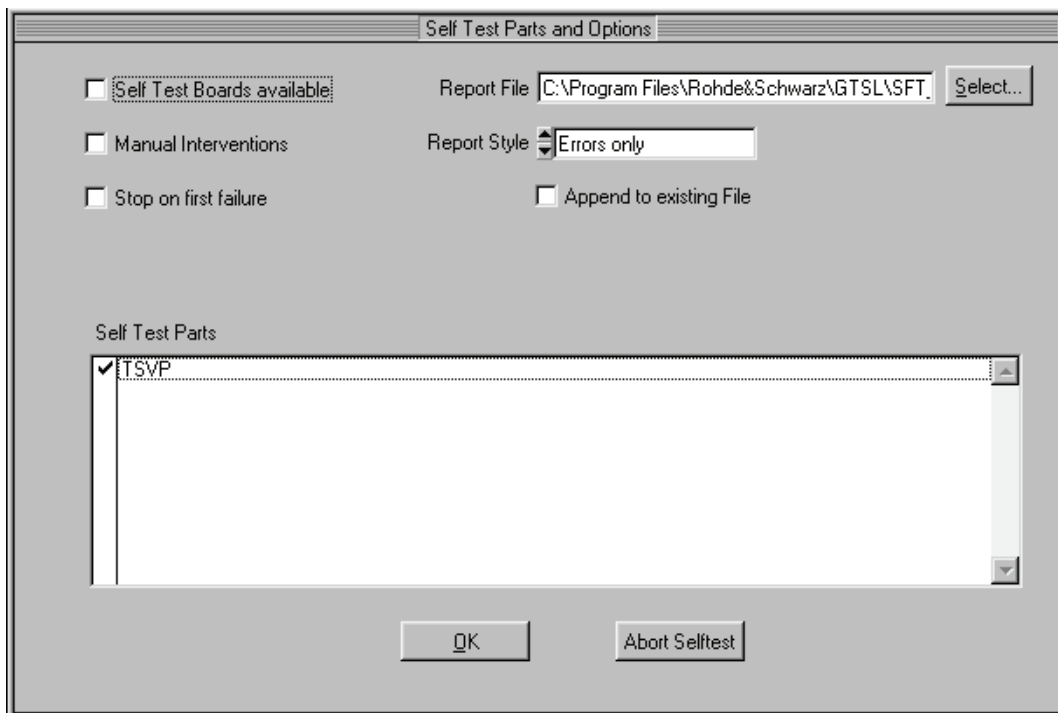


Figure 4-5 Self Test Parts and Options

Self Test Boards available

The Self Test Boards necessary for performing the individual test steps are available. The self test boards are plugged into the corresponding interface as prompted during the self test sequence.

**NOTE:**

No Self Test Boards are available for the R&S CompactTSVP modules. The Self Test Boards are used by Production for final inspection.

Manual Interventions

Manual intervention in the self test sequence by the operator is permitted, e.g., the fitting of self test boards or the selection of individual test components.

Stop on first failure

The self test sequence is interrupted on the first failed test.

Report File

At this point the location and file name for the self test report are entered.



The location and file name of the test report are selected using the **Select...** button.

Report Style

In this list box the type of output for the self test report is selected.

- **Errors only**
A self test report containing only the error messages (failed tests) is prepared.
- **Small**
A self test report with header information is prepared.
- **Full**
A self test report containing all available information is prepared.

Append to existing File

The self test report prepared during the self test sequence is appended to an existing self test report.

Self Test Parts

In this window the parts to be tested are displayed. It is possible to select which parts are to be tested (checkmarks).



The self test sequence is continued using the **OK** button.



The **Abort Selftest** button immediately interrupts the performance of the self test sequence.

Depending on the combination of the two variables **Self Test Boards available** and **Manual Interventions**, different self test sequences are possible.

**NOTE:**

No Self Test Boards are available for the R&S CompactTSVP modules. The Self Test Boards are used by Production for final inspection.

Self Test Boards available
 Manual Interventions

All possible tests are performed. The self test boards must be plugged in (or unplugged) as required. Corresponding messages appear on the screen.

Self Test Boards available
 Manual Interventions

It is assumed that all the necessary self test boards are plugged in prior to the start of the self test. Only those tests that require a self test board or that the self test board does not interfere with are performed. No messages are displayed on the screen.

Self Test Boards available
 Manual Interventions

Only those tests that do not require a self test board are performed.

Self Test Boards available
 Manual Interventions

Only those tests that do not require a self test board are performed. No messages are displayed on the screen.

During the performance of the self test, the current status of the self test is displayed (see Figure 4-6).

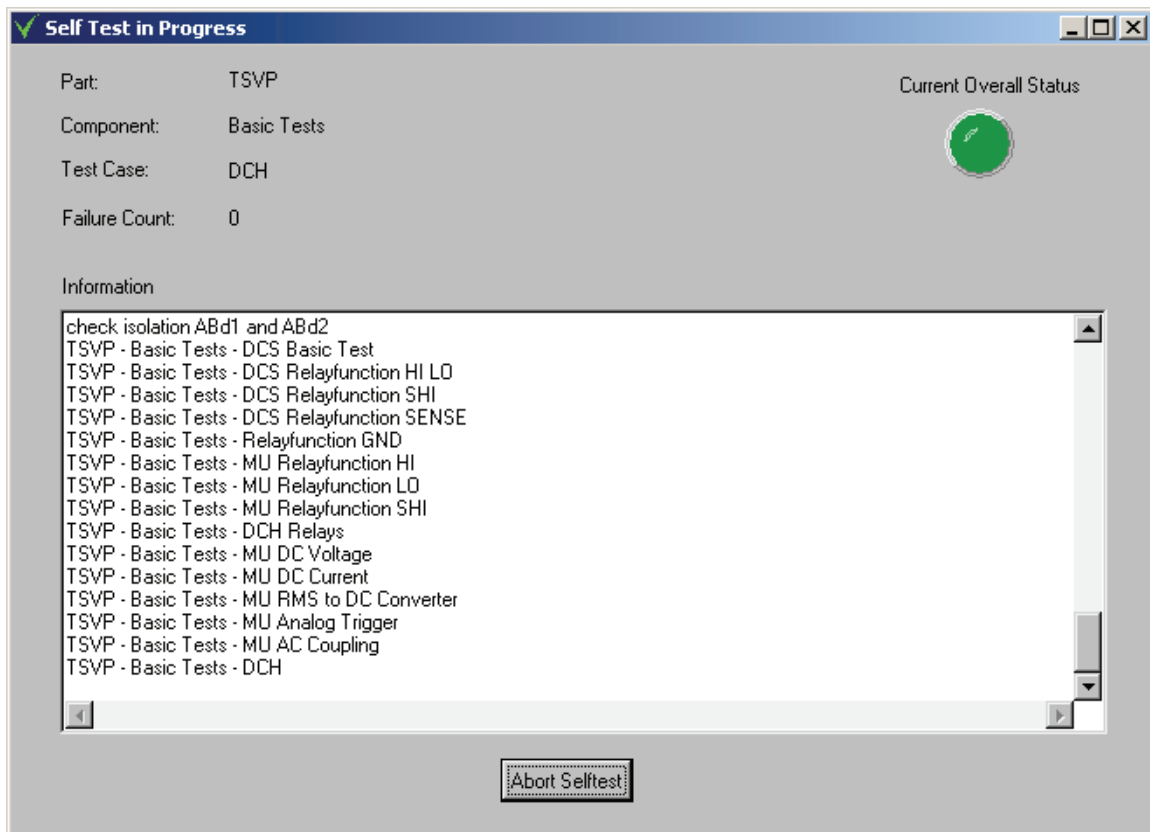


Figure 4-6 Self Test in Progress

- Part:** Indicates the self test part currently under test.
- Components:** Indicates the self test component currently under test.
- Test Case:** Indicates the current test case for the corresponding self test component.
- Failure Count:** Counts the test cases that end with the status "Failed" (failed tests).
- Information:** Indicates the test steps performed.
- Current Overall Status** Indicates the overall status of the self test sequence.
 - Green :** No error (failed test) has occurred yet.
 - Red :** At least one error (failed test) has occurred.

The **Abort Selftest** button immediately interrupts the performance of the self test sequence.

Following completion of the self test sequence, the result is displayed (see Figure 4-7 and Figure 4-8).



Figure 4-7 Self Test Result Passed



Figure 4-8 Self Test Result Failed

Show Report

If this check box is selected, the self test report is displayed after the **OK** button is clicked.

4.4 Configuration

Example configuration for the self test in the PHSYCAL.INI file:

```
physical layer .ini file
-----
[device->pmb1]
Description      = "TS-PMB, Slot 6"
Type            = PMB
ResourceDesc    = CAN0::0::1::6
DriverPrefix    = rspmb
DriverDll       = rspmb.dll
DriverOption    = Simulate=0
SFTDll         = sftmpmb.dll
SFTPrefix      = SFTMPMB

[device->psam]
Description      = "TS-PSAM, Slot 8"

Type            = PSAM
ResourceDesc    = PXI1::10::INSTR
DriverPrefix    = rpsam
DriverDll       = rpsam.dll
DriverOption    = Simulate=0
;Tested in Basic Tests!
;SFTDll         = sftmpsam.dll
;SFTPrefix      = SFTMPSAM

[device->pict]
Description      = "TS-PICT, Slot 9"
Type            = PICT
ResourceDesc    = PXI2::15::INSTR
DriverPrefix    = rspict
DriverDll       = rspict.dll
DriverOption    = Simulate=0
SFTDll         = sftmpict.dll
SFTPrefix      = SFTMPICT

[device->pmb2]
Description      = "TS-PMB, Slot 10"
Type            = PMB
ResourceDesc    = CAN0::0::1::10
DriverPrefix    = rspmb
DriverDll       = rspmb.dll
DriverOption    = Simulate=0
SFTDll         = sftmpmb.dll
SFTPrefix      = SFTMPMB

[device->pmb3]
Description      = "TS-PMB, Slot 13"
Type            = PMB
ResourceDesc    = CAN0::0::1::13
DriverPrefix    = rspmb
DriverDll       = rspmb.dll
DriverOption    = Simulate=0
SFTDll         = sftmpmb.dll
SFTPrefix      = SFTMPMB

[device->pmb4]
Description      = "TS-PMB, Slot 14"
Type            = PMB
ResourceDesc    = CAN0::0::1::14
DriverPrefix    = rspmb
DriverDll       = rspmb.dll
DriverOption    = Simulate=0
```

```

SFTDll          = sftmpmb.dll
SFTPrefix       = SFTMPMB

;[device->pfg]
;Description    = "TS-PFG, Slot 15"
;Type          = PMB
;ResourceDesc  = PXI2::9::INSTR
;DriverPrefix  = rspfg
;DriverDll     = rspfg.dll
;DriverOption  = Simulate=0,DriverSetup=ie:1
;SFTDll       = sftmpfg.dll
;SFTPrefix    = SFTMPFG

[device->psys]
Description     = "TS-PSYS, Slot 15, rear"
Type           = PSYS1
ResourceDesc   = CAN0::0::5::15
DriverPrefix   = rpsys
DriverDll      = rpsys.dll
DriverOption   = Simulate=0
SFTDll        = sftmpsys.dll
SFTPrefix     = SFTMPSYS

;[device->psm1]
;Description    = "TS-PSM1, Slot 16"
;Type          = PSM1
;ResourceDesc  = CAN0::0::1::16
;DriverPrefix  = rpsm1
;DriverDll     = rpsm1.dll
;DriverOption  = Simulate=0
;SFTDll       = sftmpsm1.dll
;SFTPrefix    = SFTMPSM1

;mandatory analog bus entry
[device->ABUS]
Description    = "Analog Bus"
Type          = ab

```

Example configuration for the self test in the file APPLICATION.INI :

application layer .ini file

```

[ResourceManager]

;
; global tracing flags (normally off)
;
Trace          = 0
TraceFile      = %GTSLROOT%\SFT_Trace.txt

[bench->SFT]
;
; The bench SFT contains the device required to run the
; complete self test: The TS-PSAM source and measurement module
; which includes the switch matrix for analog bus access
;
DigitalMultimeter = device->psam
SwitchDevice      = device->psam
Trace            = 0

[SftOptions]
;
; The SftOptions section defines default values for the self test dialog
;

```



```
SystemName           = CompactTSVP

ReportFile           = %GTSLROOT%\SFT_Report.txt

; ReportStyle options:
; 1 = report only errors,
; 2 = short report,
; 3 = full report
ReportStyle          = 1
; Self Test Fixtures are available: 0 or 1
SFTFixture           = 0
; Allow manual interventions, i.e. selection of subtests: 0 or 1
ManualInterventions = 1

[SftParts]
;
; The SftParts section contains a list of parts to test
;
; Format: "PartX" = PartName, BenchName, SelectFlag
; The PartName must be unique for the whole section
; The name for Part 1 must be "TSVP".
;
Part1                 = TSVP, TSVP, 1

[bench->TSVP]
;
; Bench for TSVP self test
;
Trace                 = 0
```


4.5 Basic Tests

The self test frame begins with the basic tests, where the R&S CompactTSVP / R&S PowerTSVP frame and the self test instrumentation is tested. When this test is done, it walks through the list of testable devices, loads the appropriate SFT DLL dynamically and calls the test function. The order in which the tests are performed is given by the order in which the device entries are written in the physical ini file.



NOTE:

Because the Source and Measurement Module R&S TS-PSAM is needed as test instrumentation for the self test of the R&S CompactTSVP / R&S PowerTSVP, the basic test is identical with the module test on the R&S TS-PSAM (see Section 4.6.3).

4.6 Self Test of Plug-In Cards

4.6.1 Power Switch Module R&S TS-PSM1

The Power Switch Module test consists of the following test cases:

- INIT
- Extern Voltage
- Device SFT
- Configuration
- Coupling Relays
- Bus Isolation
- Shunt Relays
- Channel Relays
- LPB Relays
- Front Connector

SELF TEST

Test Case	Description	Test Sequence
INIT	Initializes the module with the function <code>rspsm1_InitWithOptions</code> .	The driver function <code>rspsm1_InitWithOptions</code> is started.
Extern Voltage	Measures the potential between all bus lines and of each individual bus line to Ground.	The following connections switch any voltages present on channels Ch1 - Ch4 to the analog buses: Ch1com - LABa1; Ch1no - LABb1; Ch2com - LABa2; Ch2no - LABb2; Ch3com - LABc1; Ch3no - LABd1; Ch4com - LABc2; Ch4no - LABd2;
		MU_LO is switched to ABa1.
		MU_HI is switched to ABa2.
		The voltage between these two buses (ABa1 - ABa2) is measured.
		The measured value is compared with the limit. If it exceeds the limit, the complete self test is cancelled with an error message.
		MU_HI is switched to ABb1.
		The voltage between ABa1 - ABb1 is measured.
		The measured value is compared with the limit. If it exceeds the limit, the complete self test is cancelled with an error message.



Test Case	Description	Test Sequence
		This measurement is repeated with all the bus lines up to ABd2.
		The MU is reset.
		MU_HI is switched to ABa1.
		MU_LO is switched to Ground.
		The voltage between ABa1 and Ground is measured.
		The measured value is compared with the limit. If it exceeds the limit, the complete self test is cancelled with an error message.
		The connections of MU_LO and MU_HI are disconnected.
		This measurement is repeated with all the bus lines from ABa2 to ABd2.
		The following connections switch any voltages present on channels Ch5 - Ch8 to the analog buses: Ch5com - LABa1; Ch5no - LABb1; Ch6com - LABa2; Ch6no - LABb2; Ch7com - LABc1; Ch7no - LABd1; Ch8com - LABc2; Ch8no - LABd2
		All analog buses are tested as described above.
		The following connections switch any voltages present on channels Ch9 - Ch12 to the analog buses: Ch9com - LABa1; Ch9no - LABb1; Ch10com - LABa2; Ch10no - LABb2; Ch11com - LABc1; Ch11no - LABd1; Ch12com - LABc2; Ch12no - LABd2
		All analog buses are tested as described above.
		The following connections switch any voltages present on channels Ch13 - Ch16 to the analog buses: Ch13com - LABa1; Ch13no - LABb1; Ch14com - LABa2; Ch14no - LABb2; Ch15com - LABc1; Ch15no - LABd1; Ch16com - LABc2; Ch16no - LABd2
		All analog buses are tested as described above.
		The following connections switch any voltages present on instrument lines IL1 and IL2 to the analog buses: IL1com - LABc1; IL1no - LABb2; IL2com - LABa1; IL2no - LABd2



Test Case	Description	Test Sequence
		All analog buses are tested as described above.
		The following connections switch any voltages present on channels LPBA - LPBD to the analog buses: LPBA - LABa1; LPBB - LABb2; LPBC - LABc1; LPBD - LABd2
		All analog buses are tested as described above.
Device SFT	Starts the Device Self Test.	Starts the function <code>rspsm1_self_test</code> .
Configuration	Reads the configuration of the module (driver version and firmware version).	Starts the function <code>getConfiguration</code> .
Coupling Relays	The eight coupling relays are tested.	All eight coupling relays are closed.
		All power relays and their connections with the corresponding analog bus lines on the PSM1 board (CH1 - CH16) are closed.
		MU_HI is switched to ABa1 and MU_LO to ABb1.
		The contact resistance of coupling relays ABa1 <--> LABa1 and ABb1 <--> LABb1 is measured.
		Coupling relay ABa1 <--> LABa1 is opened.
		The insulation resistance of coupling relay ABa1 <--> LABa1 is measured.
		Coupling relay ABa1 <--> LABa1 is closed.
		Coupling relay ABb1 <--> LABb1 is opened.
		The insulation resistance of coupling relay ABb1 <--> LABb1 is measured.
		Coupling relay ABb1 <--> LABb1 is closed.
		The coupling relays of the other buses are measured in the same way. (ABc1 - ABd1, ABa2 - ABb2, ABc2 - ABd2).
		At the end of the test case, all coupling relays and all power and analog bus relays (CH1 - CH16) are opened by calling the function <code>rspsm1_reset()</code> .
Bus Isolation	Tests the insulation resistance between all buses and all bus lines to Ground.	All coupling relays are closed.
		MU_LO is switched to ABa1 and MU_HI to ABa2.
		The insulation resistance between LABa1 and LABa2 is measured.
		MU_HI is switched to ABb1.



Test Case	Description	Test Sequence
		The insulation resistance between LABa1 and LABb1 is measured.
		MU_HI is switched to ABb2.
		The insulation resistance between LABa1 and LABb2 is measured.
		The insulation resistance of all buses and bus lines up to LABd2 is measured in the same way.
		The MU is reset.
		MU_HI is switched to ABa1.
		MU_LO is switched to Ground.
		The insulation resistance between ABa1 and Ground is measured.
		The connections of MU_LO and MU_HI are disconnected.
		MU_LO is switched to ABa2 and MU_HI to ABb1.
		The insulation resistance between LABa2 and LABb1 is measured.
		MU_HI is switched to ABb2.
		The insulation resistance between LABa2 and LABb2 is measured.
		The insulation resistance of all buses and bus lines up to LABd2 is measured in the same way.
		This process is now repeated until measurements have been carried out between all the bus lines and between each individual bus line and Ground.
		At the end of the test case, all coupling relays are opened again by calling the function <code>rspsml_reset()</code> .
Shunt Relays	Tests the shunt relays.	All coupling relays are closed.
		MU_LO is switched to ABa1.
		MU_HI is switched to ABb1.
		The connection CH1no <--> LABa1 is closed.
		The connection CH1no <--> LABb1 is closed.
		The contact resistance is measured.
		The connection CH1no <--> LABa1 is opened.
		The insulation resistance is measured.



Test Case	Description	Test Sequence
		The connection CH1no <--> LABb1 is opened.
		The connection CH5no <--> LABa1 is closed.
		The connection CH5no <--> LABb1 is closed.
		The contact resistance is measured.
		The connection CH5no <--> LABa1 is opened.
		The insulation resistance is measured.
		The connection CH5no <--> LABb1 is opened.
		The contact resistance and insulation resistance is measured in the same way up to CH8com.
		All coupling relays are opened.
Channel Relays	Tests all channel paths (CH1 - CH16).	All coupling relays are closed.
		MU_LO is switched to ABa1.
		MU_HI is switched to ABb1.
		The connection CH1com <--> LABa1 is closed.
		The connection CH1no <--> LABb1 is closed.
		The connection CH1com <--> CH1no is closed.
		The contact resistance is measured.
		The connection CH1com <--> CH1no is opened.
		The insulation resistance is measured.
		The connection CH1com <--> CH1no is closed.
		The connection CH1com <--> LABa1 is opened.
		The insulation resistance is measured.
		The connection CH1com <--> LABa1 is closed.
		The connection CH1no <--> LABb1 is opened.
		The insulation resistance is measured.
		The connection CH1com <--> LABa1 is opened.
		The connection CH1com <--> CH1no is opened.
		The contact resistance and insulation resistance are measured in the same way up to CH16. (IL1 and IL2 are also measured in this way)
		All coupling relays are opened.
LPB Relays	Tests all LBPx relays.	All coupling relays are closed.
		MU_LO is switched to ABa1.
		MU_HI is switched to ABb1.



Test Case	Description	Test Sequence
		The connection CH1no <--> LABb1 is closed.
		The connection LPBA <--> CH1no is closed.
		The insulation resistance is measured.
		The connection LPBA <--> LABa1 is closed.
		The contact resistance is measured.
		The connection LPBA <--> CH1no is opened.
		The insulation resistance is measured.
		The connection CH1no <--> LABb1 is opened.
		The connection CH2no <--> LABb2 is closed.
		The connection LPBA <--> Ch2no is closed.
		continue with 'measuring the contact resistance'
		The contact resistance and insulation resistance of all LPBx relays are measured in the same way.
		All coupling relays are opened.
Front Connector	Tests all connections with the front connector X10. (The self test adapter must be connected to X10 for this test)	The MU is reset.
		All coupling relays are closed.
		The output voltage of the DCS is set
		The current limit of the DCS is set.
		DCS_LO is switched to GND.
		DCS_HI is switched to ABa1 and ABa2.
		Coupling relays ABa1-LABa1 and ABa2-LABa2 on R&S TS-PSAM are closed.
		The ground relay is closed.
		The matrix relay P1 - LABa1 is closed.
		The DCS output is activated.
		Is the DCS in the current limit? Yes -> Test OK No -> Test not OK
		The DCS output is deactivated.
		All ports (P1 - P90) are tested in the same way.
		All relays are opened.

END TEST

Test Case	Description	Test Sequence
Shunt Resistors	Tests all shunt resistors. (The self test adapter must be connected to X10 and X1 for this test.)	The MU is configured for a 4-wire resistance test.
		MU_SHI is switched to ABa1 (applied directly to CH1no).
		MU_SLO is switched to ABb1 (applied directly to CH1no).
		MU_HI is switched to ABa2 (continues via CH2com and the short-circuit connector at X1 via power relay CH1com - CH1no).
		MU_LO is switched to ABb2 (via CH2no to the short-circuit connector at X10).
		The relay between CH1no - LABa1 is closed.
		The relay between CH1no - LABb1 is closed.
		The relay between CH2com - LABa2 is closed.
		The relay between CH2no - LABb2 is closed.
		The relay between CH1com - CH1no is closed.
		The resistance of the shunt on CH1no is measured.
		All relays on the PSM1 board are opened again.
		All shunt resistors are tested in the same way.

4.6.2 Matrix Module B R&S TS-PMB

4.6.2.1 Initialization

4.6.2.1.1 Description

The driver is opened. The „Resource Descriptor“ and the optional „Option String“ from the Physical INI File is used for this. If the initialization of the driver fails, the test for the module is aborted.

4.6.2.1.2 Sequence

The function `rspmb_InitWithOptions` is called.

4.6.2.2 Configuration

4.6.2.2.1 Description

The current configuration parameters (Driver and Firmware version, assigned slot, Hardware Code) are determined. The „Option String“ used during the initialization is also shown in the report. The mode necessary for the self-test for operation of the coupling relay is set.

4.6.2.2.2 Sequence

Call of the function `rspmb_revision_query` and query of the attribute `RSPAM_ATTR_HW_CODE`. The attribute `RSPMB_ATTR_CR_AUTO` is set to 0.

4.6.2.3 Device Self Test

4.6.2.3.1 Description

The self-test function in the driver is started. This function conducts internal tests on the component and when there is an error, delivers a message about the first error found.

4.6.2.3.2 Sequence

Call of the function `rspmb_self_test`.

4.6.2.4 External Voltage

4.6.2.4.1 Description

The coupling relays on the component are closed. Then, voltage measurements between each individual bus line and GND and between all bus lines are carried out. If too high a level is measured, the self-test for this component must be aborted.

4.6.2.4.2 Sequence

- Close coupling relay
- Connect DMM_LO with GND
- For all bus lines
 - Switch DMM_HI to the line to be tested
 - Carry out voltage measurement
 - Disconnect DMM_HI from the bus line
- Disconnect DMM_LO from GND
- For all combinations of bus lines
 - Switch DMM_LO to the first line
 - Switch DMM_HI to the second line
 - Carry out voltage measurement
 - Disconnect DMM_LO from the bus line
 - Disconnect DMM_HI from the bus line

4.6.2.5 Bus Isolation

4.6.2.5.1 Description

The coupling relays on the component are closed and the insulation resistance of the bus lines to one another and the resistance of the individual bus lines to GND are measured. For the measurement against GND, the DCS is used because high-ohm resistances against GND cannot be carried out with the resistance measuring function in the Mode V (voltage injection and current measurement) of the R&S TS-PSAM module.

To determine whether the minimum permitted resistance of a bus line against GND is not reached, DCS_LO is connected with GND and DCS_HI switched to the line to be tested. A voltage of 5 V and a current limit of 10 μ A gives a threshold of the 500 kOhm. If the insulation resis-

tance is low, the source goes into the current limit and thus displays an error.

The insulation resistance between two bus lines is measured in the 10 MΩ range of the resistance measuring function. If too low a resistance is found, then the measurement with Autorange switched on is repeated to determine the exact value.

4.6.2.5.2 Sequence

Test all bus lines against GND.

Test all combinations of bus lines against one another.

Temporarily store result for the test of the relay on the bus lines.

4.6.2.6 Coupling Relays

4.6.2.6.1 Description

The function of the coupling relay is reported. For each relay, a contact and insulation measurement is carried out. During the measurement of the contact resistance, the serial connection of multiple relays is always measured.

4.6.2.6.2 Sequence

The coupling relay is tested together with the matrix relay. Here, measuring path is always set up as follows:

DMM_HI - LABx (PSAM) - ABx <Kx> LABx - Px - LABy <Ky> ABY - LABy (PSAM)
- DMM_LO

Signal	Comment
DMM_HI	HI line of the resistance measuring unit
LABx (PSAM)	HI line on local analog bus R&S TS-PSAM
ABx	HI line on analog bus
Kx	Coupling relay in the HI line
LABx	HI line on local analog bus R&S TS-PAM
Px	Device connection R&S TS-PMB
LABy	LO line on local analog bus R&S TS-PAM
Ky	Coupling relay in the LO line
ABy	LO line on analog bus



Signal	Comment
LAB _y (PSAM)	LO line on local analog bus R&S TS-PSAM
DMM_LO	LO line of the resistance measuring unit

Two bus lines are always selected which show no short circuit with each other. For this, the result of the bus insulation measurement is used.

If the measuring path shows a low-ohm connection, the measured value is recorded as contact resistance for both relays (K_x and K_y). Then, K_x and K_y are individually opened and on each a insulation measurement is carried out.

If no low-ohm connection is detected, one of the four relays on the module R&S TS-PMB does not close. No insulation measurement for the coupling relay can thus be carried out. The measurement is repeated with the next channel P_x . If on all lines P_x no connection is found, a coupling relay is probably defective.

The measurements are repeated for all bus lines AB_x .

4.6.2.7 P Matrix Relays

4.6.2.7.1 Description

The function of the relay for the pins P1 up to P90 is tested. For each relay, a contact and insulation measurement is carried out. During the measurement of the contact resistance, the serial connection of multiple relays is always measured.

4.6.2.7.2 Sequence

A measuring path is always set up as follows:

DMM_HI - LAB_x (PSAM) - AB_x - LAB_x <K_x> P_x <K_y> LAB_y - AB_y - LAB_y (PSAM) - DMM_LO

Signal	Comment
DMM_HI	HI line of the resistance measuring unit
LAB _x (PSAM)	HI line on local analog bus R&S TS-PSAM
AB _x	HI line on analog bus
LAB _x	HI line on local analog bus R&S TS-PAM
K _x	Matrix relay in the HI line

Signal	Comment
Px	Device connection R&S TS-PMB
Ky	Matrix relay in the LO line
LABy	LO line on local analog bus R&S TS-PAM
ABy	LO line on analog bus
LABy (PSAM)	LO line on local analog bus R&S TS-PSAM
DMM_LO	LO line of the resistance measuring unit

Two bus lines are always selected which show no short circuit with each other. For this, the result of the bus insulation measurement is used.

If the measuring path shows a low-ohm connection, the measured value is recorded as contact resistance for both relays (K_x and K_y). Then, K_x and K_y are individually opened and on each a insulation measurement is carried out.

If no low-ohm connection is detected, one of the four relays on the module R&S TS-PMB does not close. No insulation measurement for the matrix relay can thus be carried out. The two relays are marked and in a second run, individually tested against a functioning relay on the line Px according to the same procedure.

The measurements are repeated for all bus lines ABx.

4.6.2.8 IL Matrix Relays

The function of the matrix relay for the lines IL1, IL2 and IL3 is tested. The test procedure is the same as in Section 4.6.2.7

4.6.2.9 Sense Relays

4.6.2.9.1 Description

The function of the Sense Relays is tested. For each relay, a contact and insulation measurement is carried out. During the measurement of the contact resistance, the serial connection of multiple relays is always measured.

4.6.2.9.2 Sequence

The following measuring path is set up:

DMM_HI - LAB_x (PSAM) - AB_x - LAB_x <K_x> LAB_y - AB_y - LAB_y (PSAM) - DMM_LO

The contact resistance is measured and recorded for the relay K_x.

Then, K_x is opened and an insulation measurement carried out.

The measurement is repeated for all Sense Relays.

4.6.2.10 Front Connector

4.6.2.10.1 Description

For this test, the self-test board is necessary.

The contacts on the front side plug are to be tested. The DCS with the adjustable current limit is used for evaluation. The DCS is wired as follows:

DCS_LO GND

DCS_HI to ABa1 and ABa2

All coupling relays on R&S TS-PSAM and R&S TS-PAM are closed.

The settings for the source were selected as follows:

Voltage:	0.4 V
Current limit:	100 mA

A threshold of 4 Ohms results.

The following signal paths were selected on the module:

AB_x - P_y <X10.z> GNDNO <K65> GND

Because in this path there is also the relay against GND (K65), this is tested during each contact measurement. The first low-ohm path is therefore also used for the „Ground Relay“ test case.

4.6.2.10.2 Sequence

- Coupling relays are closed
- Connect DCS_LO with GND
- Connect DCS_HI with ABa1 and ABa2
- Set DCS voltage and current limit for contact measurement
- For each channel Py
 - Switch Py to corresponding bus line ABa1 or ABa2
 - Query DCS status
 - Disconnect Py from the bus line

4.6.2.11 Ground Relay

4.6.2.11.1 Description

For this test, the self-test board is necessary.

The path found in the test case „Front connector“ is restored. The contact measurement was already carried out in the „Front connector“ test case. The relay against GND is now opened and the insulation measurement carried out. If no usable path was found, the relay against GND probably does not close.

4.6.2.11.2 Sequence

- Coupling relays are closed
- Connect DCS_LO with GND
- Connect DCS_HI with ABa1 and ABa2
- Set DCS voltage and current limit for insulation measurement
- Restore found path from „Front connector“ test case
- Open relay against ground
- Carry out insulation measurement.



4.6.3 Source and Measurement Module R&S TS-PSAM

The Source and Measurement Module test consists of the following test cases:

- INIT
- Configuration
- Coupling Relays
- Bus Isolation
- DCS Basic Test
- DCS Relayfunction HI LO
- DCS Relayfunction SHI
- DCS Relayfunction SENSE
- Relayfunction GND
- MU Relayfunction HI
- MU Relayfuntion LO
- MU Relayfunction SHI
- MU Relayfunction SLO
- DCH Relays
- MU DC Voltage
- MU DC Current
- MU RMS to DC Converter
- MU Analog Trigger
- MU AC Coupling
- DCH
- Trigger Bus
- Relays Multiplexer
- External Trigger

Test Case	Description	Test Sequence
INIT	Initializes the module with the function <code>rspsam_InitWithOptions</code> .	The driver function <code>rspsam_InitWithOptions</code> is started.
Configuration	Reads the configuration of the module (firmware version, slot number, hardware code).	The function <code>getConfiguration</code> is started.



Test Case	Description	Test Sequence
Coupling Relays	The eight coupling relays are tested.	All eight coupling relays are closed.
		All relays on the MU_HI and MU_LO lines on the R&S TS-PSAM board under test are closed.
		The test looks for a reference bus line -> Refline..
		MU_HI is switched to ABa1 and MU_LO to ABa2.
		The contact resistance of coupling relays ABa1 <--> LABa1 and ABa1 <--> LABa2 is measured.
		Coupling relay ABa1 <--> LABa1 is opened.
		The insulation resistance of coupling relays ABa1 <--> LABa1 is measured. If the measurement is OK, then ABa1 is the Refline.
		Coupling relay ABa1 <--> LABa1 is closed.
		All bus lines are measured against the Refline.
		The contact resistance of coupling relays Refline (ABa1) and ABa2 <--> LABa2 is measured.
		Coupling relay ABa2 <--> LABa2 is opened.
		The insulation resistance of coupling relay ABa2 <--> LABa2 is measured.
		Coupling relay ABa2 <--> LABa2 is closed.
		The coupling relays of the other buses are measured in the same way. (Reflin(ABa1) - ABb1, Reflin(ABa1) - ABb2, Reflin(ABa1) - ABc1, Reflin(ABa1) - ABc2, Reflin(ABa1) - ABd1, Reflin(ABa1) - ABd2)
		At the end of the test case, all coupling and matrix relays are opened again by calling the function <code>rspmb_reset()</code> .
Bus Isolation	Tests the insulation resistance between all buses and all bus lines to Ground.	All coupling relays are closed.
		MU_LO is switched to ABa1 and MU_HI to ABa2.
		The insulation resistance between LABa1 and LABa2 is measured.
		MU_HI is switched to ABb1.
		The insulation resistance between LABa1 and LABb1 is measured.
		MU_HI is switched to ABb2.
		The insulation resistance between LABa1 and LABb2 is measured.



Test Case	Description	Test Sequence
		The insulation resistance of all buses and bus lines up to LABd2 is measured in the same way.
		The MU is reset.
		MU_HI is switched to ABa1.
		MU_LO is switched to Ground.
		The insulation resistance between ABa1 and Ground is measured.
		The connections of MU_LO and MU_HI are opened again.
		MU_LO is switched to ABa2 and MU_HI to ABb1.
		The insulation resistance between LABa2 and LABb1 is measured.
		MU_HI is switched to ABb2.
		The insulation resistance between LABa2 and LABb2 is measured.
		The insulation resistance of all buses and bus lines up to LABd2 is measured in the same way.
		This process is now repeated until measurements have been carried out between all the bus lines and between each individual bus line and Ground.
		At the end of the test case, all coupling and matrix relays are opened again by calling the function <code>rspmb_reset()</code> .
DCS Basic Test	The insulation resistance between DCS_HI and DCS_LO and DCS_HI and GND is measured.	The connection DCS_LO <--> GND is opened.
		The DCS is set to 5 V.
		The DCS current limiter is set to the minimum value.
		With 1 μ A there is a measurable insulation resistance of 5 MOhm.
		The DCS must not go into the current limiter. The resistance between DCS_HI and DCS_LO is therefore greater than the measurable insulation resistance.
		DCS_LO is switched to GND.
		The DCS must not go into the current limiter. The resistance between DCS_HI and GND is therefore greater than the measurable insulation resistance.



Test Case	Description	Test Sequence
		The connection DCS_LO <--> GND is opened.
		DCS_HI is switched to ABa1.
		The DCS must not go into the current limiter. The insulation resistance of the relay bus line to DCS_LO is therefore greater than the measurable insulation resistance.
		The connection DCS_HI <--> ABa1 is opened.
		This measurement is repeated for all analog bus lines up to ABd2.
		DCS_LO is switched to GND.
		DCS_HI is switched to ABa1.
		The DCS must not go into the current limiter. The insulation resistance of the relay bus line to DCS_LO and of the bus line to GND is therefore greater than the measurable insulation resistance.
		The connection DCS_HI <--> ABa1 is opened.
		This measurement is repeated for all analog bus lines up to ABd2.
		The test results are recorded in the SFT Report.
DCS Relayfunction HI LO	Tests the function of the relays between DCS_HI and analog bus and DCS_LO and analog bus.	The connection DCS_LO <--> GND is opened.
		The DCS voltage is set to 0.3 V.
		The DCS current limiter is set to maximum value (100 mA).
		DCS_HI is switched to ABa1.
		DCS_LO is switched to ABa1.
		The DCS is switched on.
		The DCS must go into the current limiter. The resistance is therefore less than 3 Ohm
		The DCS is switched off.
		The connection DCS_HI <--> ABa1 is opened.
		The connection DCS_LO <--> ABa1 is opened.
		This measurement is repeated for all bus lines up to ABd2.
		If a low-resistance connection has been found
		The DCS voltage is set to 5 V.
		The DCS current limiter is set to minimum value.
		The connection DCS_HI <--> ABa1 is opened.
		The DCS is switched on.



Test Case	Description	Test Sequence
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		The connection DCS_LO <--> ABa1 is opened.
		DCS_HI is switched to ABa1.
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		The connection DCS_HI <--> ABa1 is opened.
		The DCS is switched off.
		This measurement is repeated for all analog bus lines up to ABd2.
		The test results are recorded in the SFT Report.
DCS Relayfunction SHI	Tests the function of the relays between DCS_SHI and the analog bus. The DCS_SHI line is connected to DCS_HI via 100 kOhm. The volume resistance cannot be measured very accurately in this way.	The DCS voltage is set to 5 V.
		The DCS is switched on.
		The connection DCS_LO <--> GND is opened.
		The DCS current limiter is set to 45 µA.
		DCS_SHI is switched to ABa1.
		DCS_LO is switched to ABa1.
		The DCS must go into the current limiter. The resistance is therefore less than 111 kOhm.
		The connection DCS_SHI <--> ABa1 is opened.
		The connection DCS_LO <--> ABa1 is opened.
		This measurement is repeated for all analog bus lines up to ABd2.
		If a connection has been found
		The DCS current limiter is set to the minimum value.
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		The connection DCS_LO <--> analog bus is opened.
		This measurement is repeated for all analog bus lines up to ABd2.
		The test results are recorded in the SFT Report.

Test Case	Description	Test Sequence
DCS Relayfunction SENSE	Tests the function of the relays between DCS_SHI and analog bus and DCS_SLO and analog bus. It is assumed that the relays of the DCS_HI line are functioning. The DCS_SLO line is connected to the DCS_LO line via 100 kOhm. The SENSE line is connected to DCS_SLO via a relay. This relay is also tested. Here again, the contact resistance cannot be determined very accurately.	The DCS voltage is set to 5 V.
		The DCS is switched on.
		The contact measurement of the "DCS_SLO <-->SENSE" relay is not initialized correctly.
		The DCS current limiter is set to 45 µA.
		DCS_SHI is switched to ABa1.
		SENSE is switched to ABa1.
		The DCS must go into the current limiter. The resistance is therefore less than 111 kOhm.
		The connection DCS_SHI <--> ABa1 is opened.
		The connection SENSE <--> ABa1 is opened.
		This measurement is repeated for all analog bus lines up to ABd2.
		If a contact is found
		The DCS current limiter is set to the minimum value.
		The contact measurement of the "DCS_SLO->SENSE" relay is marked as successful.
		If the insulation of the "DCS_SLO->SENSE" relay has not yet been measured
		Open the relay "DCS_SLO->SENSE"
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		Close relay "DCS_SLO->SENSE" again
		The connection SENSE <--> ABa1 is opened.
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		The connection SENSE <--> ABa1 is opened.
This measurement is repeated for all analog bus lines up to ABd2.		
If no contact is found in any of the analog bus lines, then the relay between DCS_LO and SENSE is very probably faulty.		



Test Case	Description	Test Sequence
		The test results are recorded in the SFT Report.
Relayfunction GND	Tests the function of the ground relays. Both ground relays are connected in series and short circuit the DCS with an analog bus line.	Measuring path: DCS_HI -> analog bus line -> MU_LO -> GND -> DCS_LO
		One or more matrix relays could be faulty, so the test looks for a functioning connection over the analog bus. For this test to work, the selected analog bus line must be safely isolated from the DCS_LO line! If this were not done, both insulation measurements of the ground relays would fail. This also applies if the relay between MU_LO and DCS_LO were to stick. This test case therefore tests the function of this relay as well.
		The DCS voltage is set to 0.3 V.
		The DCS current limiter is set to maximum value (100 mA).
		DCS_LO is switched to GND.
		MU_LO is switched to GND.
		DCS_HI is switched to an analog bus line.
		MU_LO is switched to an analog bus line.
		The DCS is switched on.
		The DCS must go into the current limiter. If it does, there is continuity, and all contact resistors are OK.
		The DCS is switched off.
		The connection DCS_HI <--> analog bus is opened.
		The connection MU_LO <--> analog bus is opened.
		If there is continuity
		The DCS is switched off.
		The connection DCS_LO <--> GND is opened.
		The DCS voltage is set to 5 V.
		The DCS current is set to the minimum value.
		The DCS is switched on.
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance. Therefore the relay between MU_LO and DCS_LO also isolates cleanly.
		DCS_LO is switched to GND.
		The connection MU_LO <--> GND is opened.
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.



Test Case	Description	Test Sequence
		The DCS is switched off.
		MU_LO is connected to DCS_LO via the configuration relay.
		The DCS voltage is set to 0.3 V.
		The DCS current limiter is set to maximum value (100 mA).
		The DCS is switched on.
		The DCS must go into the current limiter. The contact resistance has now been checked.
		MU_LO is switched to GND.
		The connection DCS_HI <--> analog bus is opened.
		The connection MU_LO <--> analog bus is opened.
		This measurement is repeated for all analog bus lines up to ABd2.
		The test results are recorded in the SFT Report.
MU Relayfunction HI	Tests the function of the relays on the MU_HI line. In this test, the relays of the DCS_HI line and the two ground relays must function. The low-resistance connection between MU_HI and MU_LO must also be guaranteed in the current measurement with the MU.	Measuring path: DCS_HI -> analog bus line -> MU_HI -> MU_LO -> GND -> DCS_LO
		The DCS voltage is set to 0.3 V.
		The DCS current limiter is set to maximum value (100 mA).
		DCS_LO is switched to GND.
		MU_LO is switched to GND.
		The MU is switched to the current measuring mode (100 mA range) (current measuring without shunt).
		DCS_HI is switched to the analog bus line.
		MU_HI is switched to the analog bus line.
		The DCS is switched on.
		The DCS must go into the current limiter. The contact resistance is therefore less than 3 Ohm
		The DCS is switched off.
		The connection MU_HI <--> analog bus is opened.
		If there was continuity, the DCS voltage is set to 5 V.
		The DCS current limiter is set to the minimum value.
		The DCS is switched on.



Test Case	Description	Test Sequence
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		The connection DCS_HI <--> analog bus is opened.
		This measurement is repeated for all analog bus lines up to ABd2.
		The test results are recorded in the SFT Report.
MU Relayfunction LO	Tests the function of the relays on the MU_LO line. In this test, the relays of the DCS_HI line and the two ground relays must function.	Measuring path: DCS_HI -> analog bus line -> MU_LO -> GND -> DCS_LO
		The DCS voltage is set to 0.3 V.
		The DCS current limiter is set to maximum value (100 mA).
		DCS_LO is switched to GND.
		MU_LO is switched to GND.
		The MU is switched to the voltage measurement mode (10 V range) (high-resistance input stage).
		DCS_HI is switched to the analog bus line.
		DCS_LO is switched to the analog bus line.
		The DCS is switched on.
		The DCS must go into the current limiter. The contact resistance is therefore less than 3 Ohm
		The DCS is switched off.
		The connection MU_LO <--> analog bus line is opened.
		If there was continuity, the DCS voltage is set to 5 V.
		The DCS current limiter is set to the minimum value.
		The DCS is switched on.
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		The connection DCS_HI <--> analog bus is opened.
		This measurement is repeated for all analog bus lines up to ABd2.
		The test results are recorded in the SFT Report.
MU Relayfunction SHI	Tests the function of the relays between SENSE and MU_SHI. This test assumes that a number of relays function correctly.	Measuring path: DCS_HI -> analog bus -> SENSE -> MU_SHI via 10kOhm on MU_HI -> second analog bus line -> DCS_LO

Test Case	Description	Test Sequence
		The DCS voltage is set to 5 V.
		The DCS current limiter is set to 450 μ A.
		DCS_LO is switched to GND.
		The connection MU <--> GND is opened.
		The following connections are made:
		DCS_HI <--> Analog bus
		Analog bus <--> SENSE
		SENSE <--> MU_SHI
		MU_HI <--> second analog bus line
		second analog bus line <--> DCS_LO
		The DCS is switched on.
		The DCS must go into the current limiter. The resistance is therefore less than 11 kOhm.
		The connection SENSE <--> MU_SHI is opened.
		If a contact was found, the DCS current limiter is set to the minimum value.
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		The test results are recorded in the SFT Report.
MU Relayfunction SLO	Tests the function of the relays between SENSE and MU_SLO.	tbd
		The test results are recorded in the SFT Report.
DCH Relays	Tests the function of the two relays on the DCH_HI line. The function of relays DCS_HI <--> ABA1 and DCS_LO <--> ABA2 must be guaranteed.	Measuring path: DCS_HI -> ABA1 -> DCH_HI -> ABA2 -> DCS_LO
		The DCS voltage is set to 0.5 V.
		The DCS current limiter is set to maximum value (100 mA).
		The connection DCS_LO <--> GND is opened.
		The following connections are made:
		DCS_HI <--> ABA1
		DCH_HI <--> ABA1
		DCH_HI <--> ABA2
		DCS_LO <--> ABA2
		The DCS is switched on.



Test Case	Description	Test Sequence
		The DCS must go into the current limiter. The resistance is therefore less than 5 Ohm.
		The DCS is switched off.
		The connection DCH_HI <--> ABa1 is opened.
		The connection DCH_HI <--> ABa2 is opened.
		If a contact was found, the DCS voltage is set to 5 V.
		The DCS current limiter is set to the minimum value.
		The DCS is switched on.
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		DCH_HI is switched to ABa1.
		The connection DCH_HI <--> ABa2 is opened.
		The test waits for a while because the complete DCH unit is on the DCS_HI line.
		The DCS must not go into the current limiter. The insulation resistance of the relay is therefore greater than the measurable insulation resistance.
		The connection DCH_HI <--> ABA1 is opened.
		The remaining connections are removed.
		The test results are recorded in the SFT Report.
MU DC Voltage	This test tests the MU and DCS together. The DCS unit generates DC voltages which are measured with the MU. The MU checks every possible setting of the amplifier stages. If all measurements fail, then the source is probably faulty. If the measurements within a certain range fail, then one amplifier stage in the measurement chain is probably faulty.	DCS_LO is switched to GND.
		The connection MU_LO <--> GND is opened.
		DCS_HI is switched to the analog bus.
		DCS_SHI is switched to the analog bus.
		MU_SHI is switched to the analog bus.
		DCS_LO is switched to the second analog bus.
		DCS_SLO is switched to the second analog bus.
		MU_SLO is switched to the second analog bus.
		Fixed DCS settings:
		Current limiter: 100 mA (fast loading of parasitic capacitors)



Test Case	Description	Test Sequence
		Fixed MU settings:
		Config: DC Volts
		Filter: 400 Hz
		The test results are recorded in the SFT Report.
MU DC Current	Tests the MU current ranges with the help of the DCS. All possible settings of the amplifier stages are checked.	DCS_LO is switched to GND.
		The connection MU_LO <--> GND is opened.
		DCS_HI is switched to the analog bus.
		DCS_SHI is switched to the analog bus.
		MU_SHI is switched to the analog bus.
		DCS_LO is switched to the second analog bus.
		DCS_SLO is switched to the second analog bus.
		MU_SLO is switched to the second analog bus.
		Fixed DCS settings:
		Voltage: +5 V or -5 V
		Fixed MU settings:
		Config: DC Current
		Filter: 400 Hz
		The test results are recorded in the SFT Report.
MU RMS-to-DC Converter	Tests the accuracy of the RMS-to-DC converter. This test is carried out with the DCS. The measuring unit is run in the "AC plus DC" mode. The coupling capacitor is linked out.	Fixed DCS settings:
		Current limiter: 100 mA (fast loading of parasitic capacitors)
		Fixed MU settings:
		Config: AC plus DC Volts
		Filter: 400 Hz
		The test results are recorded in the SFT Report.
MU Analog Trigger	Tests the analog trigger signals. Powering on the DCS generates a trigger event.	The DCS is connected to the MU with the analog bus.
		The connection MU <--> GND is opened.
		DCS_LO is switched to GND.
		The DCS current limiter is set to 0.1 mA.



Test Case	Description	Test Sequence
		The DCS voltage is set to 5 V.
		The trigger threshold for XTA1 is programmed to 4 V.
		The voltage measurement triggered by XTA1 is configured
		The DCS is switched on.
		The measurement result is read out. There must be no timeout. The result must be greater than 4 V.
		The DCS is switched off.
		The trigger threshold for XTA2 is programmed to 4 V.
		The voltage measurement triggered by XTA2 is configured
		The DCS is switched on.
		The measurement result is read out. There must be no timeout. The result must be greater than 4 V.
		The DCS is switched off.
		The DCS voltage is set to -5 V.
		The trigger threshold for XTA1 is programmed to -4 V.
		The voltage measurement triggered by XTA1 is configured
		The DCS is switched on.
		The measurement result is read out. There must be no timeout. The result must be greater than -4 V.
		The DCS is switched off.
		The trigger threshold for XTA2 is programmed to -4 V.
		The voltage measurement triggered by XTA2 is configured
		The DCS is switched on.
		The measurement result is read out. There must be no timeout. The result must be greater than -4 V.
		The DCS is switched off.
		The test results are recorded in the SFT Report.
MU AC Coupling	Tests the MU AC Coupling.	The DCS is connected to the MU.
		The MU is run in the AC voltage mode in the 1 V range
		Stimulus DC:
		The DCS generates a DC voltage of 1 V.
		The MU must not indicate any voltage.
		Stimulus AC:

Test Case	Description	Test Sequence
		The test results are recorded in the SFT Report.
DCH	Tests the function of the discharge circuit.	DCS_HI is switched to ABa1.
		DCS_LO is switched to GND.
		MU_HI is switched to ABa1.
		MU_LO is switched to GND.
		DCH_HI is switched to ABa1.
		MU settings:
		Function: DC Volt
		Range: 10 V
		Filter: 400 Hz
		The DCS is switched on.
		The DCH is switched on.
		The following settings are made for all ranges of the DCH unit:
		The DCH range is set.
		The DCS current limiter is set.
		The DCS voltage is set to 2 V.
		The DCS must go into the current limiter.
		The voltage is measured and recorded.
		The DCS voltage is set to -2 V.
		The DCS must go into the current limiter.
		The voltage is measured and recorded.
		The test results are recorded in the SFT Report.
Trigger Bus	Tests the function of the driver and receiver chips to the trigger bus.	A trigger pulse is configured with the help of IT1 on the current trigger bus line.
		A triggered voltage measurement is configured on the current trigger bus line.
		The trigger pulse is initiated.
		The test result is obtained. There must be no timeout.
		This measurement is repeated for all trigger bus lines.
		The test results are recorded in the SFT Report.



Test Case	Description	Test Sequence
Relays Multiplexer	The relay contacts of the two multiplexers can be tested with the self test board. This board contains connections between the local analog bus and the relay contacts. This test therefore also tests the plug-in contacts of the analog bus. (The test can only be carried out with the self test adapter connected to X10.)	The test results are recorded in the SFT Report.
External Trigger	Tests the function of the XTOx and XTlx signals. The outputs are connected to the trigger inputs via the self test board. (The test can only be carried out with the self test adapter connected to X10.)	Configure trigger pulse on XTO1 with the help of IT1.
		Configure triggered voltage measurement with XT11.
		Initiate trigger pulse.
		Get test result. There must be no timeout.
		Configure trigger pulse on XTO2 with the help of IT1.
		Configure triggered voltage measurement with XT12.
		Initiate trigger pulse.
		Get test result. There must be no timeout.
		The test results are recorded in the SFT Report.

4.6.4 Arbitrary Function Generator Module R&S TS-PFG

The Arbitrary Function Generator Module test consists of the following test cases:

- Initialization
- Device self test
- Configuration
- Coupling Relays
- Bus Isolation
- Matrix Relays
- Ground Relays
- Channel Connect Relay
- Function Generator
- Front Connector

Test Case	Description	Test Sequence
INIT	Initializes the module with the function <code>rspfg_InitWithOptions</code> .	The driver function <code>rspfg_InitWithOptions</code> is started.
Device SFT	Starts the Device Self Test.	The function <code>rspfg_self_test</code> is started.
Configuration	Reads the configuration of the module (firmware version, slot number, hardware code).	Starts the function <code>getConfiguration</code> .
Coupling Relays	The eight coupling relays are tested.	All eight coupling relays are closed.
		All relays on the lines CH1_HI, CH1_LO on the R&S TS-PFG board under test are closed.
		The test looks for a reference bus line -> Refline.
		MU_HI is switched to ABa1 and MU_LO to ABa2.
		The contact resistance of coupling relays ABa1 <--> LABa1 and ABa1 <--> LABa2 is measured.
		Coupling relay ABa1 <--> LABa1 is opened.
		The insulation resistance of coupling relays ABa1 <--> LABa1 is measured. If the measurement is OK, then ABa1 is the Refline.
		Coupling relay ABa1 <--> LABa1 is closed.



Test Case	Description	Test Sequence
		All bus lines are measured against the Refline.
		The contact resistance of coupling relays Refline (ABa1) and ABa2 <--> LABa2 is measured.
		Coupling relay ABa2 <--> LABa2 is opened.
		The insulation resistance of coupling relay ABa2 <--> LABa2 is measured.
		Coupling relay ABa2 <--> LABa2 is closed.
		The coupling relays of the other buses are measured in the same way. Reflin(ABa1) - ABb1, Reflin(ABa1) - ABb2, Reflin(ABa1) - ABc1, Reflin(ABa1) - ABc2, Reflin(ABa1) - ABd1, Reflin(ABa1) - ABd2
		At the end of the test case, all coupling and matrix relays are opened again by calling the function <code>rspfg_reset()</code> .
Bus Isolation	Tests the insulation resistance between all buses and all bus lines to Ground.	All coupling relays are closed.
		MU_LO is switched to ABa1 and MU_HI to ABa2.
		The insulation resistance between LABa1 and LABa2 is measured.
		MU_HI is switched to ABb1.
		The insulation resistance between LABa1 and LABb1 is measured.
		MU_HI is switched to ABb2.
		The insulation resistance between LABa1 and LABb2 is measured.
		The insulation resistance of all buses and bus lines up to LABd2 is measured in the same way.
		The MU is reset.
		MU_HI is switched to ABa1.
		MU_LO is switched to Ground.
		The insulation resistance between ABa1 and Ground is measured.
		The connections of MU_LO and MU_HI are opened again.
		MU_LO is switched to ABa2 and MU_HI to ABb1.
		The insulation resistance between LABa2 and LABb1 is measured.
		MU_HI is switched to ABb2.



Test Case	Description	Test Sequence
		The insulation resistance between LABa2 and LABb2 is measured.
		The insulation resistance of all buses and bus lines up to LABd2 is measured in the same way.
		This process is now repeated until measurements have been carried out between all the bus lines and between each individual bus line and Ground.
		At the end of the test case, all coupling relays are opened again by calling the function <code>rspfg1_reset()</code> .
Matrix Relays	Tests all matrix relays.	All coupling relays are closed.
		MU_LO is switched to ABa1.
		MU_HI is switched to ABa2.
		CH1_HI on LABa1 is closed.
		CH1_HI on LABa1 is closed.
		The contact resistance is measured.
		CH1_HI on LABa1 is closed.
		The insulation resistance is measured (CH1_HI on LABa1).
		CH1_HI on LABa1 is closed.
		CH1_HI on LABa2 is closed.
		The insulation resistance is measured (CH1_HI on LABa2).
		CH1_HI on LABa1 is closed.
		This measurement is now repeated with all matrix relays on all eight buses.
		All coupling relays are opened.
Ground Relays	Tests the GROUND relays which connect the LO lines of channels CH1 and CH2 to Ground.	MU_LO is switched to AGND.
		MU_HI is switched to ABa1.
		Coupling relay ABa1 <--> LABa1 is closed.
		CH1_LO on LABa1 is closed.
		The GROUND relay that connects CH1_LO to AGND is closed.



Test Case	Description	Test Sequence
		The contact resistance is measured.
		The GROUND relay that connects CH1_LO to AGND is opened.
		The insulation resistance is measured.
		CH1_LO on LABa1 is opened.
		The same measurement is carried out with CH2_LO.
Channel Connect Relay	Tests the relays that connects CH1_LO with CH2_HI.	MU_HI is switched to ABa1.
		MU_LO is switched to ABa2.
		The coupling relays between ABa1-LABa1 and ABa2-LABa2 are closed.
		CH1_LO on LABa1 is closed.
		CH2_HI on LABa2 is closed.
		The relay between CH1_LO and CH2_HI is closed.
		The contact resistance is measured.
		The relay between CH1_LO and CH2_HI is opened.
		The insulation resistance is measured.
Function Generator	Tests the signal generators of CH1 and CH2.	MU_LO is switched to ABa1.
		MU_HI is switched to ABa2.
		The coupling relays between ABa1-LABa1 and ABa2-LABa2 are closed.
		CH1_LO on LABa1 is closed.
		CH1_HI on LABa1 is closed.
		An output signal of 1 kHz and 10 Vpp is generated on CH1.
		The RMS value is measured(3.536 V).
		CH1_LO on LABa1 is opened.
		CH1_HI on LABa2 is closed.
		The same measurement is repeated with CH2.
Front Connector	Tests the connections to the front connector X10. (This test can only be carried out with the self test adapter connected.)	All coupling relays are closed.

Test Case	Description	Test Sequence
		MU_LO is switched to ABa1.
		MU_HI is switched to ABa2.
		The contact resistance is measured.
		The test is repeated with the buses ABb1 - ABb2, ABc1 - ABc2 and ABd1 - ABd2.

4.6.5 InCircuit Test Module R&S TS-PICT

The InCircuit Test Module test consists of the following test cases:

- Initialization
- Device self test
- Configuration
- Bus Isolation
- Matrix Relays

Testcase	Description	Test Sequence
INIT	Initializes the module with the function <code>rspict_InitWithOptions</code> .	The driver function <code>rspict_InitWithOptions</code> is started.
Device SFT	Starts the Device Self Test.	The function <code>rspict_self_test</code> is started.
Configuration	Reads the configuration of the module (firmware version, slot number, hardware code).	The function <code>getConfiguration</code> is started.
Bus Isolation	Tests the insulation resistance between all buses and all bus lines to Ground.	MU_LO is switched to ABa1 and MU_HI to ABa2.
		The MU is reset.
		The DCS is set to 5.0 V and 10.0 μ A.
		All coupling relays of the MU are closed.
		DCS_LO is switched to Ground.
		DCS_HI is switched to ABa1.
		The DCS is energized, its status interrogated and it is then de-energized again immediately.
		If the DCS was in the current limit, then the insulation resistance is < 500 kOhm and the test was FAILED, otherwise PASSED



Testcase	Description	Test Sequence
		MU_HI is switched to ABa2.
		The DCS is energized, its status interrogated and it is then de-energized again immediately.
		If the DCS was in the current limit, then the insulation resistance is < 500 kOhm and the test was FAILED, otherwise PASSED
		The insulation resistance of all buses and bus lines up to LABd2 is measured in the same way.
		The MU is reset.
		MU_LO is switched to ABa1 and MU_HI to ABa2.
		The insulation resistance between LABa1 and LABa2 is measured.
		MU_HI is switched to ABb1.
		The insulation resistance between LABa1 and LABb1 is measured.
		The insulation resistance of all buses and bus lines up to LABd2 is measured in the same way.
		MU_LO is switched to ABa2 and MU_HI to ABb1.
		The insulation resistance between LABa2 and LABb1 is measured.
		MU_HI is switched to ABb2.
		The insulation resistance between LABa2 and LABb2 is measured.
		The insulation resistance of all buses and bus lines up to LABd2 is measured in the same way.
		This process is now repeated until all the bus lines have been tested one to the other.
		The MU is reset.
		If this test case ended with FAILED, all the following tests cases are skipped.
Matrix Relays	Tests all matrix relays.	MU_LO is switched to ABa1.
		MU_HI is switched to ABa2.
		The relays between AOS_HI - ABa1 and between AOS_HI - ABa2 are closed.
		The contact resistance is measured.
		The relay between AOS_HI - ABa1 is opened.
		The insulation resistance is measured.



Testcase	Description	Test Sequence
		The relay between AOS_HI - ABa1 is closed and the relay between AOS_HI - ABa2 is opened.
		The insulation resistance is measured.
		The relays between AOS_HI - ABa1 and between AOS_HI - ABa2 are both opened.
		The relays between CMU_HI - ABa1 and CMU_HI - ABa2 are closed.
		The contact resistance is measured.
		The relay between CMU_HI - ABa1 is opened.
		The insulation resistance is measured.
		The relay between CMU_HI - ABa1 is closed and the relay between CMU_HI - ABa2 is opened.
		The insulation resistance is measured.
		The relays between CMU_HI - ABa1 and between CMU_HI - ABa2 are both opened.
		MU_LO is switched to ABb1.
		MU_HI is switched to ABb2.
		The relays between AOS_HI - ABb1 and between AOS_HI - ABb2 are closed.
		The contact resistance is measured.
		The relay between AOS_HI - ABb1 is opened.
		The insulation resistance is measured.
		The relay between AOS_HI - ABb1 is closed and the relay between AOS_HI - ABb2 is opened.
		The insulation resistance is measured.
		The relays between AOS_HI - ABb1 and between AOS_HI - ABb2 are both opened again.
		The contact resistance and the insulation resistance is measured on all matrix relays in the same way.
Check AOS	Tests the function of the AOS on the R&S TS-PICT module with the R&S TS-PSAM module.	MU_LO is switched to ABc1.
		MU_HI is switched to ABa1.
		The relays between AOS_HI - ABa1 and GND - ABc1 are closed.



Testcase	Description	Test Sequence
		The AOS output signal is configured: DC: +5 V, 0 V, -5 V AC (1 kHz): 0.1 V, 0.2 V, 1.0 V
		The output of the AOS is activated.
		The RMS value is measured with the R&S TS-PSAM module.
		The output of the AOS is de-activated.
		The relays between AOS_HI - ABa1 and GND - ABc1 are opened.
Check CMU	Tests the function of the CMU on the R&S TS-PICT module with the R&S TS-PSAM module.	DCS_HI and DCS_SHI (R&S TS-PSAM) are switched to ABa1. DCS_LO and DCS_SLO are switched to ABc1.
		All coupling relays on the R&S TS-PSAM are closed.
		The individual ranges of the CMU are now tested with the DCS on the R&S TS-PSAM. AC: 1 μ A, 2 μ A DC: 20 μ A, 200 μ A, 2 mA, 20 mA, 50 mA, 100 mA, 200mA The reference resistance (3.3 kOhm) is inserted on the R&S TS-PICT for the three smallest ranges (1 μ A, 2 μ A, 20 μ A).
		The results are compared with their limits and recorded in the SFT Report.
Check AOS OutRes	Tests the output resistors of the AOS. (This test case is only run when the CheckAOS and CheckCMU tests cases have been passed)	The relays between AOS_HI - ABa1 and CMU_HI - ABa1 are closed.
		Configure the AOS output signal (0.1 V) Output resistance: 0 Ohm 10 Ohm 100 Ohm 1000 Ohm
		Configure the CMU for the current measurement.
		The output of the AOS is activated.
		The current is measured with the CMU and the output resistance of the AOS is computed together with the selected AOS output voltage (0.1 V).
		The output of the AOS is de-activated.
		The measurement is carried out separately for all four possible output resistances of the AOS.



Testcase	Description	Test Sequence
Check RefComp	Tests the reference components on the PICT module (R,C) and the relays that switch them to the analog bus (this test case is only run when the CheckAOS and CheckCMU test cases have been passed)	MU_LO is switched to ABa1.
		MU_HI is switched to ABb1.
		The relays between REF_RC - ABa1 and REF_COM - ABb1 are closed.
		The resistance is measured.
		The relay between REF_COM - ABb1 is opened.
		The insulation resistance is measured.
		The relay between REF_COM - ABb1 is closed again and the relay between REF_RC - ABa1 is opened.
		The insulation resistance is measured.
		The MU is disconnected from the analog bus.
		The relays between REF_RC - ABa1 and REF_COM - ABb1 are closed.
		AOS_HI is switched to ABa1 and CMU_HI is switched to ABb1.
		The AOS is switched to the AC mode.
		The CMU is configured.
		The AOS is configured.
		The AOS output is activated.
		The current is measured with the CMU.
		The AOS output is deactivated.
		The RMS value of the measured current is computed and stored in the result array.
		The measurement is now repeated with the frequencies 100 Hz, 1 kHz, 10 kHz
		The R&S TS-PICT is reset and the test results recorded in the SFT Report.
Trigger Bus Input	Tests the trigger input ports PXI0 to PXI7	For all lines PXI0 to PXI7
		SFT DMM generates a trigger signal on PXI
		TS-PICT performs a dummy current measurement
		first measurement without trigger must run into timeout
		second measurement must return correct values
Trigger Bus Output	Tests the trigger output ports PXI0 to PXI7	For all lines PXI0 to PXI7
		TS-PICT generates a trigger signal on PXI



Testcase	Description	Test Sequence
		SFT DMM performs a dummy current measurement
		first measurement without trigger must run into timeout
		second measurement must return correct values

4.6.6 Digital Functional Test Module R&S TS-PDFT

The Digital Functional Test Module test consists of the following test cases:

- Initialization
- Configuration
- Device self test
- Check Static Pattern
- Check Level
- Check Dynamic Pattern
- Check Trigger Bus
- Check Aux Relais
- Check Remaining DIN / DOUT lines
- Check Dynamic Pattern over X10

Test Case	Description	Test Sequence
INIT	Initializes the module with the function <code>rspdft_InitWithOptions</code> .	The driver function <code>rspdft_InitWithOptions</code> is started.
Configuration	Reads the configuration of the module (firmware version, slot number, hardware code).	The function <code>getConfiguration</code> is started.
Device SFT	Starts the Device Self Test.	The function <code>rspdft_self_test</code> is started.
Check Static Pattern	Runs a static pattern test.	A pattern is generated.
		The mode is configured.
		The outputs (DOUT) are configured. 5.0 V 500 mA
		The inputs (DIN) are configured. threshold1 = 2.0 V threshold2 = 2.0 V
		The inputs (DIN) and the outputs (DOUT) are connected to each other for the loop back test.
		The Pattern is prepared.
		The Pattern is executed.



Test Case	Description	Test Sequence
		The inputs (DIN) are read and the result stored in an array.
		This test is now repeated with the following pattern: 0x00000000, 0x00000001, 0x00000002, 0x00000004, 0x00000008, 0x00000010, 0x00000020, 0x00000040, 0x00000080, 0x00000100, 0x00000200, 0x00000400, 0x00000800, 0x00001000, 0x00002000, 0x00004000, 0x00008000, 0x00010000, 0x00020000, 0x00040000, 0x00080000, 0x00100000, 0x00200000, 0x00400000, 0x00800000, 0x01000000, 0x02000000, 0x04000000, 0x08000000, 0x10000000, 0x20000000, 0x40000000, 0x80000000, 0x7b7b7b7b, 0xb7b7b7b7, 0xffffffff All 36 patterns have now been executed and read back.
		The inputs (DIN) and the outputs (DOUT) are separated from one another.
		The last pattern is run again to see whether all DIN / DOUT connections have been separated.
		The ResponsePattern Array is compared with the StimulusPattern Array.
Check Level	Tests the output levels of the outputs (DOUT) and the voltage thresholds of the inputs (DIN).	A pattern is generated.
		The mode is configured.
		The outputs (DOUT) are configured (Analog Mode): 9.0 V 500 mA
		The inputs (DIN) are configured. threshold1 = 9.5 V threshold2 = 8.5 V
		The inputs (DIN) and the outputs (DOUT) are connected to each other for the loop back test.
		The pattern (0xffffffff) is prepared.
		The Pattern is executed.
		The inputs (DIN) are read and the result stored in an array.
		The inputs (DIN) are configured. threshold1 = 10.0 V threshold2 = 9.6 V
		The inputs (DIN) are read and the result stored in an array.
		The outputs (DOUT) are configured. 3.3V (TTL Mode)

Test Case	Description	Test Sequence
		The inputs (DIN) are configured. threshold1 = 3.8 V threshold2 = 2.8 V
		The inputs (DIN) are read and the result stored in an array.
		The inputs (DIN) are configured. threshold1 = 4.9 V threshold2 = 3.9 V
		The inputs (DIN) are read and the result stored in an array.
		At the end of the test case, the set levels and the read response patterns are recorded in the Self test Report.
Check Dynamic Pattern	Runs a dynamic pattern test.	The memory for stimulus and response pattern set is reserved.
		The ports are configured.
		The mode is configured.
		The inputs (DIN) and the outputs (DOUT) are connected to one another.
		The data buffer is filled with 36 patterns.
		The Stimulus and Response mode is configured.
		The Timing is configured.
		The Patternset is loaded.
		The Patternset is executed.
		The Patternset is read back.
		The response Patternset is compared with the stimulus Patternset.
Check Trigger Bus	Tests the trigger bus output buffer and input ports. A trigger signal is send to itself and via trigger bus to the SFT-DMM module. For that reason the measurement unit is configured for external trigger input.	For all lines PXI0 to PXI7
		configure TS-PDFT GP to trigger output configure TS-PDFT for external trigger input configure SFT DMM to external trigger
		generate a trigger puls
		read the TS-PDFT response data; read the result from the SFT DMM



Test Case	Description	Test Sequence
Check AUX Relais	Tests all AUX relays (The self test adapter must be connected for this test.)	All connections between the inputs (DIN) and the outputs (DOUT) are disconnected.
		A Pattern is generated..
		The mode is configured.
		The outputs (DOUT) are configured.
		The inputs (DIN) are configured.
		Now only one bit in the pattern (for the channels OUT1 to OUT4) is set to high at a time.
		The corresponding AUX relay is closed.
		The prepared Pattern is executed.
		The Pattern is read back.
		The test checks whether the right bit is set to high.
		The AUX relay is opened.
		The Pattern is executed again.
		The Pattern is read back.
		The test now checks whether no single bit is set to high.
This check is repeated for all four AUX relays.		
Check Remaining DIN / DOUT lines	The remaining DIN / DOUT channels are tested (all the channels that have not been tested with the AUX relay test).	All connections between the inputs (DIN) and the outputs (DOUT) are disconnected.
		A Pattern is generated..
		The mode is configured.
		The outputs (DOUT) are configured.
		The inputs (DIN) are configured.
		Now only one bit in the pattern (for the remaining channels OUT5 to OUT32) is set to high at a time.
		The prepared Pattern is executed.
		The Pattern is read back.
		The test checks whether the right bit is set to high.
		The check is now repeated for all the remaining channels (OUT5 to OUT32)
Dynamic Pattern over X10 (The self test adapter 1 must be connected for this test.)	Identical to Testcase "Check Dynamic Pattern" but the inputs and output are connected in the self test adapter	

Test Case	Description	Test Sequence
Serial Interface (The self test adapter 1 must be connected for this test.)	Tests the serial interfaces (RS232, TTL, K-Bus) using loopbacks in the self test adapter 1	configure the interface
		prepare the data buffers
		read and discard bogus data coming from configuration
		send / receive data
		compare the send and received data
Max Load Test (The self test adapter 2 must be connected for this test.)	Tests the digital outputs with loads in the self test adapter 2	configure a loop back test
		For some pattern
		execute a static pattern fetch the response result evaluate the result

4.6.7 Analyzer Module R&S TS-PAM

4.6.7.1 Initialization

4.6.7.1.1 Description

The driver is opened. For this, the „Resource Descriptor“ and the optional „Option String“ from the Physical INI File are used. If the initialization of the driver fails, the test for the module is aborted.

4.6.7.1.2 Sequence

The function `rspam_InitWithOptions` is called.

4.6.7.2 Configuration

4.6.7.2.1 Description

The current configuration parameters (Driver and Firmware version, assigned slot, Hardware Code) are determined. The „Option String“ used during the initialization is shown in the report.

4.6.7.2.2 Sequence

Call of the function `rspam_revision_query` and query of the attribute `RSPAM_ATTR_SLOT_NUMBER` and `RSPAM_ATTR_HW_CODE`.

4.6.7.3 Device Self Test

4.6.7.3.1 Description

The self-test function in the driver is started. This function conducts internal tests on the component and when there is an error, delivers a message on the first error found.

4.6.7.3.2 Sequence

Call of the function `rspam_self_test`.

4.6.7.4 External Voltage

4.6.7.4.1 Description

The coupling relays on the component are closed. Then, voltage measurements between each individual bus line and GND and between all bus lines are carried out. If too high a level is measured, the self-test for this component must be aborted.

4.6.7.4.2 Sequence

- Close coupling relay
- Connect `DMM_LO` with `GND`
- For all bus lines
 - Switch `DMM_HI` to the line to be tested
 - Carry out voltage measurement
 - Disconnect `DMM_HI` from the bus line
- Disconnect `DMM_LO` from `GND`
- For all combinations of bus lines
 - Switch `DMM_LO` to the first line
 - Switch `DMM_HI` to the second line
 - Carry out voltage measurement
 - Disconnect `DMM_LO` from the bus line
 - Disconnect `DMM_HI` from the bus line

4.6.7.5 Bus Isolation

4.6.7.5.1 Description

The coupling relays on the component are closed and the insulation resistance of the bus lines with each other and the resistance of the single bus lines against `GND` is measured. For the measurement against `GND`, the `DCS` is used, because high-ohm resistors against `GND` cannot be carried out with the resistance measuring function in the Mode V (voltage injection and current measurement) of the R&S TS-PSAM module.

To determine whether the minimum permitted resistance of a bus line against `GND` is not reached, `DCS_LO` is connected with `GND` and `DCS_HI` switched to the line to be tested. A voltage of 5 V and a current limit of 10 μA gives a threshold of the 500 kOhm. If the insulation resistance is low, the source goes into the current limit and thus displays an



error.

The insulation resistance between two bus lines is measured in the 10 MΩ range of the resistance measuring function. If too low a resistance is found, then the measurement with Autorange switched on is repeated to determine the exact value.

4.6.7.5.2 Sequence

Test all bus lines against GND.

Test all combinations of bus lines against one another.

Temporarily store result for the test of the relay on the bus lines.

4.6.7.6 Coupling Relays Bus Lines A, B

4.6.7.6.1 Description

The function of the coupling relay of the four bus lines ABa1, ABa2 , ABb1 and ABb2 is tested. For each relay, a contact and insulation measurement is carried out. During the measurement of the contact resistance, the serial connection of multiple relays is always measured.

4.6.7.6.2 Sequence

The coupling relay is tested together with the matrix relay. Here, measuring path is always set up as follows:

DMM_HI - LABx (PSAM) - ABx <Kx> LABx - CHzn - LABy <Ky> ABY - LABy (PSAM)
- DMM_LO

Signal	Comment
DMM_HI	HI line of the resistance measuring unit
LABx (PSAM)	HI line on local analog bus R&S TS-PSAM
ABx	HI line on analog bus
Kx	Coupling relay in the HI line
LABx	HI line on local analog bus R&S TS-PAM
CHzn	Device connection R&S TS-PAM
LABy	LO line on local analog bus R&S TS-PAM
Ky	Coupling relay in the LO line
ABy	LO line on analog bus

Signal	Comment
LAB _y (PSAM)	LO line on local analog bus R&S TS-PSAM
DMM_LO	LO line of the resistance measuring unit

Two bus lines are always selected which show no short circuit with each other. For this, the result of the bus insulation measurement is used.

If the measuring path shows a low-ohm connection, the measured value is recorded as contact resistance for both relays (K_x and K_y). Then, K_x and K_y are individually opened and on each a insulation measurement is carried out.

If no low-ohm connection is detected, one of the four relays on the module R&S TS-PAM does not close. No insulation measurement for the coupling relay can thus be carried out. The measurement is repeated with the next device channel CH_{zn}. If on all lines CH_{zn} no connection is found, there is probably a defective coupling relay.

The measurements are repeated for all bus lines AB_x.

4.6.7.7 Coupling Relays Bus Lines C, D

The function of the coupling relay of the four bus lines AB_{c1}, AB_{c2}, AB_{d1} and AB_{d2} is tested. The test procedure is the same as in Section 4.6.7.6

4.6.7.8 Matrix Relays Bus Lines A, B

4.6.7.8.1 Description

The function of the relay on the analog bus lines is tested. For each relay, a contact and insulation measurement is carried out. During the measurement of the contact resistance, the serial connection of multiple relays is always measured.

4.6.7.8.2 Sequence

A measuring path is always set up as follows:

DMM_HI - LAB_x (PSAM) - AB_x - LAB_x <K_x> CH_{zn} <K_y> LAB_y - AB_y - LAB_y (PSAM)
 - DMM_LO

Signal	Comment
DMM_HI	HI line of the resistance measuring unit
LAB _x (PSAM)	HI line on local analog bus R&S TS-PSAM
AB _x	HI line on analog bus
LAB _x	HI line on local analog bus R&S TS-PAM
K _x	Matrix relay in the HI line
CH _{zn}	Device connection R&S TS-PAM
K _y	Matrix relay in the LO line
LAB _y	LO line on local analog bus R&S TS-PAM
AB _y	LO line on analog bus
LAB _y (PSAM)	LO line on local analog bus R&S TS-PSAM
DMM_LO	LO line of the resistance measuring unit

Two bus lines are always selected which show no short circuit with each other. For this, the result of the bus insulation measurement is used.

If the measuring path shows a low-ohm connection, the measured value is recorded as contact resistance for both relays (K_x and K_y). Then, K_x and K_y are individually opened and on each a insulation measurement is carried out.

If no low-ohm connection is detected, one of the four relays on the module R&S TS-PAM does not close. No insulation measurement for the matrix relay can thus be carried out. The two relays are marked and in a second run, individually tested against a functioning relay according to the same procedure.

The measurements are repeated for all bus lines AB_x.

4.6.7.9 Matrix Relays Bus Lines C, D

The function of the matrix relay of the bus lines AB_c1, AB_c2, AB_d1 and AB_d2 is tested. The test procedure is the same as in Section 4.6.7.8

4.6.7.10 Ground Relays

4.6.7.10.1 Description

The relays against ground for both data acquisition paths are tested. The DCS with the adjustable current limit is used for evaluation. The DCS is wired as follows:

DCS_LO to ABa1, ABc1 and GND

DCS_HI to ABb1, ABd1

All coupling relays on R&S TS-PSAM and R&S TS-PAM are closed.

The settings for the source were selected as follows:

Type of measurement	Voltage in V	Current limit in A	Comment
Contact measurement	0.7	10e-3	Threshold at 70 Ohm because of the 50 Ohm resistance against GND
Insulation measurement	5.0	10e-6	Threshold at 500 kOhm

The following signal paths were selected on the module:

ABb1 - CHA1_HI - CHA_LO <RY29> GND

ABb1 - CHB1_HI - CHB_LO <RY30> GND

4.6.7.10.2 Sequence

- DCS is switched to the analog bus
- For all data acquisition paths
 - Set DCS for the contact measurement
 - Set up measuring path
 - Query DCS status
 - Open relay against ground
 - If DCS is in the current limit, the contact measurement was successful and the insulation measurement can be carried out. Otherwise the insulation measurement is left out.
 - Insulation measurement: Configure DCS for the insulation measurement, query DCS status
 - Remove measuring path



4.6.7.11 CHx_LO to CHxy_HI Relays

4.6.7.11.1 Description

The relays between CHx_LO and CHxy_HI for both data acquisition paths and all oscilloscope channels are tested. The DCS with the adjustable current limit is used for evaluation. The DCS is wired as follows:

DCS_LO to ABa1, ABc1 and GND

DCS_HI to ABb1, ABd1

All coupling relays on R&S TS-PSAM and R&S TS-PAM are closed.

The settings for the source were selected as follows:

Type of measurement	Voltage in V	Current limit in A	Comment
Contact measurement	0.7	10e-3	Threshold at 70 Ohm because of the 50 Ohm resistance against GND
Insulation measurement	5.0	10e-6	Threshold at 500 kOhm

The following signal paths were selected on the module:

Data acquisition path A:

ABb1 - CHA1_HI <RY55> CHA_LO - GND
 ABb1 - CHA2_HI <RY56> CHA_LO - GND
 ABd1 - CHA3_HI <RY57> CHA_LO - GND
 ABd1 - CHA4_HI <RY58> CHA_LO - GND

Data acquisition path B:

ABb1 - CHB1_HI <RY59> CHB_LO - GND
 ABb1 - CHB2_HI <RY60> CHB_LO - GND
 ABd1 - CHB3_HI <RY61> CHB_LO - GND
 ABd1 - CHB4_HI <RY62> CHB_LO - GND

4.6.7.11.2 Sequence

- DCS is switched to the analog bus
- The following run is carried out for both data acquisition paths:
 - Connect CH_x_LO with GND
 - The following procedure is carried out for all oscilloscope channels:
 - * Set DCS for the contact measurement
 - * Set up measuring path
 - * Query DCS status
 - * Open relay to be tested
 - * If DCS is in the current limit, the contact measurement was successful and the insulation measurement can be carried out. Otherwise the insulation measurement is left out.
 - * Insulation measurement: Configure DCS for the insulation measurement, query DCS status
 - * Remove measuring path
 - Disconnect CH_x_LO from GND



4.6.7.12 Amplifier Offset

4.6.7.12.1 Description

The offset error of the oscilloscope channels is determined. The data acquisition path is thus connected with GND. The input is connected with CH_x_LO and the offset error measured in each range.

The following settings are selected:

Input impedance:	200 mV to 5 V: 10 MΩ;
	10 V to 100 V: 1 MΩ
Filter:	400 Hz
Observation time:	20.0 ms
Sampling values:	1000

The average value is taken from the sample values.

4.6.7.12.2 Sequence

- For each data acquisition path
 - Connect CH_x_LO with GND
 - For each oscilloscope channel
 - * Connect CH_x_LO with CH_{xy}_HI
 - * For each measurement range
 - Set range
 - Carry out measurement
 - * Disconnect CH_x_LO from CH_{xy}_HI
 - Disconnect CH_x_LO from GND

4.6.7.13 Amplifier Gain

4.6.7.13.1 Description

The oscilloscope channels are provided with a DC Voltage. The LO line of the source (DCS on R&S TS-PSAM) is connected with GND, the data acquisition paths are ungrounded.

The following settings are selected:

Input impedance:	200 mV to 5 V: 10 M Ω
	10 V to 100 V: 1 M Ω
Filter:	400 Hz
Observation time:	20.0 ms
Sampling values:	1000

The average value is taken from the sample values.

The DCS is wired as follows:

DCS_LO to ABa1, ABc1 and GND

DCS_HI to ABb1, ABd1

All coupling relays on R&S TS-PSAM and R&S TS-PAM are closed.

4.6.7.13.2 Sequence

- DCS is switched to the analog bus
- For each data acquisition path
 - For each oscilloscope channel
 - * Connect channel with analog bus
 - * For each measurement range
 - Set range
 - Set source
 - Carry out measurement
 - * Disconnect channel from the analog bus

4.6.7.14 Scanner Offset

4.6.7.14.1 Description

The offset error of the scanner is checked. To do this, all oscilloscope channels of a data acquisition path are connected with one another and switched to GND. All possible combinations of the channels are measured:

Data acquisition path A:

CHA1-CHA2
 CHA1-CHA3
 CHA1-CHA4
 CHA2-CHA3
 CHA2-CHA4
 CHA3-CHA2
 CHA3-CHA4
 CHA4-CHA2
 CHA4-CHA3

Data acquisition path B:

CHB1-CHB2
 CHB1-CHB3
 CHB1-CHB4
 CHB2-CHB3
 CHB2-CHB4
 CHB3-CHB2
 CHB3-CHB4
 CHB4-CHB2
 CHB4-CHB3

The following settings are selected:

Range: 200 mV
 Input impedance: 10 MΩ
 Filter: 400 Hz
 Observation time: 20.0 ms
 Sampling values: 1000

The average value is taken from the sample values.

4.6.7.14.2 Sequence

- For each data acquisition path
 - Connect CH_x_LO with GND
 - Connect CH_x_LO with the four channels CH_{xy}_HI
 - For each combination of oscilloscope channels
 - * Configure channels

- * Carry out measurement
- Disconnect CH_x_LO from the four channels CH_xy_HI
- Disconnect CH_x_LO from GND

4.6.7.15 Scanner Gain

4.6.7.15.1 Description

The oscilloscope channels are provided with a DC Voltage. The LO line of the source (DCS on R&S TS-PSAM) is connected with GND, the data acquisition paths are ungrounded. All possible combinations of the channels are measured:

Data acquisition path A:

CHA1-CHA2
 CHA1-CHA3
 CHA1-CHA4
 CHA2-CHA3
 CHA2-CHA4
 CHA3-CHA2
 CHA3-CHA4
 CHA4-CHA2
 CHA4-CHA3

Data acquisition path B:

CHB1-CHB2
 CHB1-CHB3
 CHB1-CHB4
 CHB2-CHB3
 CHB2-CHB4
 CHB3-CHB2
 CHB3-CHB4
 CHB4-CHB2
 CHB4-CHB3

The following settings are selected:

Range:	1 V
Input impedance:	10 MΩ
Filter:	400 Hz
Observation time:	20.0 ms
Sampling values:	1000

The average value is taken from the sample values.

The DCS is wired as follows:

DCS_LO to ABa1, ABc1 and GND

DCS_HI to ABb1, ABd1

The source is set as follows:

Voltage: 1 V

Current limit: 1 mA

All coupling relays on R&S TS-PSAM and R&S TS-PAM are closed.

4.6.7.15.2 Sequence

- DCS is switched to the analog bus
- For each data acquisition path
 - For each combination of oscilloscope channels
 - * Connect channel 1 with bus line LO
 - * Connect channel 2 with bus line HI
 - * Configure channels
 - * Carry out measurement
 - * Disconnect channel 1 from bus line LO
 - * Disconnect channel 2 from bus line HI

4.6.7.16 Filter DC

4.6.7.16.1 Description

The signal path through the filter is tested. For this, a DC Signal is used. So that each filter is controlled, the three filter settings are tested with two different connections of the oscilloscope channels:

Data acquisition path A:

CHA2-CHA3

CHA3-CHA2

Data acquisition path B:

CHB2-CHB3

CHB3-CHB2

Channel 1 is connected with DCS_HI, channel 2 with DCS_LO.

The following settings are selected:

Range:	1 V
Input impedance:	10 M Ω
Filter:	400 Hz
Observation time:	20.0 ms
Sampling values:	1000

The average value is taken from the sample values.

The DCS is wired as follows:

DCS_LO to ABa1, ABc1 and GND

DCS_HI to ABb1, ABd1

The source is set as follows:

Voltage:	1 V
Current limit:	1 mA

All coupling relays on R&S TS-PSAM and R&S TS-PAM are closed.



4.6.7.16.2 Sequence

- DCS is switched to the analog bus
- For each data acquisition path
 - For the two combinations of the oscilloscope channels
 - * Connect channel 1 with bus line LO
 - * Connect channel 2 with bus line HI
 - * Configure channels
 - * For all filter settings
 - Select filter
 - Carry out measurement
 - * Disconnect channel 1 from bus line LO
 - * Disconnect channel 2 from bus line HI

4.6.7.17 DAC

4.6.7.17.1 Description

The function of the digital to analog converter (DAC) is tested. The data acquisition path is connected with GND. Each oscilloscope channel is connected one after another with the associated DAC. The following measurements are carried out:

DAC voltage in V	Measurement range in V
0.0	0.2
0.5	1.0

The following settings are the same for all measurements:

Input impedance: 10 MΩ
 Filter: 400 Hz
 Observation time: 20.0 ms
 Sampling values: 1000

The average value is taken from the sample values.

4.6.7.17.2 Sequence

- For each data acquisition path
 - Connect CH_x_LO with GND
 - For each oscilloscope channel
 - * Connect UREF_{xy} with CH_{xy}_HI
 - * For each voltage
 - Set range
 - Set DAC
 - Carry out measurement
 - * Disconnect UREF_{xy} from CH_{xy}_HI
 - Disconnect CH_x_LO from GND

4.6.7.18 DAC Multi Channel

4.6.7.18.1 Description

During this test, both data acquisition paths are tested one after another as follows. Each path is connected with GND. Each oscilloscope channel is connected with the associated DAC. Each DAC supplies different voltage:

Channel	Voltage in V
CHx1	0.25
CHx2	0.50
CHx3	0.75
CHx4	1.00

All oscilloscope channels are simultaneously started and record the voltages quasi simultaneously with the maximum possible sampling rate.

The following settings are the same for all measurements:

Range: 1 V
 Input impedance: 10 MΩ
 Filter: off
 Observation time: 6.5536 ms
 Sampling values: 32768

The average, minimum and maximum value is determined from the sample values. Also the number of the sample values which lie outside the tolerance band are recorded.

4.6.7.18.2 Sequence

- For each data acquisition path
 - Connect CHx_LO with GND
 - connect all four UREFxy with associated CHxy_HI
 - Set all four DAC on different voltages
 - Configure all four oscilloscope channels
 - Carry out measurement
 - Disconnect all four UREFxy from associated CHxy_HI
 - Disconnect CHx_LO from GND

4.6.7.19 Trigger Bus Input

4.6.7.19.1 Description

Tests the trigger inputs PXI0 to PXI7. The module R&S TS-PSAM generates trigger pulses with a length of 200 ns on the corresponding lines. The tests are carried out with the data acquisition path A, oscilloscope channel „1“.

4.6.7.19.2 Sequence

- Set path A for external triggering
- Configure oscilloscope channel
- For all lines PXI0 to PXI7
 - Configure trigger generator, activate output
 - Start first measurement, call read function and test for expected exceeding of measuring time (no trigger signal). If the measurement was triggered in an unexpected way, abort test for this line.
 - Start second measurement
 - Generate trigger signal
 - Query status until measurement is terminated
 - Get measurement data
 - Deactivate trigger output on R&S TS-PSAM



4.6.7.20 Trigger Bus Output

4.6.7.20.1 Description

Tests the trigger outputs `PXI0` to `PXI7`. The module R&S TS-PAM generates trigger pulses with a length of 200 ns. The measuring unit on the module R&S TS-PSAM is set to external triggering and receives the signals.

4.6.7.20.2 Sequence

- Set pulse width in the trigger generator path A at 200 ns
- Set oscilloscope channel A1 for software triggering
- Configure oscilloscope channel
- For all lines `PXI0` to `PXI7`
 - Configure and activate trigger output
 - Configure external triggering on R&S TS-PSAM
 - Start measurement on R&S TS-PSAM
 - Start measurement on R&S TS-PAM
 - Generate trigger signal
 - Query status until measurement is terminated
 - Get measurement data
 - Deactivate trigger output

4.6.7.21 Analog Trigger

4.6.7.21.1 Description

The comparators for the analog trigger are tested. For this, a threshold of 4.0 V is set in the 5.0 V range. Each oscilloscope channel is ungrounded and is connected one after another with the DCS. The source is programmed to 5 V voltage and to a current limit of 5 μ A. When the source is switched on, a voltage ramp of 0 V to 5 V, which should trigger the oscilloscope, arises conditionally through the parasitary capacitances and the low current limit.

The following settings are selected:

Range:	5 V
Input impedance:	10 M Ω
Filter:	off
Observation time:	500 μ s
Sampling values:	10000

The DCS is wired as follows:

DCS_LO to ABa1, ABc1 and GND

DCS_HI to ABb1, ABd1

The source is set as follows:

Voltage:	5 V
Current limit:	5 μ A

All coupling relays on R&S TS-PSAM and R&S TS-PAM are closed.



4.6.7.21.2 Sequence

- DCS is switched to the analog bus
- Configure DCS
- For each data acquisition path
 - Configure analog trigger
 - Set sampling parameters
 - For each oscilloscope channel
 - * Connect CH_x_LO with the analog bus
 - * Connect CH_xy_HI with the analog bus
 - * Configure channel
 - * Start measurement
 - * Switch on DCS
 - * Query status until measurement is completed
 - * Get measurement data
 - * Switch off DCS
 - * Disconnect CH_xy_HI from the analog bus
 - * Disconnect CH_x_LO from the analog bus

4.6.7.22 External Trigger In / Out

4.6.7.22.1 Description

For this test, the self-test board is necessary.

It tests the trigger inputs XTI_x and trigger outputs XTO_x . In the self-test board, there are the following connections:

$XTO1 \rightarrow XTI2$
 $XTO2 \rightarrow XTI1$

During the test, a data acquisition path generates a trigger signal on XTO_x and triggers the second data acquisition path on XTI_y . The generated trigger pulse is 200 ns wide.

The following settings are selected:

Range:	100 V
Input impedance:	1 M Ω
Filter:	off
Observation time:	500 μ s
Sampling values:	10000

4.6.7.22.2 Sequence

- Self-test board is present
- Set sampling parameters for path A
- Configure oscilloscope channel A1
- Set sampling parameters for path B
- Configure oscilloscope channel B1
- For both trigger outputs XTO_x
 - Configure trigger output and activate
 - Configure trigger signal
 - Set trigger source (path x: Software; path y: XTI_y)
 - Start measurement path x
 - Start measurement path y
 - Trigger path x by software and thus generate trigger signal on XTO_x (path y is triggered by XTI_y)
 - Query status until recording is completed
 - Discard path x results
 - Discard path y results
 - Deactivate trigger output

4.6.7.23 Channel Multiplexer

4.6.7.23.1 Description

For this test, the self-test board is necessary.

The relays of the input multiplexer are tested. The DCS with the adjustable current limit is used for evaluation. DCS_LO is connected with GND. All coupling relays on R&S TS-PSAM and R&S TS-PAM are closed.

The settings for the source were selected as follows:

Type of measurement	Voltage in V	Current limit in A	Comment
Contact measurement	0.7	10e-3	Threshold at 70 Ohm because of the 50 Ohm resistance against GND
Insulation measurement	5.0	10e-6	Threshold at 500 kOhm

The DCS_HI line is individually switched to the corresponding bus lines. In the self-test board, the local analog bus is connected with the input multiplexer.

The following signal paths were selected on the module:

Data acquisition path A:

```

LABa1 - CHA1_HI1 <RY9> CHA1_HI - CHA_LO - GND
LABa2 - CHA1_HI2 <RY9> CHA1_HI - CHA_LO - GND
LABb1 - CHA1_HI3 <RY9> CHA1_HI - CHA_LO - GND
LABa1 - CHA2_HI1 <RY9> CHA2_HI - CHA_LO - GND
LABa2 - CHA2_HI2 <RY9> CHA2_HI - CHA_LO - GND
LABb1 - CHA2_HI3 <RY9> CHA2_HI - CHA_LO - GND
LABa1 - CHA3_HI1 <RY11> CHA3_HI - CHA_LO - GND
LABa2 - CHA3_HI2 <RY11> CHA3_HI - CHA_LO - GND
LABb1 - CHA3_HI3 <RY11> CHA3_HI - CHA_LO - GND
LABa1 - CHA4_HI1 <RY11> CHA4_HI - CHA_LO - GND
LABa2 - CHA4_HI2 <RY11> CHA4_HI - CHA_LO - GND
LABb1 - CHA4_HI3 <RY11> CHA4_HI - CHA_LO - GND

```

Data acquisition path B:

```

LABc1 - CHB1_HI1 <RY15> CHB1_HI - CHB_LO - GND
LABc2 - CHB1_HI2 <RY15> CHB1_HI - CHB_LO - GND
LABd1 - CHB1_HI3 <RY15> CHB1_HI - CHB_LO - GND
LABc1 - CHB2_HI1 <RY15> CHB2_HI - CHB_LO - GND
LABc2 - CHB2_HI2 <RY15> CHB2_HI - CHB_LO - GND
LABd1 - CHB2_HI3 <RY15> CHB2_HI - CHB_LO - GND
LABc1 - CHB3_HI1 <RY18> CHB3_HI - CHB_LO - GND
LABc2 - CHB3_HI2 <RY18> CHB3_HI - CHB_LO - GND
LABd1 - CHB3_HI3 <RY18> CHB3_HI - CHB_LO - GND
LABc1 - CHB4_HI1 <RY18> CHB4_HI - CHB_LO - GND
LABc2 - CHB4_HI2 <RY18> CHB4_HI - CHB_LO - GND
LABd1 - CHB4_HI3 <RY18> CHB4_HI - CHB_LO - GND

```

4.6.7.23.2 Sequence

- Self-test board is present
- Coupling relays R&S TS-PSAM and R&S TS-PAM are closed
- DCS_LO is connected with GND
- For each data acquisition path
 - Connect CH_x_LO with GND
 - For each oscilloscope channel
 - * Connect CH_x_LO with CH_{xy}_HI
 - * For each input of the input multiplexer
 - Connect DCS_HI with the corresponding analog bus line
 - Connect CH_{xy}_HI_z with CH_{xy}_HI
 - Set voltage and current limit for contact measurement
 - Carry out contact measurement
 - Disconnect CH_{xy}_HI_z from CH_{xy}_HI
 - If the contact measurement was not successful, skip the insulation measurement
 - Set voltage and current limit for insulation measurement
 - Carry out insulation measurement
 - Disconnect DCS_HI from the analog bus
 - * Disconnect CH_x_LO from CH_{xy}_HI
 - Disconnect CH_x_LO from GND

4.6.7.24 CH_x_LO to CH_x_LO1 Relay
4.6.7.24.1 Description

For this test, the self-test board is necessary.



The relays between CH_x_LO and CH_x_LO1 are tested. The DCS with the adjustable current limit is used for evaluation. DCS_LO is connected with GND. All coupling relays on R&S TS-PSAM and R&S TS-PAM are closed. The settings for the source were selected as follows:

Type of measurement	Voltage in V	Current limit in A	Comment
Contact measurement	0.7	10e-3	Threshold at 70 Ohm because of the 50 Ohm resistance against GND
Insulation measurement	5.0	10e-6	Threshold at 500 kOhm

The DCS_HI line is individually switched to the corresponding bus lines. In the self-test board, each line of the local analog bus is connected with CH_x_LO1.

The following signal paths were selected on the module:

Data acquisition path A:

LABb2 - CHA_LO1 <RY5700> CHA_LO - GND

Data acquisition path B:

LABd2 - CHB_LO1 <RY5701> CHB_LO - GND

4.6.7.24.2 Sequence

- Self-test board is present
- Coupling relays R&S TS-PSAM and R&S TS-PAM are closed
- DCS_LO is connected with GND
- For each data acquisition path
 - Connect CHx_LO with GND
 - Connect DCS_HI with the corresponding analog bus line
 - Connect CHx_LO with CHx_LO1
 - Set voltage and current limit for contact measurement
 - Carry out contact measurement
 - Disconnect CHx_LO from CHx_LO1
 - If the contact measurement was not successful, skip the insulation measurement
 - Set voltage and current limit for insulation measurement
 - Carry out insulation measurement
 - Disconnect DCS_HI from the analog bus
 - Disconnect CHx_LO from GND

4.6.8 System Module R&S TS-PSYS1 and R&S TS-PSYS2

The System Module test consists of the following test cases:

- Initialization
- Device self test
- Configuration
- HW State
- Voltage Source
- Digital Input/Output
- Temperature measurement
- SYNC Signal
- Trigger Lines
- CAN-Bus Loopback

Test Case	Description	Test Sequence
INIT	Initializes the module with the function <code>rspsys_InitWithOptions</code> .	The driver function <code>rspsys_InitWithOptions</code> is started.
Voltage Source	The supply voltages are checked.	The following supply voltages are measured: <ul style="list-style-type: none"> • 3,3 V • 5 V • +12 V • -12 V (only R&S TS-PSYS1)
Check Digital Input/Output	Tests the digital inputs and outputs. (The test can only be carried out with the self test adapter connected.)	<ul style="list-style-type: none"> • Output DOUT1 is set. Inputs DIN1 and DIN3 must be 1. Inputs DIN2 and DIN4 must be 0. • Output DOUT2 is set. Inputs DIN2 and DIN4 must be 1. Inputs DIN1 and DIN3 must be 0. • Output DOUT3 is set. Inputs DIN1 and DIN3 must be 1. Inputs DIN2 and DIN4 must be 0. • Output DOUT4 is set. Inputs DIN2 and DIN4 must be 1. Inputs DIN1 and DIN3 must be 0.
Check temperature	Measures voltage <code>TEMP_OUT</code> . (The test can only be carried out with the self test adapter connected.)	The temperature is read as attribute <code>RSPSYS_ATTR_HW_STATE_TEMP</code> and compared.
Check trigger-lines	The eight trigger lines are tested. (The test can only be carried out with the self test adapter connected.)	The R&S TS-PSAM module generates a trigger signal. The eight trigger lines are tested by two trigger lines being connected at a time.
RSCAN_read	Tests the CAN Bus (the test can only be carried out with the self test adapter connected).	The Loopback Test is carried out.

4.6.9 Power Supply/Load Module R&S TS-PSU

4.6.9.1 Initialisation

4.6.9.1.1 Description

The driver is opened. The “Resource Descriptor“ and optional “Option String” from the physical INI file are used to do this. If the initialisation of the driver fails, the test for the module is interrupted.

4.6.9.1.2 Sequence

Function `rspsu_InitWithOptions` is called.

4.6.9.2 Configuration

4.6.9.2.1 Description

The current configuration parameters (driver and firmware version, assigned slot on the frame and hardware code) are determined. The “Option String“ used during initialisation is also generated in the report.

4.6.9.2.2 Sequence

Call to function `rspsu_revision_query` and query of attributes `RSPSU_ATTR_SLOT_NUMBER` and `RSPSU_ATTR_HW_CODE`.

4.6.9.3 Device self-test

4.6.9.3.1 Description

The self-test function is started in the driver. This function performs internal tests in the module. In the event of an error it returns a message identifying the first error that was found.

4.6.9.3.2 Sequence

Call to function `rspsu_self_test`.

4.6.9.4 External voltage

4.6.9.4.1 Description

The coupling relays in the module are closed. Then voltage measurements are performed between each individual bus lines and GND as well as between all individual bus lines. If too high a level is detected, the self-test must be interrupted for that module.

4.6.9.4.2 Sequence

- Close coupling relays
- Connect DMM_LO with GND
- For all bus lines
 - Switch DMM_HI to the line that will be tested
 - Perform voltage measurement
 - Disconnect DMM_HI from the bus line
- Disconnect DMM_LO from GND
- For all combinations of bus lines
 - Switch DMM_LO to the first line
 - Switch DMM_HI to the second line
 - Perform voltage measurement
 - Disconnect DMM_LO from the bus line
 - Disconnect DMM_HI from the bus line

4.6.9.5 Bus isolation

4.6.9.5.1 Description

The coupling relays on the component are closed and the insulation resistance of the bus lines with each other and the resistance of the single bus lines against GND is measured. For the measurement against GND, the DCS is used, because high-ohm resistors against GND cannot be carried out with the resistance measuring function in the Mode V (voltage injection and current measurement) of the R&S TS-PSAM module.

To determine whether the minimum permitted resistance of a bus line against GND is not reached, DCS_LO is connected with GND and DCS_HI switched to the line to be tested. A voltage of 5 V and a current limit of 10 μ A gives a threshold of the 500 kOhm. If the insulation resist-

ance is low, the source goes into the current limit and thus displays an error.

The insulation resistance between two bus lines is measured in the 10 MΩ range of the resistance measuring function. If too low a resistance is found, then the measurement with Autorange switched on is repeated to determine the exact value.

4.6.9.5.2 Sequence

Test all bus lines against GND.

Test all combinations of bus lines between each other.

Temporarily store the result for the test of relays on bus lines.

4.6.9.6 Coupling relays - bus lines A, B

4.6.9.6.1 Description

The function of the four coupling relays of bus lines ABa1, ABa2, ABb1 and ABb2 is logged. A contact and isolation measurement is performed for each relay. In the measurement of the contact resistance, multiple relays are always measured wired in series.

4.6.9.6.2 Sequence

The coupling relays are tested together with the matrix relays. The measurement path is always set up as follows:

DMM_HI - LABx (PSAM) - ABx <Kx> LABx - CHx_y - LABy <Ky> ABY - LABy (PSAM) - DMM_LO

Signal	Note
DMM_HI	HI line of the resistance measurement unit
LABx (PSAM)	HI line on the local analogue bus R&S TS-PSAM
ABx	HI line on analogue bus
Kx	Coupling relay in the HI line
LABx	HI line on the local analogue bus R&S TS-PSU
CHx_y	R&S TS-PSU device connection
LABy	LO line on the local analogue bus R&S TS-PSU
Ky	Coupling relay in the LO line
ABY	LO line on analogue bus

Signal	Note
LAB _y (PSAM)	LO line on the local analogue bus R&S TS-PSAM
DMM_LO	LO line of the resistance measurement unit

Two bus lines must always be selected that do not have any short-circuit between them. The results of the bus isolation measurement are used for this purpose.

If the measurement branch is a low-Ohm connection, the measurement value is logged as a contact resistance for both relays (K_x and K_y). Then K_x and K_y are each opened individually and a separate isolation measurement is performed for each.

If no low-Ohm connection is determined, one of the four relays involved on the module will not close. Then no isolation measurement can be performed for the coupling relay. The measurement is repeated with the next device connection CH_{x_y}. If no connection is found on any lines CH_{x_y}, a coupling relay is probably faulty.

The measurements are repeated for all bus lines AB_x.

4.6.9.7 Coupling Relays Bus Lines C, D

The function of the four coupling relays of bus lines ABc1, ABc2, ABd1 and ABd2 is logged. This procedure is described in Section 4.6.9.6.

4.6.9.8 Matrix relays - bus lines A, B

4.6.9.8.1 Description

The function of relays on analogue bus lines is tested. A contact and isolation measurement is performed for each relay. In the measurement of the contact resistance, multiple relays are always measured wired in series.

4.6.9.8.2 Sequence

The measurement path is always set up as follows:

DMM_HI - LAB_x (PSAM) - AB_x - LAB_x <K_x> CH_{x_y} <K_y> LAB_y - AB_y - LAB_y (PSAM) - DMM_LO

Signal	Note
DMM_HI	HI line of the resistance measurement unit
LAB _x (PSAM)	HI line on the local analogue bus R&S TS-PSAM
AB _x	HI line on analogue bus
LAB _x	HI line on the local analogue bus R&S TS-PSU
K _x	Matrix relay in the HI line
CH _{zn}	R&S TS-PSU device connection
K _y	Matrix relay in the LO line
LAB _y	LO line on the local analogue bus R&S TS-PSU
AB _y	LO line on analogue bus
LAB _y (PSAM)	LO line on the local analogue bus R&S TS-PSAM
DMM_LO	LO line of the resistance measurement unit

Two bus lines must always be selected that do not have any short-circuit between them. The results of the bus isolation measurement are used for this purpose.

If the measurement branch is a low-Ohm connection, the measurement value is logged as a contact resistance for both relays (K_x and K_y). Then K_x and K_y are each opened individually and a separate isolation measurement is performed for each.

If no low-Ohm connection is determined, one of the four relays involved on the module will not close. Then no isolation measurement can be performed for the matrix relay. The two relays are marked and tested in the second pass-through against a relay that is functioning reliably.

The measurements are repeated for all bus lines AB_x.

4.6.9.9 Matrix Relays Bus Lines C, D

The function of the matrix relays of bus lines AB_{c1}, AB_{c2}, AB_{d1} and AB_{d2} is tested. This procedure is described in Section 4.6.9.8.

4.6.9.10 Ground relays

4.6.9.10.1 Description

Relays against ground are tested for both channels. The DCS with adjustable current limitation is used for the evaluation. The DCS is switched as follows:

DCS_LO to ABa1, ABc1 and GND

DCS_HI to ABb1, ABd1

All coupling relays to R&S TS-PSAM and R&S TS-PSU are closed.

The settings for the source were selected as follows:

Measurement type	Voltage in V	Current limit in A	Note
Contact measurement	0.5	50e-3	Threshold at 10 Ohm
Isolation measurement	5.0	100e-6	Threshold at 50 kOhm

The following signal paths are selected on the module:

ABb1 - CH1_LO <K33> GND

ABb1 - CH2_LO <K38> GND

4.6.9.10.2 Sequence

- DCS is switched to the analogue bus
- For each channel
 - Adjust DCS for contact measurement
 - Set up the measurement path
 - Query DCS status
 - Open the relay against ground
 - If DCS was in the current limit, the contact measurement was successful and the isolation measurements can be performed. Otherwise the isolation measurement is omitted.
 - Isolation measurement: Configure DCS for isolation measurement; query DCS status
 - Remove measurement path

4.6.9.11 Voltage setting

4.6.9.11.1 Description

The output voltage is verified. Various levels are programmed and then measured with the SFT DMM. The following settings are used for current limiting:

Range: 3 A
Level: 1 mA

The PSU channels are grounded.

4.6.9.11.2 Sequence

For each channel

- Connect CH_x_LO and CH_x_HI with the analogue bus
- Set current limiting
- Turn on the channel
- For each level
 - Set the voltage (range and value)
 - Measure the voltage with DMM
- Move the channel to its basic state
- Disconnect the channel from the analogue bus

4.6.9.12 Current setting

4.6.9.12.1 Description

Current limiting is verified. Various levels are programmed and then measured with the SFT DMM. The following settings are used for the voltage:

Range: 50 V
Level: 5 V

The PSU channels are grounded.

4.6.9.12.2 Sequence

- Configure DMM for current measurement
- For each channel
 - Connect CH_x_LO and CH_x_HI with the analogue bus
 - Set the voltage (range and value)
 - Turn on the channel
 - For each level
 - * Set current limiting (range and value)
 - * Measure the current with DMM
 - Move the channel to its basic state
 - Disconnect the channel from the analogue bus
- Configure DMM for voltage measurements

4.6.9.13 PAC control

4.6.9.13.1 Description

The output voltage of the PAC module is verified. The measurement is performed with the internal measurement unit. The measurement is configured as follows:

Sampling values: 40
Interval: 1 ms
Delay: 0

The PSU channels are grounded.

4.6.9.13.2 Sequence

For each channel

- Configure measurement
- Set control voltage for PAC
- Measure PAC output voltage
- Reset PAC control to “Automatic”

4.6.9.14 Measurement of voltage force

4.6.9.14.1 Description

The measurement of the force voltage with the measurement unit is verified. The following settings are used for current limiting:

Range: 3 A
Level: 50 mA

The measurement is configured as follows:

Sampling values: 40
Interval: 1 ms
Delay: 0

The PSU channels are grounded.

4.6.9.14.2 Sequence

For each channel

- Set current limiting
- Turn on the channel
- For each level
 - Set the voltage (range and value)
 - Measure the voltage with the measurement unit
- Move the channel to its basic state

4.6.9.15 Measurement of voltage sense

4.6.9.15.1 Description

The measurement of the sense voltage with the measurement unit is verified. The sense lines are connected with the force lines via the local analogue bus. The following settings are used for current limiting:

Range: 3 A
Level: 1 mA

The measurement is configured as follows:

Sampling values: 40
Interval: 1 ms
Delay: 0

The PSU channels are grounded.

4.6.9.15.2 Sequence

For each channel

- Connect CH_x_LO and CH_x_HI with the analogue bus
- Connect CH_x_SLO and CH_x_SHI with the analogue bus
- Configure measurement unit
- Set current limiting
- Turn on the channel
- For each level
 - Set the voltage (range and value)
 - Measure the voltage with DMM
- Move the channel to its basic state
- Disconnect the channel from the analogue bus

4.6.9.16 Measurement current

4.6.9.16.1 Description

The current measurement function of the measurement unit is verified. The force lines are short-circuited via the local analogue bus. The following settings are used for the voltage:

Range: 50 V
Level: 5 V

The measurement is configured as follows:

Sampling values: 40
Interval: 1 ms
Delay: 0

The PSU channels are grounded.

4.6.9.16.2 Sequence

For each channel

- Connect `CHx_LO` and `CHx_HI` to each other via the analogue bus
- Configure measurement unit
- Set the voltage (range and value)
- Turn on the channel
- For each level
 - Set current limiting (range and value)
 - Perform current measurement
- Move the channel to its basic state
- Disconnect the channel from the analogue bus

4.6.9.17 Trigger bus input

4.6.9.17.1 Description

Tests trigger inputs `PXI0` to `PXI7`. The R&S TS-PSAM module generates trigger signals with a duration of 200 ns on the corresponding lines. The tests are performed with Channel 1 of the R&S TS-PSU.

4.6.9.17.2 Sequence

- Set external triggering
- Configure channel
- For all lines `PXI0` to `PXI7`
 - Configure trigger generator, activate output
 - Start the first measurement, call the read function and test for expected exceeding of measurement time (no trigger signal). If the measurement was triggered in an unexpected manner, interrupt the test for that line.
 - Start the second measurement
 - Generate trigger signal
 - Retrieve measurement data
 - Deactivate trigger output to R&S TS-PSAM

4.6.9.18 Trigger bus output

4.6.9.18.1 Description

Tests trigger outputs $PXI0$ to $PXI7$. The R&S TS-PSU module generates trigger pulses with a length of approximately $1 \mu s$. The measurement unit on the R&S TS-PSAM module is set to external triggering and receives the signals.

4.6.9.18.2 Sequence

For all lines $PXI0$ to $PXI7$

- Configure and activate trigger output
- Configure external triggering to R&S TS-PSAM
- Start measurement on R&S TS-PSAM
- Generate trigger signal
- Retrieve measurement data from R&S TS-PSAM
- Deactivate trigger output

4.6.9.19 External trigger In / Out

4.6.9.19.1 Description

The self-test connector is required for this test.

It tests trigger inputs $XTIx$ and trigger outputs $XTOx$. The following connections are implemented in the self-test connector:

$XTO1 \rightarrow XTI2$
 $XTO2 \rightarrow XTI1$

During the test, each channel generates a trigger signal to $XTOx$ and thereby triggers the measurement unit for the second channel via $XTIy$.

4.6.9.19.2 Sequence

- Self-test connector is present
- For both trigger outputs $XTOx$
 - Configure trigger output
 - Configure trigger signal
 - Define trigger source for Channel y
 - Start measurement for Channel y

- Generate trigger signal
- Retrieve results for Channel y

4.6.9.20 Monitor output

4.6.9.20.1 Description

The self-test connector is required for this test.

Monitor outputs CH1_MHI, CH1_MLO and CH2_MHI, CH2_MLO are tested. The monitor output of Channel 1 is connected with the sense input of Channel 2 and the monitor output of Channel 2 is connected with the sense input of Channel 1 in the self-test connector. The following signal paths are used:

CH1_Mx - CH2_S4 <K42> CH2_S
 CH2_Mx - CH1_S4 <K4> CH1_S

The measurement is performed using an input of sense multiplexer. Because of this, the corresponding relay is tested as well. The result of the relay test is logged in the "Sense Relays" test case.

The following settings are used for current limiting:

Range: 3 A
 Level: 50 mA

The measurement is configured as follows:

Sampling values: 40
 Interval: 1 ms
 Delay: 0

4.6.9.20.2 Sequence

For each channel

- Set up signal path
- Set contact test for the relay involved to "Skipped"
- Configure monitor output to "Voltage Force"
- Turn on channel with configured monitor output
- Configure measurement on other channel
- For all output voltages
 - Adjust voltage on channel with configured monitor output
 - Measure voltage on monitor output with other channel
 - If voltage is within valid range, set contact test for the relay in-



involved to “Passed”.

- Open the sense relay involved
- If the contact test was successful
 - Repeat measurement
 - If the measured voltage is low enough
 - * Set isolation test for the relay to “Passed”
 - otherwise
 - * Set isolation test for the relay to “Failed”
- otherwise
 - Set contact test for the relay to “Failed”
 - Set isolation test for the relay to “Skipped”
- Move the channel to its basic state

4.6.9.21 High current

4.6.9.21.1 Description

The self-test connector is required for this test.

Output of high currents and the current measurement function of the measurement unit is checked. The force lines are short-circuited via the self-test connector. The following settings are used for the voltage:

Range: 50 V
Level: 5 V

The measurement is configured as follows:

Sampling values: 40
Interval: 1 ms
Delay: 0

The following signal paths are selected:

CH1 <K30> CH1_2
CH2 <K35> CH2_2

The PSU channels are grounded.

4.6.9.21.2 Sequence

For each channel

- Connect CHx_LO and CHx_HI to each other via the force multiplexer and self-test connector
- Configure measurement unit
- Set the voltage (range and value)
- Turn on the channel
- For each level
 - Set current limiting (range and value)
 - Perform current measurement
- Move the channel to its basic state
- Disconnect the channel from the self-test connector

4.6.9.22 External sensing

4.6.9.22.1 Description

The self-test connector is required for this test.

The voltage adjustment will be tested using the sense lines. Resistors are built into the self-test connector for this purpose. The set voltage is measured with the SFT DMM.

The following connections are set up:

Channel 1:

```
CH1 <K29> CH1_1
CH1_S <K1 > CH1_S1
CH1_HI with ABb1
CH1_LO with ABa1
```

Channel 2:

```
CH2 <K34> CH2_1
CH2_S <K39> CH2_S1
CH2_HI with ABd1
CH2_LO with ABc1
```

The PSU channels are grounded.

The sense lines run through an input of sense multiplexer. Because of this, the corresponding relay is tested as well. If the relay is opened, thereby interrupting the sense lines, the output voltage changes accordingly. The result of the relay test is logged in the “Sense Relays”



test case.

The following settings are used for current limiting:

Range: 3 A
Level: 50 mA

The measurement is configured as follows:

Sampling values: 40
Interval: 1 ms
Delay: 0

4.6.9.22.2 Sequence

For each channel

- Set up signal path
- Set contact test for the sense relay involved to “Skipped”
- Switch the channel to external sensing and turn on
- For all output voltages
 - Adjust the voltage
 - Configure DMM
 - If voltage is within valid range, set contact test for the sense relay involved to “Passed”.
- Open the sense relay involved
- If the contact test was successful
 - Repeat measurement
 - If the measured voltage is high enough
 - * Set isolation test for the sense relay to “Passed”
 - otherwise
 - * Set isolation test for the sense relay to “Failed”
- otherwise
 - Set contact test for the sense relay to “Failed”
 - Set isolation test for the sense relay to “Skipped”
- Move the channel to its basic state
- Disconnect connection

4.6.9.23 Sense protection

4.6.9.23.1 Description

The self-test connector is required for this test.

The sense lines are short-circuited via the self-test connector. The output voltage may only exceed the set voltage up to a specified value. It is measured with the SFT DMM.

The following connections are set up:

Channel 1:

```
CH1_S <K2 > CH1_S2  
CH1_HI with ABb1  
CH1_LO with ABa1
```

Channel 2:

```
CH2_S <K40> CH2_S2  
CH2_HI with ABd1  
CH2_LO with ABc1
```

The PSU channels are grounded.

The following settings are used for the voltage:

Level: 5 V

The following settings are used for current limiting:

Range: 3 A

Level: Minimum

4.6.9.23.2 Sequence

For each channel

- Set up signal path
- Adjust voltage level
- Switch the channel to external sensing and turn on
- For each voltage range
 - Set up range
 - Measure output voltage
- Move the channel to its basic state
- Disconnect connection

4.6.9.24 Sense relays

4.6.9.24.1 Description

The self-test connector is required for this test.

The sense relays on the multiplexer that are not tested yet are tested with the SFT DMM. The DMM is switched by the matrix to the contact short-circuited in the self-test connector. A contact and isolation measurement is performed.

During the isolation measurement, the input divider of the sense lines is measured.

The results of all sense relay tests are logged together.

Relays are checked in the following test cases:

Channel1	Channel2	Test case
K1	K39	External sensing
K2	K40	Sense relays
K3	K41	Sense relays
K4	K42	Monitor output

4.6.9.24.2 Sequence

For each channel

- Switch DMM to sense lines
- For each sense relay
 - Close sense relay
 - Perform contact measurement
 - Open sense relay
 - If the contact measurement was successful
 - * Set contact test to “Passed”
 - * Perform isolation measurement
 - * If successful
 - Set isolation test to “Passed”
 - * otherwise
 - Set isolation test to “Failed”
 - otherwise
 - * Set contact test to “Failed”
 - * Set isolation test to “Skipped”
- Disconnect DMM from sense lines

4.6.9.25 Force relays

4.6.9.25.1 Description

The self-test connector is required for this test.

The function of the force relays is tested. Using the self-test connector, the force lines are short circuited or connected with each other through a resistor. The function of the contact is tested using adjustable current limiting.

The settings for the source were selected as follows:

Measurement type	Voltage in V	Current limiting in A	Note
Isolation measurement	50.0	1000e-6	Threshold at 50 kOhm
Contact measurement - CHx_1	10	500e-6	Threshold at 20 kOhm
Contact measurement - CHx_2, CHx_3	0.5	100e-3	Threshold at 5 Ohm
Contact measurement - CHx_4	1.0	100e-3	Threshold at 10 Ohm

The following signal paths are used for measurements:

Channel 1

Only channel 1 is connected with GND

- CH1_HI <K29> CH1_HI1 < 10 kOhm > CH1_LO1 <K29> CH1_LO
- CH1_HI <K30> CH1_HI2 - CH1_LO2 <K30> CH1_LO
- CH1_HI <K31> CH1_HI3 - CH1_LO3 <K31> CH1_LO
- CH1_HI <K32> CH1_HI4 - CH2_HI4 <K37> CH2_HI <K45> LAB_D2 <K50> CH2_LO <K37> CH2_LO4 - CH1_LO4 <K32> CH1_LO

Channel 2

Only channel 2 is connected with GND

- CH2_HI <K34> CH2_HI1 < 10 kOhm > CH2_LO1 <K34> CH2_LO
- CH2_HI <K35> CH2_HI2 - CH2_LO2 <K35> CH2_LO
- CH2_HI <K36> CH2_HI3 - CH2_LO3 <K36> CH2_LO
- CH2_HI <K37> CH2_HI4 - CH1_HI4 <K32> CH1_HI <K8> LAB_B2 <K12> CH1_LO <K32> CH1_LO4 - CH2_LO4 <K37> CH2_LO

4.6.9.25.2 Sequence

For each channel

- Short-circuit the force lines of the other channel via the matrix
- Connect CH_x with CH_x_4 of the other contact
- For each force relay
 - Close the relay to be tested
 - Configure source for contact measurement
 - Turn on source
 - Query status of source
 - Turn off source
 - Open the relay to be tested
 - If the contact measurement was successful
 - * Set contact test to “Passed”
 - * Configure source for isolation measurement
 - * Turn on source
 - * Query status of source
 - * Turn off source
 - * If the source was not within the current limits
 - Set isolation test to “Passed”
 - * otherwise
 - Set isolation test to “Failed”
 - otherwise
 - * Set contact test to “Failed”
 - * Set isolation test to “Skipped”
- Disconnect CH_x from CH_x_4 of the other contact
- Disconnect force lines of the other channel from the matrix
- Switch the channel to its basic state

4.6.9.26 Sink mode

4.6.9.26.1 Description

The self-test connector is required for this test.

In this test, Channel 1 is connected with Channel 2 through the self-test connector. One channel is operated in source mode and the other channel is operated in sink mode. The current is limited by the channel in sink mode. The current is measured with the measurement unit of the channel in source mode (plus sign).

The following connection is set up:

CH1_HI <K32> CH1_HI4 - CH2_HI4 <K37> CH2_HI
CH1_LO<K32> CH1_LO4 - CH2_LO4<K37> CH2_LO

Both channels are grounded.

Settings of the channel in source mode:

Voltage range: 50 V
Voltage level: 5 V
Current range: 3 A
Current level: 0.5 A

Fixed settings of the channel in sink mode:

Voltage range: 50 V
Voltage level: 2 V

4.6.9.26.2 Sequence

Connect Channel 1 with Channel 2 using the self-test connector

For each channel

- Move channel to source mode
- Switch the other channel to sink mode
- Turn on both channels
- Configure the current measurement
- Set the current range and current of the other channel
- Perform measurement
- Move both channels to their basic states

Disconnect Channel 1 from Channel 2

4.6.10 Switch/Multiplex Module 2 R&S TS-PSM2

4.6.10.1 Initialisation

4.6.10.1.1 Description

The driver is opened. The “Resource Descriptor” and optional “Option String” from the physical INI file are used to do this. If the initialisation of the driver fails, the test for the module is interrupted.

4.6.10.1.2 Sequence

Function `rspsm2_InitWithOptions` is called.

4.6.10.2 Configuration

4.6.10.2.1 Description

The current configuration parameters (driver and firmware version, assigned slot on the frame and hardware code) are determined. The “Option String” used during initialisation is also generated in the report.

4.6.10.2.2 Sequence

Call to function `rspsm2_revision_query` and query of attributes `RSPSM2_ATTR_FRAME_NUMBER`, `RSPSM2_ATTR_SLOT_NUMBER` and `RSPSM2_ATTR_HW_CODE`.

4.6.10.3 Device self-test

4.6.10.3.1 Description

The self-test function is started in the driver. This function performs internal tests in the module. In the event of an error it returns a message identifying the first error that was found.

4.6.10.3.2 Sequence

Call to function `rspsm2_self_test`.

4.6.10.4 External voltage

4.6.10.4.1 Description

The following connections are made on the module one after the other using the R&S TS-PSAM. Voltage measurements are performed in between these via the bus lines. Measurements are performed between each individual bus line and GND as well as between all individual bus lines. If too high a level is detected, the self-test must be limited for that module.

Connection 1 is designed to determine voltages on the local analogue bus (this bus is available on X20 and on the side connector). For this purpose, only the coupling relays are turned. They remain set for subsequent measurements. Connections 2 to 5 are designed to determine voltages that could reach the measurement system because of a jammed "Local Power Bus" relay through the "side connector".

4.6.10.4.2 Sequence

The following sub-sequence is traversed after each connection.

Volage measurements:

- /Connect DMM_LO with GND
- For all bus lines
 - Switch DMM_HI to the line that will be tested
 - Perform voltage measurement
 - Disconnect DMM_HI from the bus line
- Disconnect DMM_LO from GND
- For all combinations of bus lines
 - Switch DMM_LO to the first line
 - Switch DMM_HI to the second line
 - Perform voltage measurement
 - Disconnect DMM_LO from the bus line
 - Disconnect DMM_HI from the bus line

Connection 1:

- Close all coupling relays
- Perform voltage measurements

Connection 2:

- All coupling relays are closed
- CH1-LPBA, CH1_HI-LABa1, CH1_LO-LABa2
- CH5-LPBB, CH5_HI-LABc1, CH5_LO-LABc2
- Perform voltage measurements

Connection 3:

- All coupling relays are closed
- CH2-LPBA, CH2_HI-LABa2, CH2_LO-LABa1
- CH6-LPBB, CH6_HI-LABc2, CH6_LO-LABc1
- Perform voltage measurements

Connection 4:

- All coupling relays are closed
- CH3-LPBA, CH3_HI-LABb1, CH3_LO-LABb2
- CH7-LPBB, CH7_HI-LABd1, CH7_LO-LABd2
- Perform voltage measurements

Connection 5:

- All coupling relays are closed
- CH4-LPBA, CH4_HI-LABb2, CH4_LO-LABb1
- CH8-LPBB, CH8_HI-LABd2, CH8_LO-LABd1
- Perform voltage measurements

4.6.10.5 Bus isolation

4.6.10.5.1 Description

The coupling relays on the component are closed and the insulation resistance of the bus lines with each other and the resistance of the single bus lines against GND is measured. For the measurement against GND, the DCS is used, because high-ohm resistors against GND cannot be carried out with the resistance measuring function in the Mode V (voltage injection and current measurement) of the R&S TS-PSAM module.

To determine whether the minimum permitted resistance of a bus line against GND is not reached, DCS_LO is connected with GND and DCS_HI switched to the line to be tested. A voltage of 5 V and a current

limit of 10 μA gives a threshold of the 500 kOhm. If the insulation resistance is low, the source goes into the current limit and thus displays an error.

The insulation resistance between two bus lines is measured in the 10 M Ω range of the resistance measuring function. If too low a resistance is found, then the measurement with Autorange switched on is repeated to determine the exact value.

4.6.10.5.2 Sequence

- Test all bus lines against GND.
- Test all combinations of bus lines between each other.
- Temporarily store the result for the test of relays on bus lines (matrix).

4.6.10.6 Matrix relays LABa1, LABa2

4.6.10.6.1 Description

The function of relays on analogue bus lines is tested. A contact and isolation measurement is performed for each relay. In the measurement of the contact resistance, multiple relays are always measured wired in series.

4.6.10.6.2 Sequence

The measurement path is always set up as follows:

DMM_HI - LABx (PSAM) - ABx - LABx <Kx> CHx_y <Ky> LABy - ABy - LABy (PSAM) - DMM_LO

Signal	Note
DMM_HI	HI line of the resistance measurement unit
LABx (PSAM)	HI line on the local analogue bus R&S TS-PSAM
ABx	HI line on analogue bus
LABx	HI line on the local analogue bus R&S TS-PSM2
Kx	Matrix relay in the HI line
CHx_y	Channel to R&S TS-PSM2
Ky	Matrix relay in the LO line
LABy	LO line on the local analogue bus R&S TS-PSM2

Signal	Note
AB _y	LO line on analogue bus
LAB _y (PSAM)	LO line on the local analogue bus R&S TS-PSAM
DMM_LO	LO line of the resistance measurement unit

Two bus lines must always be selected that do not have any short-circuit between them. The results of the bus isolation measurement are used for this purpose.

If the measurement branch is a low-Ohm connection, the measurement value is logged as a contact resistance for both relays (K_x and K_y). Then K_x and K_y are each opened individually and a separate isolation measurement is performed for each.

If no low-Ohm connection is determined, one of the four relays involved on the module will not close. Then no isolation measurement can be performed for the matrix relay.

4.6.10.7 Matrix relays LABb1, LABb2

The function of the matrix relays of bus lines ABb1, ABb2 is tested. The same procedure is used for the test as described in Chapter 4.6.10.6.

4.6.10.8 Matrix relays LABc1, LABc2

The function of the matrix relays of bus lines ABc1, ABc2 is tested. The same procedure is used for the test as described in Chapter 4.6.10.6.

4.6.10.9 Matrix relays LABd1, LABd2

The function of the matrix relays of bus lines ABd1, ABd2 is tested. The same procedure is used for the test as described in Chapter 4.6.10.6.

4.6.10.10 Coupling relays

4.6.10.10.1 Description

The function of the coupling relays of the bus lines is logged. A contact and isolation measurement is performed for each relay. In the measurement of the contact resistance, multiple relays are always measured wired in series.

4.6.10.10.2 Sequence

The coupling relays are tested together with the matrix relays. The measurement path is always set up as follows:

DMM_HI - LAB_x (PSAM) - AB_x <K_x> LAB_x - CH_{x_y} - LAB_y <K_y> AB_y - LAB_y (PSAM) - DMM_LO

Signal	Note
DMM_HI	HI line of the resistance measurement unit
LAB _x (PSAM)	HI line on the local analogue bus R&S TS-PSAM
AB _x	HI line on analogue bus
K _x	Coupling relay in the HI line
LAB _x	HI line on the local analogue bus R&S TS-PSM2
CH _{x_y}	Channel to R&S TS-PSM2
LAB _y	LO line on the local analogue bus R&S TS-PSM2
K _y	Coupling relay in the LO line
AB _y	LO line on analogue bus
LAB _y (PSAM)	LO line on the local analogue bus R&S TS-PSAM
DMM_LO	LO line of the resistance measurement unit

Two bus lines must always be selected that do not have any short-circuit between them. The results of the bus isolation measurement are used for this purpose.

If the measurement branch is a low-Ohm connection, the measurement value is logged as a contact resistance for both relays (K_x and K_y). Then K_x and K_y are each opened individually and a separate isolation measurement is performed for each.

If no low-Ohm connection is determined, one of the four relays involved on the module will not close. Then no isolation measurement can be performed for the coupling relay. The measurement is repeated with the next device connection CH_{x_y}. If no connection is found on any lines CH_{x_y}, a coupling relay is probably faulty.

The measurements are repeated for all bus lines AB_x.

4.6.10.11 Local power bus relays

4.6.10.11.1 Description

The function of the eight two-pin “Local Power Bus” relays (LPB relays) is tested. Each pin of this relay is designed as a change-contact.

The normally closed contact connects the “side connector” with the corresponding channel. This contact cannot be tested in the self-test because generally nothing is connected to the “X40 side connector” and no self-test connector can be provided for X40.

A contact and isolation measurement is performed for each normally open contact of the LPB relays. In the measurement of the contact resistance, multiple relays are always measured wired in series. The isolation measurement can only be performed if the contact measurement was successful. The following signal paths are set up one after the other:

```

LABa1 - CH1_HI <K1010> LPBA <K2010> CH2_HI - LABa2
LABa1 - CH1_LO <K1010> LPBA <K2010> CH2_LO - LABa2
LABb1 - CH3_HI <K3010> LPBA <K4010> CH4_HI - LABb2
LABb1 - CH3_LO <K3010> LPBA <K4010> CH4_LO - LABb2
LABc1 - CH5_HI <K5010> LPBB <K6010> CH6_HI - LABc2
LABc1 - CH5_LO <K5010> LPBB <K6010> CH6_LO - LABc2
LABd1 - CH7_HI <K7010> LPBB <K8010> CH8_HI - LABd2
LABd1 - CH7_LO <K7010> LPBB <K8010> CH8_LO - LABd2

```

4.6.10.11.2 Sequence

- Coupling relays R&S TS-PSAM and R&S TS-PSM2 are closed
- For each signal path
 - Set up signal path
 - Switch DMM to the corresponding analogue bus lines
 - Perform contact measurement
 - If the contact measurement was successful
 - * Open first relay
 - * Perform isolation measurement for first relay
 - * Close first relay again
 - * Open second relay
 - * Perform isolation measurement for second relay
 - * Close second relay again
 - Disconnect signal path
 - Disconnect DMM from analogue bus

4.6.10.12 Shunt resistor path

4.6.10.12.1 Description

The function of the shunt resistor and the partial function of the sense and multiplexer relay is tested. There is a 1 kOhm resistor in the sense line that is measured during this test. The isolation measurement of the multiplexer relay involved cannot be performed with this measurement system connection. In the likely event that a contact is merely stuck, a high-Ohm resistance would still be measured after the two-pin relay is opened! The isolation measurement is therefore performed in an additional test case with a self-test connector.

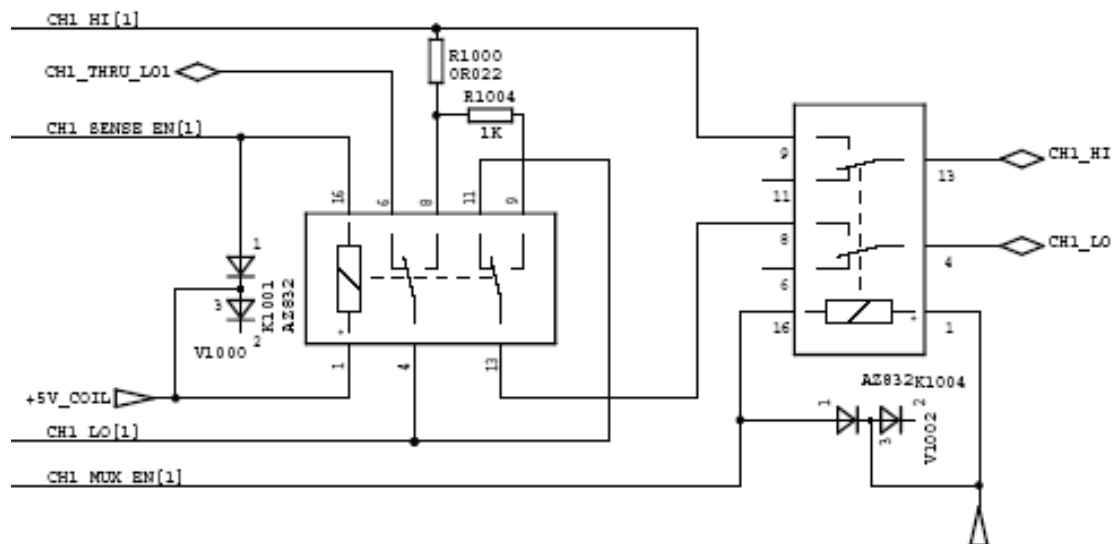


Figure 4-9 Shunt resistor path

If the resistance measured is too great, either the shunt resistor is faulty or one of the relays involved is not closing. Thus an isolation measurement for the sense really is also not possible.

If the measured resistance is too small on the other hand, the sense relay is faulty (normally close contact between CH_x_LO_y and CH_x_LO_y_com is stuck). Thus an isolation measurement is superfluous.

If the resistance value is within the limits, the sense relay is opened and an isolation measurement is performed. If one of the two pins is not opened, too low a resistance is measured (approx. 2 Ohm or 1 kOhm) and the corresponding contact is stuck.

No conclusions may be drawn regarding the contact resistance be-



tween CHx_LOy-CHx_HIy and CHx_LOy - CHx_THRU_LOx based on these measurements. Thus the only way to test the sense relays completely is with a self-test connector!

All 32 multiplexer channels are tested one after the other. Before the signal paths are set up, the corresponding LPB relay (“Local Power Bus” relay) is closed so there is no connection to the “side connector”.

The following signal paths are set up:

```
LABa1-CH1_HI<K1004>CH1_HI1<R1000><R1004><K1001><K1004>CH1_LO-LABa2  
LABa1-CH1_HI<K1005>CH1_HI2<R1001><R1005><K1002><K1005>CH1_LO-LABa2  
LABa1-CH1_HI<K1011>CH1_HI3<R1002><R1006><K1008><K1011>CH1_LO-LABa2  
LABa1-CH1_HI<K1012>CH1_HI4<R1003><R1007><K1009><K1012>CH1_LO-LABa2
```

```
LABa1-CH2_HI<K2004>CH2_HI1<R2000><R2004><K2001><K2004>CH2_LO-LABa2  
LABa1-CH2_HI<K2005>CH2_HI2<R2001><R2005><K2002><K2005>CH2_LO-LABa2  
LABa1-CH2_HI<K2011>CH2_HI3<R2002><R2006><K2008><K2011>CH2_LO-LABa2  
LABa1-CH2_HI<K2012>CH2_HI4<R2003><R2007><K2009><K2012>CH2_LO-LABa2
```

```
LABb1-CH3_HI<K3004>CH3_HI1<R3000><R3004><K3001><K3004>CH3_LO-LABb2  
LABb1-CH3_HI<K3005>CH3_HI2<R3001><R3005><K3002><K3005>CH3_LO-LABb2  
LABb1-CH3_HI<K3011>CH3_HI3<R3002><R3006><K3008><K3011>CH3_LO-LABb2  
LABb1-CH3_HI<K3012>CH3_HI4<R3003><R3007><K3009><K3012>CH3_LO-LABb2
```

```
LABb1-CH4_HI<K4004>CH4_HI1<R4000><R4004><K4001><K4004>CH4_LO-LABb2  
LABb1-CH4_HI<K4005>CH4_HI2<R4001><R4005><K4002><K4005>CH4_LO-LABb2  
LABb1-CH4_HI<K4011>CH4_HI3<R4002><R4006><K4008><K4011>CH4_LO-LABb2  
LABb1-CH4_HI<K4012>CH4_HI4<R4003><R4007><K4009><K4012>CH4_LO-LABb2
```

```
LABc1-CH5_HI<K5004>CH5_HI1<R5000><R5004><K5001><K5004>CH5_LO-LABc2  
LABc1-CH5_HI<K5005>CH5_HI2<R5001><R5005><K5002><K5005>CH5_LO-LABc2  
LABc1-CH5_HI<K5011>CH5_HI3<R5002><R5006><K5008><K5011>CH5_LO-LABc2  
LABc1-CH5_HI<K5012>CH5_HI4<R5003><R5007><K5009><K5012>CH5_LO-LABc2
```

```
LABc1-CH6_HI<K6004>CH6_HI1<R6000><R6004><K6001><K6004>CH6_LO-LABc2  
LABc1-CH6_HI<K6005>CH6_HI2<R6001><R6005><K6002><K6005>CH6_LO-LABc2  
LABc1-CH6_HI<K6011>CH6_HI3<R6002><R6006><K6008><K6011>CH6_LO-LABc2  
LABc1-CH6_HI<K6012>CH6_HI4<R6003><R6007><K6009><K6012>CH6_LO-LABc2
```

```
LABd1-CH7_HI<K7004>CH7_HI1<R7000><R7004><K7001><K7004>CH7_LO-LABd2  
LABd1-CH7_HI<K7005>CH7_HI2<R7001><R7005><K7002><K7005>CH7_LO-LABd2  
LABd1-CH7_HI<K7011>CH7_HI3<R7002><R7006><K7008><K7011>CH7_LO-LABd2  
LABd1-CH7_HI<K7012>CH7_HI4<R7003><R7007><K7009><K7012>CH7_LO-LABd2
```

```
LABd1-CH8_HI<K8004>CH8_HI1<R8000><R8004><K8001><K8004>CH8_LO-LABd2  
LABd1-CH8_HI<K8005>CH8_HI2<R8001><R8005><K8002><K8005>CH8_LO-LABd2  
LABd1-CH8_HI<K8011>CH8_HI3<R8002><R8006><K8008><K8011>CH8_LO-LABd2  
LABd1-CH8_HI<K8012>CH8_HI4<R8003><R8007><K8009><K8012>CH8_LO-LABd2
```

4.6.10.12.2 Sequence

- Coupling relays R&S TS-PSAM and R&S TS-PSM2 are closed
- For each “Local Power Bus” channel
 - Close LPB relay (disconnect channel from “side connector”)
 - Switch CHx_HI and CHx_LO to analogue bus
 - Switch DMM_HI and DMM_LO to analogue bus
 - For each multiplexer channel
 - * Connect CHx_y with CHx
 - * Connect CHx_HIy with CHx_LOy (activate sense relay)
 - * Perform resistance measurement
 - * Disconnect CHx_HIy from CHx_LOy (deactivate sense relay)
 - * If the resistance value is within the limits
 - Perform isolation measurement
 - * Disconnect CHx_y from CHx
 - Disconnect DMM_HI and DMM_LO from the analogue bus
 - Disconnect CHx_HI and CHx_LO from the analogue bus
 - Open LPB relay

4.6.10.13 Multiplexer relays

A self-test connector is required for this test case.

4.6.10.13.1 Description

The function of 32 multiplexer relays will be tested. A contact and isolation measurement is performed for each normally open contact of the two-pin relays.

If the contact measurement was successful in a signal path, the connection CHx_LOy - CHx_LOy_com is also ensured through the corresponding sense relay. If necessary, an isolation measurement can also be performed for this case between CHx_LOy and CHx_LOy_comin. Because of the special connection of this relay, the 1-kOhm resistance in the sense path must be measured within the tolerance. The corresponding relay is marked as defective for all other measurement values.

The following signal paths are set up one after the other:

```

LABa1-CH1_HI<K1004>          CH1_HI1-CH5_HI1 <K5004>CH5_HI-LABc1
LABa1-CH1_LO<K1004><K1001>CH1_LO1-CH5_LO1<K5001><K5004>CH5_LO-LABc1
LABa1-CH1_HI<K1005>          CH1_HI2-CH5_HI2 <K5005>CH5_HI-LABc1
LABa1-CH1_LO<K1005><K1002>CH1_LO2-CH5_LO2<K5002><K5005>CH5_LO-LABc1
LABa1-CH1_HI<K1011>          CH1_HI3-CH5_HI3 <K5011>CH5_HI-LABc1
  
```



LABa1-CH1_LO<K1011><K1008>CH1_LO3-CH5_LO3<K5008><K5011>CH5_LO-LABc1
 LABa1-CH1_HI<K1012> CH1_HI4-CH5_HI4 <K5012>CH5_HI-LABc1
 LABa1-CH1_LO<K1012><K1009>CH1_LO4-CH5_LO4<K5009><K5012>CH5_LO-LABc1

LABa1-CH2_HI<K2004> CH2_HI1-CH6_HI1 <K6004>CH6_HI-LABc1
 LABa1-CH2_LO<K2004><K2001>CH2_LO1-CH6_LO1<K6001><K6004>CH6_LO-LABc1
 LABa1-CH2_HI<K2005> CH2_HI2-CH6_HI2 <K6005>CH6_HI-LABc1
 LABa1-CH2_LO<K2005><K2002>CH2_LO2-CH6_LO2<K6002><K6005>CH6_LO-LABc1
 LABa1-CH2_HI<K2011> CH2_HI3-CH6_HI3 <K6011>CH6_HI-LABc1
 LABa1-CH2_LO<K2011><K2008>CH2_LO3-CH6_LO3<K6008><K6011>CH6_LO-LABc1
 LABa1-CH2_HI<K2012> CH2_HI4-CH6_HI4 <K6012>CH6_HI-LABc1
 LABa1-CH2_LO<K2012><K2009>CH2_LO4-CH6_LO4<K6009><K6012>CH6_LO-LABc1

LABb1-CH3_HI<K3004> CH3_HI1-CH7_HI1 <K7004>CH7_HI-LABd1
 LABb1-CH3_LO<K3004><K3001>CH3_LO1-CH7_LO1<K7001><K7004>CH7_LO-LABd1
 LABb1-CH3_HI<K3005> CH3_HI2-CH7_HI2 <K7005>CH7_HI-LABd1
 LABb1-CH3_LO<K3005><K3002>CH3_LO2-CH7_LO2<K7002><K7005>CH7_LO-LABd1
 LABb1-CH3_HI<K3011> CH3_HI3-CH7_HI3 <K7011>CH7_HI-LABd1
 LABb1-CH3_LO<K3011><K3008>CH3_LO3-CH7_LO3<K7008><K7011>CH7_LO-LABd1
 LABb1-CH3_HI<K3012> CH3_HI4-CH7_HI4 <K7012>CH7_HI-LABd1
 LABb1-CH3_LO<K3012><K3009>CH3_LO4-CH7_LO4<K7009><K7012>CH7_LO-LABd1

LABb1-CH4_HI<K4004> CH4_HI1-CH8_HI1 <K8004>CH8_HI-LABd1
 LABb1-CH4_LO<K4004><K4001>CH4_LO1-CH8_LO1<K8001><K8004>CH8_LO-LABd1
 LABb1-CH4_HI<K4005> CH4_HI2-CH8_HI2 <K8005>CH8_HI-LABd1
 LABb1-CH4_LO<K4005><K4002>CH4_LO2-CH8_LO2<K8002><K8005>CH8_LO-LABd1
 LABb1-CH4_HI<K4011> CH4_HI3-CH8_HI3 <K8011>CH8_HI-LABd1
 LABb1-CH4_LO<K4011><K4008>CH4_LO3-CH8_LO3<K8008><K8011>CH8_LO-LABd1
 LABb1-CH4_HI<K4012> CH4_HI4-CH8_HI4 <K8012>CH8_HI-LABd1
 LABb1-CH4_LO<K4012><K4009>CH4_LO4-CH8_LO4<K8009><K8012>CH8_LO-LABd1

4.6.10.13.2 Sequence

- Self-test connector present
- Coupling relays R&S TS-PSAM and R&S TS-PSM2 are closed
- For each signal path
 - Close LPB relays involved (disconnect channels from “side connector”)
 - Set up signal path
 - Perform contact measurement
 - If the contact measurement was successful
 - * If no isolation measurement has been performed yet for CHx_LOy - CHx_LOy_com (see test case “Shunt Resistor Path”)
 - Activate sense relay
 - Perform resistance measurement
 - Deactivate sense relay

- * Open the first multiplexer relay involved
- * Perform isolation measurement
- * Close first multiplexer relay again
- * Open the second multiplexer relay
- * Perform isolation measurement
- * Close second multiplexer relay again
- Disconnect signal path
- Open the LPB relay involved (disconnect channels from LPB)

4.6.10.14 Sense relays

A self-test connector is required for this test case.

4.6.10.14.1 Description

The 32 sense relays are tested with additional measurements. The contact and isolation resistance is determined between CH_x_HI_y and CH_x_LO_y.

The contact resistance between CH_x_THRU_LO1 and CH_x_LO1 is measured in this test case. The isolation measurement is not possible with this signal path. (When the relay is activated, CH_x_LO1 is also disconnected from the multiplexer relay.) This contact is demonstrated to be isolated, however, if the contact measurement between CH_x_HI_y and CH_x_LO_y is successful (mechanics of the relay).

The following signal paths are set up for contact measurement between CH_x_HI_y and CH_x_LO_y:

```
LABc1-CH5_HI<K5004>CH5_HI1-CH1_HI1<K1001>CH1_LO1-
CH5_LO1<K5001><K5004>CH5_LO-LABc2
LABc1-CH5_HI<K5005>CH5_HI2-CH1_HI2<K1002>CH1_LO2-
CH5_LO2<K5002><K5005>CH5_LO-LABc2
LABc1-CH5_HI<K5011>CH5_HI3-CH1_HI3<K1008>CH1_LO3-
CH5_LO3<K5008><K5011>CH5_LO-LABc2
LABc1-CH5_HI<K5012>CH5_HI4-CH1_HI4<K1009>CH1_LO4-
CH5_LO4<K5009><K5012>CH5_LO-LABc2
```

```
LABc1-CH6_HI<K6004>CH6_HI1-CH2_HI1<K2001>CH2_LO1-
CH6_LO1<K6001><K6004>CH6_LO-LABc2
LABc1-CH6_HI<K6005>CH6_HI2-CH2_HI2<K2002>CH2_LO2-
CH6_LO2<K6002><K6005>CH6_LO-LABc2
LABc1-CH6_HI<K6011>CH6_HI3-CH2_HI3<K2008>CH2_LO3-
CH6_LO3<K6008><K6011>CH6_LO-LABc2
LABc1-CH6_HI<K6012>CH6_HI4-CH2_HI4<K2009>CH2_LO4-
CH6_LO4<K6009><K6012>CH6_LO-LABc2
```

```
LABd1-CH7_HI<K7004>CH7_HI1-CH3_HI1<K3001>CH3_LO1-
```



CH7_LO1<K7001><K7004>CH7_LO-LABd2
LABd1-CH7_HI<K7005>CH7_HI2-CH3_HI2<K3002>CH3_LO2-
CH7_LO2<K7002><K7005>CH7_LO-LABd2
LABd1-CH7_HI<K7011>CH7_HI3-CH3_HI3<K3008>CH3_LO3-
CH7_LO3<K7008><K7011>CH7_LO-LABd2
LABd1-CH7_HI<K7012>CH7_HI4-CH3_HI4<K3009>CH3_LO4-
CH7_LO4<K7009><K7012>CH7_LO-LABd2

LABd1-CH8_HI<K8004>CH8_HI1-CH4_HI1<K4001>CH4_LO1-
CH8_LO1<K8001><K8004>CH8_LO-LABd2
LABd1-CH8_HI<K8005>CH8_HI2-CH4_HI2<K4002>CH4_LO2-
CH8_LO2<K8002><K8005>CH8_LO-LABd2
LABd1-CH8_HI<K8011>CH8_HI3-CH4_HI3<K4008>CH4_LO3-
CH8_LO3<K8008><K8011>CH8_LO-LABd2
LABd1-CH8_HI<K8012>CH8_HI4-CH4_HI4<K4009>CH4_LO4-
CH8_LO4<K8009><K8012>CH8_LO-LABd2

LABa1-CH1_HI<K1004>CH1_HI1-CH5_HI1<K5001>CH5_LO1-
CH1_LO1<K1001><K1004>CH1_LO-LABa2
LABa1-CH1_HI<K1005>CH1_HI2-CH5_HI2<K5002>CH5_LO2-
CH1_LO2<K1002><K1005>CH1_LO-LABa2
LABa1-CH1_HI<K1011>CH1_HI3-CH5_HI3<K5008>CH5_LO3-
CH1_LO3<K1008><K1011>CH1_LO-LABa2
LABa1-CH1_HI<K1012>CH1_HI4-CH5_HI4<K5009>CH5_LO4-
CH1_LO4<K1009><K1012>CH1_LO-LABa2

LABa1-CH2_HI<K2004>CH2_HI1-CH6_HI1<K6001>CH6_LO1-
CH2_LO1<K2001><K2004>CH2_LO-LABa2
LABa1-CH2_HI<K2005>CH2_HI2-CH6_HI2<K6002>CH6_LO2-
CH2_LO2<K2002><K2005>CH2_LO-LABa2
LABa1-CH2_HI<K2011>CH2_HI3-CH6_HI3<K6008>CH6_LO3-
CH2_LO3<K2008><K2011>CH2_LO-LABa2
LABa1-CH2_HI<K2012>CH2_HI4-CH6_HI4<K6009>CH6_LO4-
CH2_LO4<K2009><K2012>CH2_LO-LABa2

LABb1-CH3_HI<K3004>CH3_HI1-CH7_HI1<K7001>CH7_LO1-
CH3_LO1<K3001><K3004>CH3_LO-LABb2
LABb1-CH3_HI<K3005>CH3_HI2-CH7_HI2<K7002>CH7_LO2-
CH3_LO2<K3002><K3005>CH3_LO-LABb2
LABb1-CH3_HI<K3011>CH3_HI3-CH7_HI3<K7008>CH7_LO3-
CH3_LO3<K3008><K3011>CH3_LO-LABb2
LABb1-CH3_HI<K3012>CH3_HI4-CH7_HI4<K7009>CH7_LO4-
CH3_LO4<K3009><K3012>CH3_LO-LABb2

LABb1-CH4_HI<K4004>CH4_HI1-CH8_HI1<K8001>CH8_LO1-
CH4_LO1<K4001><K4004>CH4_LO-LABb2
LABb1-CH4_HI<K4005>CH4_HI2-CH8_HI2<K8002>CH8_LO2-
CH4_LO2<K4002><K4005>CH4_LO-LABb2
LABb1-CH4_HI<K4011>CH4_HI3-CH8_HI3<K8008>CH8_LO3-
CH4_LO3<K4008><K4011>CH4_LO-LABb2
LABb1-CH4_HI<K4012>CH4_HI4-CH8_HI4<K8009>CH8_LO4-

CH4_LO4<K4009><K4012>CH4_LO-LABb2

The following signal paths are set up for contact measurements between CH_x_THRU_LO1 and CH_x_LO1:

LABa1-CH1_LO<K1004><K1001>CH1_THRU_LO1-
 CH2_THRU_LO1<K2001><K2004>CH2_LO-LABa2
 LABb1-CH3_LO<K3004><K3001>CH3_THRU_LO1-
 CH4_THRU_LO1<K4001><K4004>CH4_LO-LABb2
 LABc1-CH5_LO<K5004><K5001>CH5_THRU_LO1-
 CH6_THRU_LO1<K6001><K6004>CH6_LO-LABc2
 LABd1-CH7_LO<K7004><K7001>CH7_THRU_LO1-
 CH8_THRU_LO1<K8001><K8004>CH8_LO-LABd2

4.6.10.14.2 Sequence

Contact between CH_x_HI_y and CH_x_LO_y:

- Self-test connector present
- Coupling relays R&S TS-PSAM and R&S TS-PSM2 are closed
- For each signal path
 - Close LPB relays involved (disconnect channels from “side connector”)
 - Set up signal path
 - Perform contact measurement
 - If the contact measurement was successful
 - * Deactivate sense relay
 - * Perform isolation measurement
 - Disconnect signal path
 - Open the LPB relay involved (disconnect channels from LPB)

Contact between CH_x_THRU_LO1 and CH_x_LO1:

- Self-test connector present
- Coupling relays R&S TS-PSAM and R&S TS-PSM2 are closed
- For each signal path
 - Close LPB relays involved (disconnect channels from “side connector”)
 - Set up signal path
 - Perform contact measurement
 - Disconnect signal path
 - Open the LPB relay involved (disconnect channels from LPB)

4.6.11 Analog/Digital IO Module 2 R&S TS-PIO2

4.6.11.1 Initialisation

4.6.11.1.1 Description

The driver is opened. The “Resource Descriptor” and optional “Option String” from the physical INI file are used to do this. If the initialisation of the driver fails, the test for the module is interrupted.

4.6.11.1.2 Sequence

Function `rspio2_InitWithOptions` is called.

4.6.11.2 Configuration

4.6.11.2.1 Description

The current configuration parameters (driver and firmware version, assigned slot on the frame and hardware code) are determined. The “Option String” used during initialisation is also generated in the report.

4.6.11.2.2 Sequence

Call to function `rspio2_revision_query` and query of attributes `RSPIO2_ATTR_FRAME_NUMBER`, `RSPIO2_ATTR_SLOT_NUMBER` and `RSPIO2_ATTR_HW_CODE`.

4.6.11.3 Device self-test

4.6.11.3.1 Description

The self-test function is started in the driver. This function performs internal tests in the module. In the event of an error, it returns a message identifying the first error that was found.

4.6.11.3.2 Sequence

Call to function `rspio2_self_test`.

4.6.11.4 Supply Voltages

4.6.11.4.1 Description

Supply voltages of the module are logged.

4.6.11.4.2 Sequence

Using a special driver function, the power supply voltages monitored by the module are queried.

4.6.11.5 Temperatures

4.6.11.5.1 Description

The temperatures monitored by the module are logged. Temperatures saved during the last autocorrection are also logged.

4.6.11.5.2 Sequence

Using a special driver function, the temperatures monitored by the module are queried.

4.6.11.6 Correction Data

4.6.11.6.1 Description

The following items of status information are logged for correction date:

- The date of the last calibration (correction values saved in Flash EPROM)
- The corresponding temperature value of the 5-V reference (converter value)
- The date and time of the last autocorrection (1900-01-01, 01:00:00 if no correction has been performed)

4.6.11.6.2 Sequence

The information is queried with a special driver function.

4.6.11.7 External voltage

4.6.11.7.1 Description

The coupling relays in the module are closed. Then voltage measurements are performed between each individual bus lines and GND as well as between all individual bus lines. If too high a level is detected, the self-test must be interrupted for that module.

4.6.11.7.2 Sequence

- Close coupling relays
- Connect DMM_LO with GND
- For all bus lines
 - Switch DMM_HI to the line that will be tested
 - Perform voltage measurement
 - Disconnect DMM_HI from the bus line
- Disconnect DMM_LO from GND
- For all combinations of bus lines
 - Switch DMM_LO to the first line
 - Switch DMM_HI to the second line
 - Perform voltage measurement
 - Disconnect DMM_LO from the bus line
 - Disconnect DMM_HI from the bus line

4.6.11.8 Bus isolation

4.6.11.8.1 Description

The coupling relays on the component are closed and the insulation resistance of the bus lines with each other and the resistance of the single bus lines against GND is measured. For the measurement against GND, the DCS is used, because high-ohm resistors against GND cannot be carried out with the resistance measuring function in the Mode V (voltage injection and current measurement) of the R&S TS-PSAM module.

To determine whether the minimum permitted resistance of a bus line against GND is not reached, DCS_LO is connected with GND and DCS_HI switched to the line to be tested. A voltage of 5 V and a current limit of 10 μ A gives a threshold of the 500 kOhm. If the insulation resist-

ance is low, the source goes into the current limit and thus displays an error.

The insulation resistance between two bus lines is measured in the 10 MΩ range of the resistance measuring function. If too low a resistance is found, then the measurement with Autorange switched on is repeated to determine the exact value.

4.6.11.8.2 Sequence

- Test all bus lines against GND
- Test all combinations of bus lines between each other
- Temporarily store the result for the test of relays on the bus lines

4.6.11.9 Matrix relays LABa1, LABa2

4.6.11.9.1 Description

The function of relays on analog bus lines is tested. A contact and isolation measurement is performed for each relay. In the measurement of the contact resistance, multiple relays are always measured wired in series.

4.6.11.9.2 Sequence

The measurement path is always set up as follows:

DMM_HI - LABx (PSAM) - ABx - LABx <Kx> CHx_IN <Ky> LABy - ABy - LABy (PSAM) - DMM_LO

Signal	Note
DMM_HI	HI line of the resistance measurement unit
LABx (PSAM)	HI line on the local analog bus R&S TS-PSAM
ABx	HI line on analog bus
LABx	HI line on the local analog bus R&S TS-PIO2
Kx	Matrix relay in the HI line
CHx_IN	Channel to R&S TS-PIO2
Ky	Matrix relay in the LO line
LABy	LO line on the local analog bus R&S TS-PIO2
ABy	LO line on analog bus

Signal	Note
LAB _y (PSAM)	LO line on the local analog bus R&S TS-PSAM
DMM_LO	LO line of the resistance measurement unit

Two bus lines must always be selected that do not have any short-circuit between them. The results of the bus isolation measurement are used for this purpose.

If the measurement branch is a low-Ohm connection, the measurement value is logged as a contact resistance for both relays (K_x and K_y). Then K_x and K_y are each opened individually and a separate isolation measurement is performed for each.

If no low-Ohm connection is determined, one of the four relays involved on the module will not close. Then no isolation measurement can be performed for the matrix relay.

If one of the matrix relays is no longer open, a resistance value of approximately 2.1 MOhm is measured for the other lines CH_x_IN to the same bus. This value is derived from the series circuit of the input impedances. The lower limit for the isolation measurement has therefore been set to a value of 2 MOhm.

4.6.11.10 Matrix relays LABb1, LABb2

The function of the matrix relays of bus lines $ABb1$, $ABb2$ is tested. The same procedure is used for the test as described in Section 4.6.11.9.

4.6.11.11 Matrix relays LABc1, LABc2

The function of the matrix relays of bus lines $ABc1$, $ABc2$ is tested. The same procedure is used for the test as described in Section 4.6.11.9.

4.6.11.12 Matrix relays LABd1, LABd2

The function of the matrix relays of bus lines $ABd1$, $ABd2$ is tested. The same procedure is used for the test as described in Section 4.6.11.9.

4.6.11.13 Coupling relays

4.6.11.13.1 Description

The function of the coupling relays of the bus lines is logged. A contact and isolation measurement is performed for each relay. In the measurement of the contact resistance, multiple relays are always measured wired in series.

4.6.11.13.2 Sequence

The coupling relays are tested together with the matrix relays. The measurement path is always set up as follows:

DMM_HI - LAB_x (PSAM) - AB_x <K_x> LAB_x - CH_x_IN - LAB_y <K_y> AB_y - LAB_y (PSAM) - DMM_LO

Signal	Note
DMM_HI	HI line of the resistance measurement unit
LAB _x (PSAM)	HI line on the local analog bus R&S TS-PSAM
AB _x	HI line on analog bus
K _x	Coupling relay in the HI line
LAB _x	HI line on the local analog bus R&S TS-PIO2
CH _x _HI	Channel to R&S TS-PIO2
LAB _y	LO line on the local analog bus R&S TS-PIO2
K _y	Coupling relay in the LO line
AB _y	LO line on analog bus
LAB _y (PSAM)	LO line on the local analog bus R&S TS-PSAM
DMM_LO	LO line of the resistance measurement unit

Two bus lines must always be selected that do not have any short-circuit between them. The results of the bus isolation measurement are used for this purpose.

If the measurement branch is a low-Ohm connection, the measurement value is logged as a contact resistance for both relays (K_x and K_y). Then K_x and K_y are each opened individually and a separate isolation measurement is performed for each.

If no low-Ohm connection is determined, one of the four relays involved on the module will not close. Then no isolation measurement can be performed for the coupling relay.

4.6.11.14 Ground Relay

4.6.11.14.1 Description

Relay (K45) is tested against GND. The DCS with adjustable current limitation is used for the evaluation. The contact resistance of the normally closed contact of K3 is also tested in this test case. To test both poles of the relay, the contact measurement is performed once via the odd bus lines and once via the even bus lines.

All coupling relays to SFT DMM and R&S TS-PIO2 are closed.

The DCS is switched as follows:

For all measurements: DCS_LO to GND

First contact measurement: DCS_HI to ABa1, ABb1, ABc1, ABd1
(odd bus lines)

Second contact measurement: DCS_HI to ABa2, ABb2, ABc2, ABd2
(even bus lines)

The settings for the source were selected as follows:

Measurement type	Voltage in V	Current limiting in A	Note
Contact measurement	0.5	100e-3	Threshold at 5 Ohm
Isolation measurement	5.0	100e-6	Threshold at 50 kOhm

The following signal paths are wired in parallel for the first contact measurement on the module:

ABa1 <K37> LABa1 <K111> <K3> AGND <K45> GND
 ABb1 <K39> LABb1 <K111> <K3> AGND <K45> GND
 ABc1 <K41> LABc1 <K111> <K3> AGND <K45> GND
 ABd1 <K43> LABd1 <K111> <K3> AGND <K45> GND

The following signal paths are wired in parallel for the second contact measurement on the module:

ABa2 <K38> LABa2 <K111> <K3> AGND <K45> GND
 ABb2 <K40> LABb2 <K111> <K3> AGND <K45> GND
 ABc2 <K42> LABc2 <K111> <K3> AGND <K45> GND
 ABd2 <K44> LABd2 <K111> <K3> AGND <K45> GND

4.6.11.14.2 Sequence

- Connect DCS_HI with ABa1, ABb1, ABc1, ABd1
- Connect DCS_LO with GND
- Connect R&S TS-PIO2 AGND via K45 with GND
- Connect R&S TS-PIO2 LABa1, LABb1, LABc1 and LABd1 with AGND
- Adjust DCS for contact measurement
- Query DCS status
- Disconnect R&S TS-PIO2 AGND from GND
- If DCS was in current limiting
 - Contact measurement was successful and isolation measurement can be performed.
 - Mark the corresponding normally closed contact of K3 as “passed”
 - Isolation measurement: Configure DCS for isolation measurement; query DCS status
- Remove measurement path
- Connect DCS_HI with ABa2, ABb2, ABc2, ABd2
- Connect DCS_LO with GND
- Connect R&S TS-PIO2 AGND via K45 with GND
- Adjust DCS for contact measurement
- Query DCS status
- If DCS is in current limiting
 - Mark the corresponding contact of K3 as “passed”
 - If the isolation measurement for K45 has not been performed yet, perform the measurement now
- Disconnect connection

4.6.11.15 AGND to LAB Relays

4.6.11.15.1 Description

The contacts of relay K111 are tested. These contacts are tested using the same procedure as for the ground relay. In this case, however, the signal paths are set up one after the other:

```

ABa1 <K37> LABa1 <K111> <K3> AGND <K45> GND
ABa2 <K38> LABa2 <K111> <K3> AGND <K45> GND
ABb1 <K39> LABb1 <K111> <K3> AGND <K45> GND
ABb2 <K40> LABb2 <K111> <K3> AGND <K45> GND
ABc1 <K41> LABc1 <K111> <K3> AGND <K45> GND
ABc2 <K42> LABc2 <K111> <K3> AGND <K45> GND
ABd1 <K43> LABd1 <K111> <K3> AGND <K45> GND
ABd2 <K44> LABd2 <K111> <K3> AGND <K45> GND
  
```

4.6.11.15.2 Sequence

All coupling relays to SFT DMM and R&S TS-PIO2 are closed.

- Connect DCS_LO with GND
- Connect R&S TS-PIO2 AGND via K45 with GND
- For all bus lines
 - Connect DCS_HI with the corresponding bus line
 - Connect the corresponding bus line via K111 with AGND
 - Configure DCS for contact measurement
 - Query DCS status
 - Disconnect the bus line from AGND
 - If the contact measurement was successful
 - * Configure DCS for isolation measurement
 - * Query DCS status
 - Disconnect DCS_HI from the bus line
- Configure R&S TS-PIO2 ground-free again
- Disconnect DCS_LO from GND

4.6.11.16 Loop Back Relays

4.6.11.16.1 Description

The relays between channels `CHx_OUT` and `CHx_IN` (K2, K16, K18, K20, K22, K24, K26, K28, K30, K32, K34, K36, K102, K103, K104, K105) are tested. To do this, the output is programmed to 1.9 V (19 mA at 100 Ohm load). After the “Loop Back Relay” is closed, the voltage is measured via the analog bus with the SFT DMM. After a load has been placed on the output with the 100 Ohm reference resistor, the voltage is measured again. If the difference in voltages is less than 19 mV, then the value of the relay's contact resistor is less than 1 Ohm. If no voltage is measured or the difference is too great, the self-test reports an error. If the contact measurement was successful, the relay opened and a third voltage measurement is performed. If the relay is opened correctly, no level should be measured.

4.6.11.16.2 Sequence

Coupling relays are closed

- Connect `DMM_LO` with `GND`
- For all channels
 - Connect `DMM_HI` with analog bus line
 - Connect `CHx_OUT` with `CHx_IN`
 - Connect `CHx_IN` with analog bus line
 - Adjust current limiting with extended channel
 - Adjust the voltage
 - Perform voltage measurement (`V_ul`)
 - Connect analog bus line with 100 Ohm reference
 - Perform voltage measurement (`V_l`)
 - Disconnect `CHx_OUT` from `CHx_IN`
 - If voltage values are within the valid range
 - * Perform voltage measurement (`V_iso`)
 - Disconnect analog bus line from 100 Ohm reference
 - Switch channel to basic state
 - Disconnect `DMM_HI` from analog bus line
- Disconnect `DMM_LO` from `GND`

4.6.11.17 100 Ohm reference

4.6.11.17.1 Description

The 100 Ohm reference resistor is measured. The following connections are set up on the SFT DMM for this purpose:

Coupling relays are closed

DCS_HI to ABa1, ABb1, ABc1, ABd1

DCS_LO to GND

MU_HI to ABa1, ABb1, ABc1, ABd1

MU_LO to GND

The following signal paths are set up on the module:

AGND<K45>GND

ABa1 <K37> LABa1 <K111> <K3> 100R_REF - AGND

ABb1 <K39> LABb1 <K111> <K3> 100R_REF - AGND

ABc1 <K41> LABc1 <K111> <K3> 100R_REF - AGND

ABd1 <K43> LABd1 <K111> <K3> 100R_REF - AGND

The DCS is adjusted as follows:

Voltage: 2 V

Current limiting: 10 mA

The following statements hold true depending on the measurement value:

Measurement value	Statement
1.96 V <= measurement value < 2 V	No connection to the measurement object - Coupling relays not switching - K111 not switching - K45 not switching
1.02 V <= measurement value < 1.96 V	Incorrect resistance value
0.98 V <= measurement value < 1.02 V	100 Ohm resistance measured correctly
30 mV <= measurement value < 0.98 V	Incorrect resistance value
0 V <= measurement value < 30 mV	K3 not switching

4.6.11.17.2 Sequence

All coupling relays are closed

- Connect DCS and MU
- Set up signal path to R&S TS-PIO2
- Adjust DCS
- Perform measurement
- Disconnect signal paths

4.6.11.18 5 V reference

4.6.11.18.1 Description

Measure the 5-V reference voltage with DMM. DMM and R&S TS-PIO2 are grounded for this. DMM_HI is connected with bus lines ABa2, ABb2, ABc2, ABd2.

The following signal paths are wired in parallel on the module:

```

ABa2 <K38> LABa2 <K111> <K3> 5V_REF
ABb2 <K40> LABb2 <K111> <K3> 5V_REF
ABc2 <K42> LABc2 <K111> <K3> 5V_REF
ABd2 <K44> LABd2 <K111> <K3> 5V_REF

```

4.6.11.18.2 Sequence

All coupling relays are closed

- Connect DMM_LO with GND
- Connect DMM_HI with ABa2, ABb2, ABc2, ABd2
- Connect R&S TS-PIO2 AGND with GND
- Connect R&S TS-PIO2 LABa2, LABb2, LABc2 and LABd2 with AGND
- Perform voltage measurement
- If 5 V is measured, mark K3 as faulty
- Connect R&S TS-PIO2 LABa2, LABb2, LABc2 and LABd2 with K3 to 5V_REF
- Perform voltage measurement
- Disconnect connection

4.6.11.19 Reference Relay

The status of relay K3 is logged. This relay was already tested in test cases "Ground Relay", "100 Ohm Reference" and "5 V Reference".

4.6.11.20 Analog Input

4.6.11.20.1 Description

The voltage measurement is tested on all channels and in every measurement range. Measurements are performed on the 5-V reference and on 0 V (input connected with AGND).

4.6.11.20.2 Sequence

- Connect 5-V reference to analog bus lines (K3, K111)
- For all channels
 - Connect input to analog bus
 - For each range
 - * Measure voltage
 - Disconnect input from analog bus
- Connect analog bus lines to AGND (K3, K111) and thereby apply 0 V
- For all channels
 - Connect input to analog bus
 - For each range
 - * Measure voltage
 - Disconnect input from analog bus

4.6.11.21 Analog Output

4.6.11.21.1 Description

Different output voltages are measured with the corresponding inputs.

4.6.11.21.2 Sequence

- For all channels
 - Connect output with input
 - For each level
 - * Adjust the voltage
 - * Measure voltage
 - Disconnect output from input

4.6.11.22 Output Current

4.6.11.22.1 Description

In this test case, the stability of the output voltage is tested with load. The voltage is measured once at zero load and once at an output current of 25 mA. The 100-Ohm reference resistor is used as a load.

4.6.11.22.2 Sequence

- Connect 100-Ohm reference with K3 to K111
- For all channels
 - Connect output with input
 - Adjust current limiting for extended channel
 - Set output voltage to 2.5 V
 - Measure zero load voltage
 - Set output voltage to -2.5 V
 - Measure zero load voltage
 - Connect 100-Ohm reference resistor via K111 to analog bus
 - Connect input with analog bus line
 - Measure voltage
 - Set output voltage to 2.5 V
 - Measure voltage
 - Set output voltage to 0 V
 - Reset current limiting for extended channel
 - Disconnect input from analog bus line
 - Disconnect 100 Ohms from analog bus



- Disconnect output from input
- 100 Disconnect Ohm reference from analog bus

4.6.11.23 Digital Output

4.6.11.23.1 Description

Different output voltages as digital low/high level are measured with the corresponding inputs. The DAC output V_{out4} is responsible for the low level.

4.6.11.23.2 Sequence

- For all channels
 - Connect output with input
 - For each level
 - * Adjust the voltage
 - * Adjust the corresponding bit pattern
 - * Measure voltage
 - Disconnect output from input

4.6.11.24 Current Limit

4.6.11.24.1 Description

Current limiting of the extended channels (CH4, CH8, CH12 and CH16) is checked. Different currents are measured with the SFT DMM.

4.6.11.24.2 Sequence

All coupling relays are closed

- Connect R&S TS-PIO2 AGND with GND
- Connect SFT DMM with GND
- For all extended channels
 - Connect output with input
 - Connect input to analog bus line
 - Switch DMM_HI to analog bus
 - For all current and voltage settings
 - * Adjust the voltage
 - * Set current limiting
 - * Measure current with SFT DMM
 - Reset voltage and current limiting
 - Disconnect DMM_HI from analog bus
 - Disconnect input from analog bus line
 - Disconnect output from input
- Disconnect AGND from GND
- Configure SFT DMM ground free

4.6.11.25 Digital Input

4.6.11.25.1 Description

The input comparators are tested. To do this, different limits are set (“High Threshold” and “Low Threshold”), in each case to the same value. All outputs are connected with the inputs and switched to “Digital Static” mode. The “Digital Low Level” is programmed to a level just under the threshold and the “Digital High Level” is programmed to a level just over the threshold. All inputs must detect the “High” and “Low” level.

4.6.11.25.2 Sequence

- For all channels
 - Connect output with input
 - Activate “Digital Static” mode
- For all thresholds to be tested
 - For all channels
 - * Adjust input thresholds
 - * Set “Output Digital High Level”
 - * Set “Output Digital Low Level”
 - Set all outputs to “High”
 - Read bit pattern via comparators
 - Set all outputs to “Low”
 - Read bit pattern via comparators
- Reset to basic state

4.6.11.26 Square Wave

4.6.11.26.1 Description

The output of square wave signals is tested. To do this, a square wave signal with the following properties is generated on the extended channels:

Low Level: -27 V
High Level: 27 V
Frequency 100 Hz
Ratio: 50 %

The square wave signal is recorded at the maximum sampling rate and evaluated.

4.6.11.26.2 Sequence

- For all extended channels
 - Connect output with input
 - Activate “Squarewave” mode
 - Adjust level, frequency, and ratio
 - Start square wave generation
 - Record waveform
 - Stop square wave generation
 - Switch the channel to its basic state

4.6.11.27 Trigger bus input

4.6.11.27.1 Description

Tests trigger inputs `PXI0` to `PXI7`. The SFT DMM generates trigger signals with a duration of 200 ns on the corresponding lines. The sequence control of the R&S TS-PIO2 module is started by these signals.

4.6.11.27.2 Sequence

- Set external triggering
- Configure measurement
- For all lines `PXI0` to `PXI7`
 - Configure trigger generator, activate output
 - Start the first measurement, call the read function and test for expected exceeding of measurement time (no trigger signal). If the measurement was triggered in an unexpected manner, interrupt the test for that line.
 - Start second measurement
 - Generate trigger signal
 - Retrieve measurement data
 - Deactivate trigger output to SFT DMM

4.6.11.28 Trigger bus output

4.6.11.28.1 Description

Tests trigger outputs `PXI0` to `PXI7`. The R&S TS-PIO2 module generates trigger pulses approximately 1 μ s in length. The measurement unit on the SFT DMM module is set to external triggering and receives these signals.

4.6.11.28.2 Sequence

- For all lines `PXI0` to `PXI7`
 - Configure and activate trigger output
 - Configure external triggering to SFT DMM
 - Start measurement
 - Generate trigger signal with R&S TS-PIO2 module
 - Retrieve measurement data from SFT DMM
 - Deactivate trigger output

4.6.11.29 Noise Input

4.6.11.29.1 Description

In this test case, inputs are connected with $AGND$ and are sampled with the lowest and maximum input bandwidth. The average value and peak to peak value of the voltage are recorded.

4.6.11.29.2 Sequence

- Switch all bus lines to $AGND$
- For all channels
 - Connect input with analog bus line
 - For both input bandwidths
 - * Configure the sample interval and number of samples
 - * Record measurement values
 - Disconnect input from analog bus line
- Disconnect all bus lines from $AGND$

4.6.11.30 Noise Output

4.6.11.30.1 Description

In this test case, inputs are connected with the outputs and are sampled with the lowest and maximum input bandwidth. The measurements are performed at an output voltage of 0 V. The average value and peak to peak value of the voltage are recorded.

4.6.11.30.2 Sequence

- For all channels
 - Connect input with output
 - Set current limiting for the extended channels to 10 mA
 - For both input bandwidths
 - * Configure the sample interval and number of samples
 - * Record measurement values
 - Reset current limiting for the extended channels
 - Disconnect input from output

4.6.11.31 Noise Current Limit

4.6.11.31.1 Description

In this test case, inputs of the extended channels are connected with the outputs and are sampled under load with the lowest and maximum input bandwidth. The measurements are performed at an output voltage of 1 V and with active current limitations of 2 mA. The 100-Ohm reference resistor serves as the load. The average value and peak to peak value of the voltage are recorded.

4.6.11.31.2 Sequence

- Connect analog bus line with 100-Ohm reference resistor
- For all extended channels
 - Connect input with output
 - Connect input via analog bus line 100 Ohms
 - Set voltage to 1 V
 - Set current limiting to 2 mA
 - For both input bandwidths
 - * Configure the sample interval and number of samples
 - * Record measurement values
 - Reset current limiting
 - Reset voltage
 - Disconnect input from output and analog bus
- Disconnect analog bus lines from 100-Ohm reference resistor

4.6.11.32 Input Multiplexer

The self-test connector is required for this test.

4.6.11.32.1 Description

The 100-Ohm resistor and relays between `CHx_IN` and `CHx_1`, `CHx_2` in the channel input are tested. `CHx_1R` is connected with `LO` in the self-test connector. The resistance is measured with the `SFT_DMM`.

The following measurement paths are set up:

```
DMM_HI - ABx1 - CHx_IN <Kmux> CHx_1 <100R> LO <K106> AGND <K3> <K111>
ABx2 - DMM_LO
```

or

```
DMM_HI - ABx1 - CHx_IN <Kmux> CHx_2 <499R> LO <K106> AGND <K3> <K111>
ABx2 - DMM_LO
```

The contact between `LO` and `AGND` (`K106`) is also measured during resistance measurements. The isolation measurement is therefore also performed for this contact.

4.6.11.32.2 Sequence

All coupling relays are closed

Connect `AGND` with `ABa2`, `ABb2`, `ABc2` and `ABd2`

Connect `AGND` with `LO`

Connect `DMM_LO` with `ABa2`, `ABb2`, `ABc2` and `ABd2`

For all channels

- Connect input with analog bus (`CHx_IN` with `LABx1`)
- Connect resistor with input (`CHx_1` with `CHx_IN`)
- Perform measurement
- Disconnect resistor from input (`CHx_IN` from `CHx_1`)
- If the resistance measurement was in the valid range
 - Perform isolation measurement for the relay between `CHx_IN` and `CHx_1`
 - Reconnect `CHx_IN` with `CHx_1`
 - If the isolation measurement for `K106` has not been performed yet
 - * Reconnect `CHx_IN` with `CHx_1`
 - * Disconnect `LO` from `AGND` (`K106`)
 - * Perform isolation measurement for `K106`
 - * Reconnect `LO` with `AGND`



- Connect CH_x_IN with CH_x_2
- Perform resistance measurement (499 Ohm in the self-test connector)
- Disconnect CH_x_IN from CH_x_2
- If the resistance measurement was in the valid range
 - Perform isolation measurement
- Disconnect input from the analog bus

4.6.11.33 LO Relay

The self-test connector is required for this test.

The result of measurements for the LO relay (K106) is logged. The measurements were performed in test case "Input Multiplexer".

4.6.11.34 Output Standard Channel

The self-test connector is required for this test.

4.6.11.34.1 Description

In this test case, the relay between CH_x_OUT and CH_x_OUT1 is tested for the standard channels. To do this, the output voltage is first measured internally at zero load. Then a load is placed on the output via the following path:

CH_x_OUT <Kout> CH_x_OUT1 - CH_x_1 <100R> CH_x_1R - LO - AGND

The voltage on the relay contact is measured via the connection from CH_x_IN to CH_x_1. At a voltage of 2.5 V, a current of 25 mA flows through the contact and thus through the 100-Ohm resistor.

4.6.11.34.2 Sequence

- Connect AGND with LO
- For all standard channels
 - Connect output with input
 - Set voltage to 2.5 V
 - Measure voltage V_{u1} at zero load
 - Connect CH_x_OUT with CH_x_OUT1
 - Connect CH_x_IN with CH_x_1
 - Measure voltage V₁ under load
 - Disconnect CH_x_OUT from CH_x_OUT1
 - If the contact measurement was successful
 - * Measure voltage V_{iso} with relay open
 - Disconnect CH_x_IN from CH_x_1
 - Reset voltage
- Disconnect AGND from LO

4.6.11.35 Output Extended Channel

The self-test connector is required for this test.

4.6.11.35.1 Description

In this test case, the function of the relay is tested between `CHx_OUT` and `CHx_OUT1` together with switching to external sensing for the extended channels. To do this, the output voltage is first measured internally at zero load. Then a load is placed on the output via the following path:

`CHx_OUT <Kout> CHx_OUT1 <10R> CHx_1 <100R> CHx_1R <10R> LO - AGND`

The voltage on the relay contact is measured via the connection from `CHx_IN` to `CHx_1`. The test is performed at a voltage of 2.7 V.

Then external sensing is turned on and the voltage is measured on both sides of the load resistor.

4.6.11.35.2 Sequence

- Connect `AGND` with `LO`
- For all extended channels
 - Connect output with input
 - Set voltage to 2.7 V
 - Adjust current limiting to 100 mA
 - Measure voltage `V_u1` at zero load
 - Connect `CHx_OUT` with `CHx_OUT1`
 - Connect `CHx_IN` with `CHx_1`
 - Measure voltage `V_1` under load
 - Disconnect `CHx_OUT` from `CHx_OUT1`
 - If the contact measurement was successful
 - * Measure voltage `V_iso` with relay open
 - * Reconnect `CHx_OUT` with `CHx_OUT1`
 - * Turn on external sensing
 - * Measure voltage `V_sense_hi` via `CHx_1`
 - * Disconnect `CHx_IN` from `CHx_1`
 - * Connect `CHx_IN` with `CHx_2`
 - * Measure voltage `V_sense_lo` via `CHx_2`
 - * Disconnect `CHx_IN` from `CHx_2`
 - Reset voltage
- Disconnect `AGND` from `LO`

4.6.11.36 5 V Reference Load Test

The self-test connector is required for this test.

4.6.11.36.1 Description

The 5-V reference voltage is measured once with the DMM at zero load and once at a load of 499 Ohms. DMM and R&S TS-PIO2 are grounded for this.

4.6.11.36.2 Sequence

All coupling relays are closed

- Connect DMM_LO with GND
- Connect DMM_HI with ABa2
- Connect R&S TS-PIO2 AGND with GND
- Connect R&S TS-PIO2 LABa2 with AGND
- Connect CH1_IN with LABa2
- Connect AGND with LO
- Perform voltage measurement at zero load
- Connect CH1_IN with CH1_2 (499 Ohm against LO)
- Perform voltage measurement
- Disconnect connection



4.6.11.37 External Trigger

The self-test connector is required for this test.

4.6.11.37.1 Description

Signals `XTO1` and `XTI1` are connected in the self-test connector. A trigger signal is generated on line `XTO1` that starts the sequence control of the R&S TS-PIO2 module.

4.6.11.37.2 Sequence

- Configure trigger output
- Configure external triggering
- Start measurement
- Generate trigger signal `XTO1`
- Retrieve measurement data

4.6.12 High-Speed Digital Test Module R&S TS-PHDT

4.6.12.1 Initialisation

4.6.12.1.1 Description

The test for the High-Speed Digital Test Module R&S TS-PHDT is prepared. Entries in the physical INI file are read for this purpose. If the initialisation fails, the test for the module is interrupted.

4.6.12.1.2 Sequence

If no session exists for the module yet, function `rsphdt_InitWithOptions` is called.

4.6.12.2 Configuration

4.6.12.2.1 Description

The current configuration parameters (driver and firmware version, assigned slot on the frame, and hardware code of the R&S TS-PHDT module) are determined. The “Option String” used during initialisation is also generated in the report.

4.6.12.2.2 Sequence

Call to function `rsphdt_revision_query` and query of attributes `RSPHDT_ATTR_FRAME_NUMBER`, `RSPHDT_ATTR_SLOT_NUMBER` and `RSPHDT_ATTR_HW_CODE_MAIN`.

4.6.12.3 Device self-test

4.6.12.3.1 Description

The self-test function is started in the driver. This function performs internal tests in the module. In the event of an error it returns a message identifying the first error that was found.

4.6.12.3.2 Sequence

Call to function `rsphdt_self_test`.



4.6.12.4 Output Voltages

4.6.12.4.1 Description

Output voltages of the stimulus port are remeasured with the SFT-DMM.

4.6.12.4.2 Sequence

- SFT-DMM ground-free
- Connect SFT-DMM HI with ABd1
- Connect SFT-DMM LO with ABd2
- Configure SFT-DMM for voltage measurement
- For all channels
 - Connect channel with analog measurement bus
 - Define current limiting for “High” and “Low” level
 - Set channel to “High”
 - For all levels
 - * Set “High Level”
 - * Remeasure level with SFT-DMM
 - Set channel to “Low”
 - For all levels
 - * Set “Low Level”
 - * Remeasure level with SFT-DMM
 - Disconnect channel from analog measurement bus
- Disconnect SFT-DMM from analog measurement bus

4.6.12.5 Output Current Limit

4.6.12.5.1 Description

The adjustable current limiting for the stimulus outputs is remeasured with SFT-DMM.

4.6.12.5.2 Sequence

- SFT-DMM ground-free
- Connect SFT-DMM HI with ABd1
- Connect SFT-DMM LO with ABd2
- Configure SFT-DMM for current measurement
- For all channels
 - Connect channel with analog measurement bus
 - Define output voltage for “High” and “Low” level
 - Set channel to “High”
 - For all current limiting to be set
 - * Set “Current Limit High”
 - * Remeasure current with SFT-DMM
 - Set channel to “Low”
 - For all current limiting to be set
 - * Set “Current Limit Low”
 - * Remeasure current with SFT-DMM
 - Disconnect channel from analog measurement bus
- Reset SFT-DMM
- Disconnect SFT-DMM from analog measurement bus

4.6.12.6 Thresholds

4.6.12.6.1 Description

The comparators in the inputs are tested. To do this, different limits are set (“High Threshold” and “Low Threshold”, in each case to the same value). All outputs are connected with the inputs. The “Stimulus Low Level” is programmed to a level just under the limit and the “Stimulus High Level” is programmed to a level just over the limit. All inputs must detect the “High” and “Low” level.

4.6.12.6.2 Sequence

- For all channels
 - Connect output with input
- For all limits to be tested
 - Set the thresholds
 - Set High Level
 - Set Low Level
 - Set all outputs to “High”
 - Read bit sample via comparators
 - Set all outputs to “Low”
 - Read bit sample via comparators
- Produce the basic state

4.6.12.7 Dynamic

4.6.12.7.1 Description

Stimulus and reference data is transferred to the module. The outputs are connected with the inputs. The patterns are generated and read back at the fastest rate.

4.6.12.7.2 Sequence

- Transfer stimulus and reference data
- Configure stimulus and response port
- Set stimulus and response timing
- Start input and output of patterns
- Log event

4.6.12.8 Trigger bus input

4.6.12.8.1 Description

Tests trigger inputs PXI0 to PXI7. The SFT DMM generates trigger signals with a duration of 200 ns on the corresponding lines. The sequence control of the R&S TS-PHDT module is started by these signals.

4.6.12.8.2 Sequence

- Set external triggering
- Configure measurement
- For all lines PXI0 to PXI7
 - Configure trigger generator, activate output
 - Start the first measurement, call the wait function, and test for expected exceeding of measurement time (no trigger signal). If the measurement was triggered in an unexpected manner, interrupt the test for that line.
 - Start the second measurement
 - Generate trigger signal
 - Call the wait function
 - Deactivate trigger output to SFT-DMM

4.6.12.9 Trigger bus output

4.6.12.9.1 Description

Tests trigger outputs PXI0 to PXI7. Module R&S TS-PHDT generates the required trigger pulses. The measurement unit on the SFT-DMM module is set to external triggering and receives signals.

4.6.12.9.2 Sequence

- For all lines PXI0 to PXI7
 - Configure and activate trigger output
 - Configure external triggering to SFT-DMM
 - Start measurement
 - Generate trigger signal with R&S TS-PHDT module
 - Retrieve measurement data from SFT-DMM
 - Deactivate trigger output

4.6.12.10 Thresholds via X10

The self-test connector is required for this test.

4.6.12.10.1 Description

This test runs similarly to the “Thresholds” test case. Signals are directed via the self-test connector.



4.6.12.11 Dynamic via X10

The self-test connector is required for this test.

4.6.12.11.1 Description

This test runs similarly to the “Dynamic” test case. Signals are directed via the self-test connector.

4.6.12.12 External Trigger

The self-test connector is required for this test.

4.6.12.12.1 Description

XTOx and XTix signals are combined with each other in the self-test connector. A trigger signal is generated on lines XTOx which starts the sequence control of the module via the corresponding trigger input XTix.

4.6.12.12.2 Sequence

- For all external triggers
 - Configure trigger output
 - Configure external triggering
 - Configure trigger generator, activate output
 - Start the first measurement, call the wait function, and test for expected exceeding of measurement time (no trigger signal). If the measurement was triggered in an unexpected manner, interrupt the test.
 - Start the second measurement
 - Generate trigger signal
 - Call the wait function
 - Log event

4.6.13 Calibration module 2 R&S RS-PCAL2

4.6.13.1 Initialisation

4.6.13.1.1 Description

The test for the module is prepared. Entries in the physical INI file are read for this purpose. If the initialisation fails, the test for the module is interrupted.

4.6.13.1.2 Sequence

If no session exists for the module yet, the `rspmb_InitWithOptions` function is called up. The R&S TS-PCAL module is controlled by the device driver for the R&S TS-PMB module.

4.6.13.2 Configuration

4.6.13.2.1 Description

The current configuration parameters (driver and firmware version, assigned slot on the frame and hardware code) are determined. The "Option String" used during initialisation is also output in the report.

4.6.13.2.2 Sequence

Call up the `rspmb_RioRevisionQuery` function.

4.6.13.3 Temperatures

4.6.13.3.1 Description

The temperatures monitored by the module are logged. Temperatures logged during the last auto correction are also saved.

4.6.13.3.2 Sequence

The undocumented driver function `rspmb_PcalGetTempState` is used to query the temperatures monitored by the module.

4.6.13.4 Correction data

4.6.13.4.1 Description

The following items of status information are logged for the correction data:

Date of last calibration (correction values saved in Flash Eprom)

Corresponding temperature value of 5V reference (converter value)

Date and time of last auto correction (1900-01-01, 01:00:00 if no correction has been performed)

4.6.13.4.2 Sequence

The driver function `rspmb_PcalGetCorrState` is used to query the temperatures monitored by the module.

4.6.13.5 Device self test

4.6.13.5.1 Description

The following test cases are called up successively, the measured data is evaluated and logged:

- Measurement Unit / Open
- Measurement Unit / 5V Reference
- Measurement Unit / Voltage Source
- Measurement Unit / Current Source
- LAB Relay Tests
- Reference Resistors Tests
- ADS DC Voltage Tests
- ADS AC Voltage Tests
- AGND Relay Test
- Current Source Test
- GND Relay Test

4.6.13.5.2 Sequence

Call up the individual test cases.

4.6.13.6 Measurement Unit / Open

4.6.13.6.1 Description

The function of the unconnected HI and LO measurement unit input is tested. The MU_HI line represents the input to the voltage meter, while the MU_LO line is the input to the ammeter on the measurement unit. The other side of the ammeter is connected to AGND.

The two relays MU_HI - HI, MU_HI - LO and the relay MU_LO - LO remain open. The applied voltage is measured at the MU_HI wire. The current is measured at the MU_LO line.

The expected measured values are 0 Volts and 0 Amps.

4.6.13.6.2 Sequence

No measuring path is set up. All relays are opened.

The 50 Volt voltage range is set on the voltage measurement unit as this has an input resistance of 1 MOhm. With an open MU_HI line input, this is thus drawn to the defined level AGND.

No range needs to be set for the current measurement.

4.6.13.7 Measurement Unit / 5V Reference

4.6.13.7.1 Description

The function of the measurement unit HI input is tested. To do this, the 5 Volt voltage reference is connected to the measurement unit and the voltage measured.

4.6.13.7.2 Sequence

The measuring path is set up as follows:

MU_HI - HI - 5V_REF

Signal	Note
MU_HI	Measurement unit HI line (configured for voltage measurement)
HI	HI line
5V_REF	5 Volt reference voltage source (component of measurement unit)

The 50 Volt voltage range is set on the measurement unit as this has an input resistance of 1 MOhm. With an open MU_HI line input, this is

thus drawn to the defined level AGND. For this and all other test cases, unless otherwise explicitly specified, 100 samples of the voltage are recorded in a period of 20 ms and the average value from these samples is calculated.

If, as expected, the reference voltage of 5 Volt can be measured on the measurement unit, the two relays involved in the circuit are then opened in turn. The voltage on the measurement unit must fall to 0 Volt in both cases.

If the reference voltage cannot be measured with closed relays, the next test case attempts to obtain more information about whether the measurement unit or the reference voltage source is defective. In this case, rather than the reference voltage a voltage generated by the measurement unit voltage source is connected to the MU_HI line.

4.6.13.8 Measurement Unit / Voltage Source

4.6.13.8.1 Description

The function of the programmable voltage source is tested. To do this, it is connected to the measurement unit MU_HI line and the programmed voltage is measured. In conjunction with the preceding test case, which measures the 5 Volt reference source for for the R&S TS-PCAL2 module, in case of an error it is possible to determine with a high degree of probability whether the module's measurement unit or one of the voltage sources (or the corresponding actuating relay) are defective.

4.6.13.8.2 Sequence

The measuring path is set up as follows:

MU_HI - HI - CS_VS_HI

Signal	Note
MU_HI	Measurement unit HI line (configured for voltage measurement)
HI	HI line
CS_VS_HI	Current/voltage source (component of measurement unit)

The 50 Volt voltage range is set on the measurement unit as this has an input resistance of 1 MOhm. With an open MU_HI line input, this is thus drawn to the defined level AGND.

Three different levels of the voltage source are measured.

- 0.0 Volt
- 0.5 Volt
- 5.0 Volt

If, as expected, the output voltage of the programmable source can be measured on the measurement unit, the two relays involved in the circuit are then opened in turn. The voltage on the measurement unit must fall to 0 Volt in both cases.

4.6.13.9 Measurement Unit / Current Source

4.6.13.9.1 Description

The function of the programmable current source is tested. To do this, it is connected to the measurement unit MU_LO line and the programmed current is measured. Currents of up to 200 μA can be measured.

4.6.13.9.2 Sequence

The measuring path is set up as follows:

MU_LO - LO - HI - CS_VS_HI

Signal	Note
MU_LO	Measurement unit LO line (configured for current measurements)
LO	LO line
HI	HI line
CS_VS_HI	Current/voltage source (component of measurement unit)

There is only one measuring range for current measurements on the measurement unit.

Three different current source values are measured:

- 20 μA (current source cannot be set to 0 μA)
- 100 μA
- 200 μA

If, as expected, the output current of the programmable current source can be measured on the measurement unit, the four relays involved in the circuit are then opened in turn. The current on the measurement

unit must fall to 0 Amps in each case.

4.6.13.10 LAB Relay Tests

4.6.13.10.1 Description

The function of relays on analog measurement bus lines is tested. A contact and isolation measurement is performed for each relay. In the measurement of the contact resistance, multiple relays are always measured wired in series. For contact measurements, a current is supplied via CS_VS_HI and the falling voltage at the relays is measured with the voltage meter MU_HI. For isolation measurements, one of the relays to be tested is opened, a voltage is supplied via CS_VS_HI and the current flowing through the relay is measured with the ammeter MU_LO.

4.6.13.10.2 Sequence

For both the contact and isolation measurements, the measuring path is set up as follows:

CS_VS_HI - HI - <Kx> - LABxy - <Ky> - LO - MU_LO

In addition, the relay HI - MU_HI is closed.

Signal	Note
CS_VS_HI	Current/voltage source (component of measurement unit)
HI	HI line
LABxy	Local analog bus line R&S TS-PCAL2 (where x = A to D and y = 1 or 2)
LO	LO line
MU_LO	Measurement unit LO line (configured for current measurements)
MU_HI	Measurement unit HI line (configured for voltage measurement)

For the contact measurements, a current of 10 mA is supplied. For the isolation measurements, a voltage of 10 V is supplied. The voltage measurements at MU_HI are performed in the 5 V range. There is only one measuring range for current measurements on the measurement unit.

4.6.13.11 Reference Resistors Tests

4.6.13.11.1 Description

On the R&S TS-PCAL2 module there are three reference resistors with values of 10 kOhm, 100 kOhm and 1 MOhm. The resistance values for these reference resistors are determined. To do this, current is supplied and the falling voltage on the corresponding resistor is measured.

4.6.13.11.2 Sequence

The measuring path is set up as follows:

CS_VS_HI - HI - LABB2 - <Kx> - <Ky> - LABB1 - LO - MU_LO

In addition, the relay HI - MU_HI is closed.

Signal	Note
CS_VS_HI	Current/voltage source (component of measurement unit)
HI	HI line
LABB2	Local analog bus line B2 to R&S TS-PCAL2
<Kx>	Relay that closes the path to the three reference resistors.
<Ky>	One of the three relays that select the reference resistor.
LABB1	Local analog bus line B1 to R&S TS-PCAL2
LO	LO line
MU_LO	Measurement unit LO line (configured for current measurements)
MU_HI	Measurement unit HI line (configured for voltage measurement)

Depending on the reference resistor to be tested, the following currents are supplied:

- 1 MOhm: 10 μ A
- 100 kOhm: 100 μ A
- 10 kOhm: 200 μ A

If the reference resistances can be measured successfully, this means that all of the relays involved could be closed. The relays involved are then opened alternately to perform an isolation test on them. The measured current at MU_LO must then be 0 Amps.

4.6.13.12 ADS DC Voltage Tests

4.6.13.12.1 Description

The DC function of the AC / DC voltage source ADS is tested on the R&S TS-PCAL2 module. At the ADS_HI voltage source output, voltage levels from -20 V to +20 V to AGND can be applied. The ADS_LO output returns the inverted signal from ADS_HI. The voltages are verified using the R&S TS-PCAL2 voltage measurement unit at the MU_HI input. Thus, voltages from -40 V to +40 V can be reached between ADS_HI and ADS_LO. The accuracies in the data sheet are only specified for voltages between ADS_HI and ADS_LO. Therefore, in the self test the individual voltages for ADS_HI to AGND and ADS_LO to AGND are added together and checked for data retention.

4.6.13.12.2 Sequence

The measuring path is set up as follows:

ADS_HI - HI - MU_HI or

ADS_LO - LO - MU_HI

Signal	Note
ADS_HI (ADS_LO)	AC / DC voltage source (ADS_LO: inverted output from ADS_HI)
HI	HI line
MU_HI	Measurement unit HI line (configured for voltage measurement)

The following DC voltage levels are tested in range 40 volts:

- -20 V
- -10 V
- 0 V
- +10 V
- +20 V

The following DC voltage levels are tested in range 4 volts:

- -2 V
- -1 V
- 0 V
- +1 V
- +2 V

The voltage measurements at MU_HI are performed in the 50 V range. This test case also tests whether the ADS_HI - HI and ADS_LO - LO relays can be opened. The voltage at MU_HI is then reduced to 0 V.

4.6.13.13 ADS AC Voltage Tests

4.6.13.13.1 Description

The AC function of the AC / DC voltage source ADS is tested on the R&S TS-PCAL2 module. At the ADS_HI voltage source, sinusoid signals with peak values from -20 V to +20 V to AGND can be applied. The ADS_LO output returns the inverted signal from ADS_HI. The voltages are verified using the R&S TS-PCAL2 voltage measurement unit at the MU_HI input. Thus, voltages from -40 V to +40 V can be reached between ADS_HI and ADS_LO. The accuracies in the data sheet are only specified for voltages between ADS_HI and ADS_LO. In the self test the individual voltages for ADS_HI to AGND and ADS_LO to AGND are checked for data retention.

4.6.13.13.2 Sequence

The measuring path is set up as follows:

ADS_HI - HI - MU_HI or

ADS_LO - LO - MU_HI

Signal	Note
ADS_HI (ADS_LO)	AC / DC voltage source (ADS_LO: inverted output from ADS_HI)
HI	HI line
MU_HI	Measurement unit HI line (configured for voltage measurement)

The following effective sinusoid voltage values are set and verified:

- 14.14 V
- 7.07 V
- 0 V

These measurements are performed at the following ADS output frequencies:

- 55 Hz
- 500 Hz (10 scanning points at 200 µs scanning time)

The voltage measurements at MU_HI are performed in the 50 V range.

In each case, 100 samples are recorded.

4.6.13.14 AGND Relay Test

4.6.13.14.1 Description

The function of the AGND - LO relay is tested. To do this, the ADS AC / DC voltage source on the R&S TS-PCAL2 module is used to apply a voltage at the 1 MOhm reference resistor and the voltage level between the resistor and the AGND - LO relay is measured using the MU_HI voltage meter on the measurement unit. If this relay is closed, the voltage level must fall to 0 Volt.

4.6.13.14.2 Sequence

The measuring path is set up as follows:

ADS_HI - HI - LABB2 - <Kx> - <Ky> - LABB1 - LO - MU_HI

The AGND - LO relay is initially closed and is then opened.

Signal	Note
ADS_HI	AC / DC voltage source
HI	HI line
LABB2	Local analog bus line B2 to R&S TS-PCAL2
<Kx>	Relay that closes the path to the three reference resistors.
<Ky>	The 1 MOhm reference resistor is selected.
LABB1	Local analog bus line B1 to R&S TS-PCAL2
LO	LO line
MU_HI	Measurement unit HI line (configured for voltage measurement)
AGND	Floating earth on the R&S TS-PCAL2 module

A DC voltage level of 4 Volt is set on the ADS AC/DC voltage source.

The voltage measurement at MU_HI is performed in the 5V range (very high input resistance).

4.6.13.15 Current Source Test

4.6.13.15.1 Description

The current source CS on the R&S TS-PCAL2 connected to the system earth is tested. To do this, currents of different levels are supplied by the current source and verified using the measurement unit on the R&S TS-PCAL2 module. The current measuring path for the measurement unit includes a 0.18 Ohm shunt resistor. For this test case, the measurement unit must also be connected to the system earth, i.e. AGND must be connected to GND.

4.6.13.15.2 Sequence

The measuring path is set up as follows:

CS_HI - HI - MU_HI and AGND - LO - GND

Signal	Note
CS_HI	Current source connected to system earth
HI	HI line
MU_HI	Measurement unit HI line (configured for current measurement)
AGND	Floating earth on the R&S TS-PCAL2 module
LO	LO line
GND	System earth on the R&S TS-PCAL2 module

The following currents are supplied by the current source CS:

- 1 A
- 500 mA
- 100 mA

There is only one measuring range for current measurements on the measurement unit.

4.6.13.16 GND Relay Test

4.6.13.16.1 Description

The function of the GND - LO relay is tested. To do this, a current of 100 mA is supplied by the current source and verified using the measurement unit on the R S TS-PCAL2 module. The current measuring path for the measurement unit includes a 0.18 Ohm shunt resistor. For this test case, the measurement unit must be connected to the system earth, i.e. AGND must be connected to GND. The GND - LO relay is then opened. The measurement unit is then no longer connected to the system earth. The measured current must fall to 0 A.

4.6.13.16.2 Sequence

CS_HI - HI - MU_HI and AGND - LO - <Kx> - GND

The <Kx> relay is initially closed and is then opened.

Signal	Note
CS_HI	Current source connected to system earth
HI	HI line
MU_HI	Measurement unit HI line (configured for current measurement)
AGND	Floating earth on the R&S TS-PCAL2 module
LO	LO line
GND	System earth on the R&S TS-PCAL2 module

There is only one measuring range for current measurements on the measurement unit.

4.6.14 Power Supply/Load Module 12V R&S TS-PSU12

Testing the Power Supply/Load Module 12V R&S TS-PSU12 module involves performing all the test cases for the Power Supply/Load Module R&S TS-PSU (see chapter 4.6.9) with one exception. The „PAC control“ test is omitted as the TS-PSU12 module is supplied by an R&S TS-PDC. The parameters in the test cases are adjusted to the technical data for the R&S TS-PSU12 module.

4.6.15 Digital IO Module 3B R&S TS-PIO3B

Among other things, the Digital IO Module 3B R&S TS-PIO3B serves for controlling adapter or system components. For this reason, the numerous possible configurations and applications do not permit a thorough self-test. Thus, the basic status of the port is not changed. As part of the self-test, the availability of the module via the CAN bus and the topical configuration with the R&S TS PTRF module and other additional modules (e.g. R&S TS PXM1) is determined.

4.6.15.1 Initialization

4.6.15.1.1 Description

The test for the module is prepared. Entries in the physical INI file are read for this purpose. If the initialization fails, the test for the module is aborted.

4.6.15.1.2 Sequence

If a session to the module is not yet active, the `rspiob3b_InitWithOptions` function will be called.

4.6.15.2 Configuration

4.6.15.2.1 Description

The topical configuration parameters (driver and firmware version, occupied slot in the frame and hardware code) will be determined. The "Option String" used during initialization is also output in the report. In addition, the configuration of additional modules (R&S TS-PTRF, R&S TS-PXM1) is determined and output.

4.6.15.2.2 Sequence

Call of the `rspio3b_revision_query` and `rspio3b_AddOnRevisionQuery` functions. If an R&S TS-PTRF module is detected in this process, the ports will be queried for known additional modules. Using the `rspio3b_PtrfAddOnRevisionQuery` function, a module identification is performed for each port. For this purpose, a Chip Select signal is generated for the corresponding port and a "0x03 0x00 0x00" read command is transmitted to the EEPROM via the SPI bus for module identification. In addition, a sufficient number of pulses will be generated to read in a complete "IDENT block". If an additional module is connected to the port, the EEPROM will respond by sending the desired information.

4.6.15.3 Device Self-Test

4.6.15.3.1 Description

The self-test function of the driver will be enabled. The self-test will read the status register of the hardware module. Any error status is documented.

4.6.15.3.2 Sequence

Call of the `rspio3b_self_test` function.

4.6.15.4 Fuse Test

4.6.15.4.1 Description

During this test the fuses in the voltage supply lines +12 V, +5 V, +3.3 V (AUX1) and -12 V (AUX2) are checked.

4.6.15.4.2 Sequence

The function `rspio3b_ReadADC` is called with the input parameter '9' (A/D converter channel 9).

The issued voltage of the A/D converter represents the sum all input voltages to be tested. For this the input voltages are fed in common via a summing amplifier to channel 9 of the A/D converter.

If, for example, the AUX1 und AUX2 lines are activated via the jumpers

X2 and X3 (default setting) and no voltages are applied on both AUX lines, a A/D converter voltage of 1.0 V is expected. This value must be within the limits of 0.875 and 1.125 V. A fuse defect changes this value by at least 250 mV and can therefore be detected.

Changing the default jumper settings X2 and X3 or applying an external voltage on the AUX lines by the user, changes the expected A/D converter voltage. In this case the limits against which the value shall be compared, can be manually specified by the user in the file `physical.ini` within the relevant section for the module R&S TS-PIO3B.

Example:

```
SFTFuseTest = 1.2,0.8
```

```
(SFTFuseTest = <upper limit/V>,<lower limit/V>)
```

4.7 Self Test Report

See appendix A.



5 Manual Fault Finding

5.1 Visual Inspection

On the occurrence of an error on the R&S CompactTSVP / R&S PowerTSVP a visual inspection of the housing, the internal modules (e.g. backplanes) and the plug-in cards is to be performed. In the case of obvious faults, the corresponding module is to be replaced.

5.2 Supply Voltages



NOTE:

The supply voltages of the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP can be indicated by LED's on the plug-in cards.

The front panel of the Plug-In Cards incorporates three LED's with the following functions:

LED	Description
red	Fault condition: Lights up when a fault is detected on the Plug-In Card in the power-on test after the supply voltage is switched on.
yellow	Communication: Lights up briefly when the Plug-In Card is accessed via the interface.
green	Supply voltage OK: Lights up when all supply voltages are present.

Table 5-1 Display elements on the Plug-In Cards

LED Test:

When voltage is powered up all three LEDs light up for around 1 second. This ensures that the 5 V supply is present and that the LED's and power-on test are functioning.



5.3 Fans

On the occurrence of over temperature in the housing of the R&S CompactTSVP / R&S PowerTSVP , the fault may be caused by insufficient ventilation. The possible causes of the fault may be dirty or faulty fans. The fans must be cleaned at regular intervals depending on the environmental conditions. The fans must also be checked for correct operation at regular intervals. Faulty fans must be replaced.

6 Removal / Installation of Modules

6.1 Important User Notes



ELECTROCUTION HAZARD!

- **Modules are only to be removed and installed with the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP switched off.**
- **The removal and installation of modules is only permitted to be performed by suitably trained personnel.**

Training is performed as part of a training course given by specialists from ROHDE & SCHWARZ.



WARNING!

When removing or pulling out assemblies, take extra care. If the modules are pulled out too abruptly, the modules may jam and be damaged.

When plugging in modules, special attention must be paid to ensuring that no pins are bent on the connectors.

Some modules in the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP contain components that are sensitive to electrostatic discharge. To avoid further damage, the following points are to be observed:

- Components and circuit boards are only permitted to be removed and installed when unpowered. For this purpose, after switching off the power it is necessary to wait until the filter capacitors have discharged.
- The contacts on the connector on circuit boards containing parts sensitive to static and that have been removed are to be shorted together (e.g. using aluminium foil, copper foil).
- The installation and removal, as well as the repair of assemblies is only to be performed on a anti-static workstation.
- Modules removed must be stored and transported in anti-static packaging.



6.1.1 Anti-Static Work Station

Minimum requirements for an anti-static work station:

- Conducting bench and floor coverings.
- Chair with conducting covers.
- Earthed metal work top.
- Conducting armbands with a protective resistor between 200 k Ω and 1 M Ω and a connecting cable with plug-in connector.
- Earthed soldering iron.
- All conducting covers, armbands etc. must be connected together using insulated wires.

6.1.2 Tools

Commonly available electrical tools are required for the installation and removal of the modules in the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP.

6.2 Removal

In the case of the need for service, only the following modules in the R&S CompactTSVP / R&S PowerTSVP are permitted to be replaced:

- All cPCI plug-in cards
- All PXI plug-in cards
- All ROHDE & SCHWARZ specific Plug-in Cards
- Power supply
- Fans



NOTE:

If a fault occurs on one of the other modules in the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP (e.g. backplane), the entire R&S CompactTSVP / R&S PowerTSVP chassis must be sent for repair.



WARNING!

On the removal of modules from the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP the ESD regulations (electrostatic discharge) are to be observed.

6.2.1 Removing Standard cPCI/PXI Plug-in Cards

Replace cPCI/PXI plug-in cards as follows:

1. Switch off Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP and isolate from the mains.
2. Undo all cable connections to the cPCI/PXI plug-in card.
3. Undo retaining bolts on the cPCI/PXI plug-in card.
4. Release cPCI/PXI plug-in card using the ejection lever and remove from the R&S CompactTSVP / R&S PowerTSVP chassis.



6.2.2 Removing ROHDE & SCHWARZ specific Plug-in Cards

Replace ROHDE & SCHWARZ specific plug-in cards as follows:

1. Switch off Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP and isolate from the mains.
2. Undo all cable connections to the ROHDE & SCHWARZ specific plug-in card.
3. Undo retaining bolts on the ROHDE & SCHWARZ specific plug-in card.
4. Release ROHDE & SCHWARZ specific plug-in card using the ejection lever and remove from the R&S CompactTSVP / R&S PowerTSVP chassis.

6.2.3 Removing Power Supply

Replace power supply as follows:

1. Switch off Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP and isolate from the mains.
2. Undo retaining bolts on the power supply.
3. Release power supply using the ejection lever and remove from the R&S CompactTSVP / R&S PowerTSVP chassis.

6.2.4 Removing Fans

Replace fans as follows:

1. Switch off Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP and isolate from the mains.
2. Undo all connections on the front and rear of the R&S CompactTSVP / R&S PowerTSVP.
3. To remove the fans, the housing of the R&S CompactTSVP / R&S PowerTSVP must be opened.

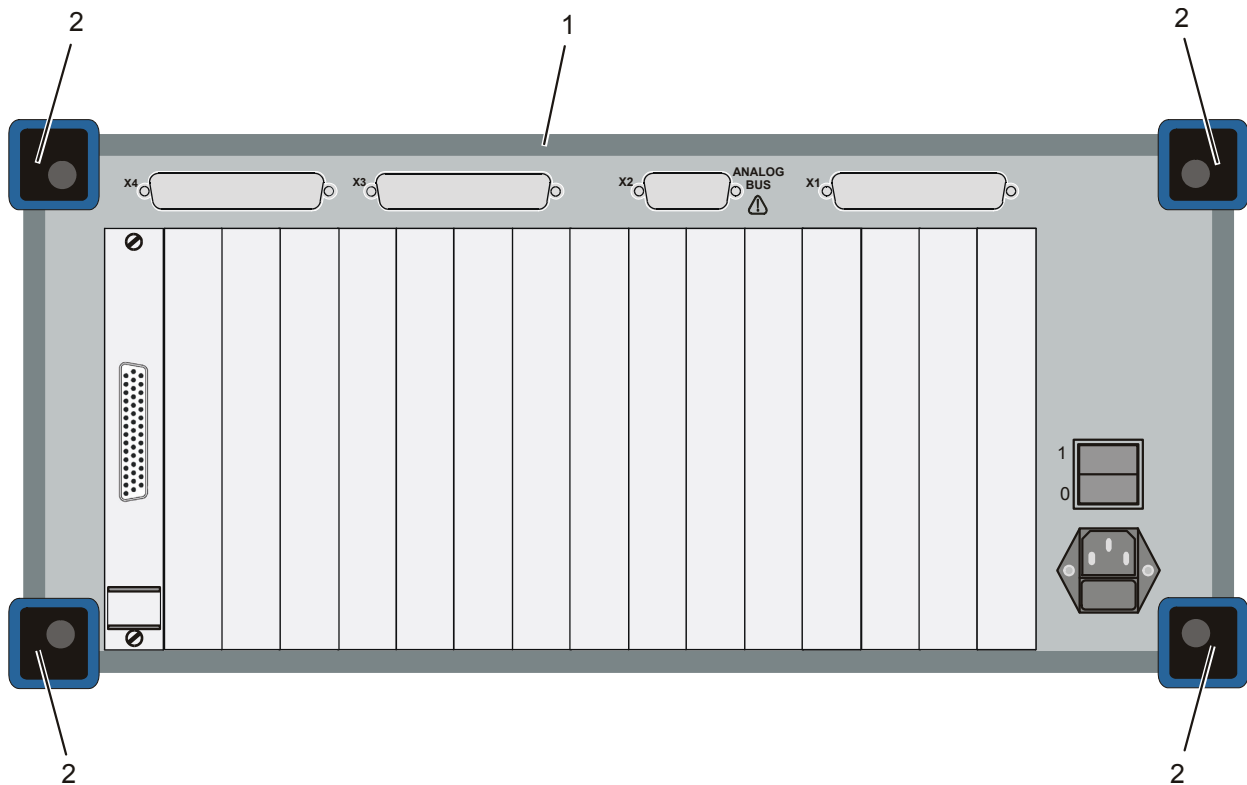


Figure 6-1 R&S CompactTSVP / R&S PowerTSVP Rear View

- 1 Housing Cover
- 2 Housing Feet (4 off)
4. Unbolt the four housing feet on the rear of the R&S CompactTSVP / R&S PowerTSVP.
5. Place the R&S CompactTSVP / R&S PowerTSVP on the handles on the front and carefully remove the housing cover from the R&S CompactTSVP / R&S PowerTSVP.
6. The R&S CompactTSVP / R&S PowerTSVP is now accessible from all sides.
7. Remove fan connector from the backplane. Undo the retaining bolts for the fan and remove the fan from the housing of the R&S CompactTSVP / R&S PowerTSVP.

6.3 Installation

The modules are installed in the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP in the reverse order of removal.


WARNING!

During the installation of modules in the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP the ESD regulations (electrostatic discharge) are to be observed.

6.4 Packaging, Shipment and Storage

Should it be necessary to send an assembly from the Test System Versatile Platform R&S CompactTSVP / R&S PowerTSVP to ROHDE & SCHWARZ, the following points are to be observed:

- The module is to be shipped in appropriate packaging. The module must not be damaged during transport.
- Electrical and electronic modules are also to be shipped in anti-static foil.
- Fit warning notes to the packaging (self-adhesive labels). E.g.:
 - Caution! Electronic Components.
 - Caution! Fragile.
- A letter is to be included with the module with, as a minimum, the following information:
 - Sender with contact person
 - Name of the assembly
 - Exact description of the system from which the module was removed
 - Completed service questionnaire (including exact description of fault)

The modules for the Test System Versatile Platform are to be stored in a dry, dust-free place of constant temperature. The modules are to be covered or stored in suitable packaging. Electrical or electronic modules are to be stored in anti-static foil.

7 Spare Parts List

7.1 Spare Parts List R&S CompactTSVP TS-PCA3

Item Number	Spare Part
1133.7260.00	FAN
1133.7353.00	BP Rueck 12TE
1133.7376.00	BP Rueck 4TE
1152.3508.00	BP Front 16TE
1152.3543.00	BP Front 4TE
1152.2601.00	CPCI Backplane
1152.2653.00	Analogbus Backplane
1152.2682.00	Power Supply
1152.2724.00	PCI-PCI-Bridge
1143.0145.00	System Module R&S TS-PSYS1

Table 7-1 Spare Parts List TS-PCA3

7.2 Spare Parts List R&S PowerTSVP TS-PWA3

Item Number	Spare Part
1133.7260.00	Fan
1133.7353.00	BP Rueck 12TE
1133.7376.00	BP Rueck 4TE
1152.3508.00	BP Front 16TE
1152.3543.00	BP Front 4TE
1157.8208.00	Control Backplane
1152.2653.00	Analogbus Backplane
1152.2682.00	Power Supply
1143.0151.00	System Module R&S TS-PSYS2

Table 7-2 Spare Parts List TS-PWA3



7.3 Spare Parts Modules

7.3.1 R&S TS-PAM

Item Number	Spare Part
1158.0100.02	Analyzer Module (with R&S TS-PDC)

Table 7-3 Spare Parts List R&S TS-PAM

7.3.2 R&S TS-PDC

Item Number	Spare Part
1157.9804.02 (obsolete)	DC/DC Converter Module
1157.9804.12 (new version)	DC/DC Converter Module

Table 7-4 Spare Parts List R&S TS-PDC

7.3.3 R&S TS-PDFT

Item Number	Spare Part
1152.3850.00	Digital Functional Test Module

Table 7-5 Spare Parts List R&S TS-PDFT

7.3.4 R&S TS-PFG

Item Number	Spare Part
1158.0052.02	Function Generator Module (with R&S TS-PDC)

Table 7-6 Spare Parts List R&S TS-PFG

7.3.5 R&S TS-PICT

Item Number	Spare Part
1158.0000.02	ICT Extension Module (with R&S TS-PDC)

Table 7-7 Spare Parts List R&S TS-PICT

7.3.6 R&S TS-PMB

Item Number	Spare Part
1153.5040.98	Matrix Module B (used part, version V2.0, for ser.no. up to 100182)
1143.0039.02	Matrix Module B (version V3.x, for ser.no. greater than 100182)
1153.5085.00	Reed Relay Modul

Table 7-8 Spare Parts List R&S TS-PMB

7.3.7 R&S TS-PSAM

Item Number	Spare Part
1142.9503.02	Analog Source and Measure- ment Module (with R&S TS- PDC)

Table 7-9 Spare Parts List R&S TS-PSAM



7.3.8 R&S TS-PSC0

Item Number	Spare Part
1157.9085.02	PCI to CompactPCI Interface Kit

Table 7-10 Spare Parts List R&S TS-PSC0

7.3.9 R&S TS-PSC3

Item Number	Spare Part
1134.2578.00	System Controller CP304
1134.2584.00	Rear I/O for System Controller RIO-02

Table 7-11 Spare Parts List R&S TS-PSC3

7.3.10 R&S TS-PSC4

Item Number	Spare Part
1134.2503.08	System Controller 4 (CP306 incl. RIO-Module)

Table 7-12 Spare Parts List R&S TS-PSC4

7.3.11 R&S TS-PSC5

Item Number	Spare Part
1134.2503.12	System Controller 5 (incl. RIO-Module)

Table 7-13 Spare Parts List R&S TS-PSC5

7.3.12 R&S TS-PSM1

Item Number	Spare Part
1143.0139.02	Power Switching Module 1
1143.0222.00	Relay AZ764
1143.0239.00	Relay AZ832
1143.0245.00	0R01 4W 1%

Table 7-14 Spare Parts List R&S TS-PSM1

7.3.13 R&S TS-PSM2

Item Number	Spare Part
1504.4901.02	Multiplex/Switch Module 2
1143.0239.00	Relay AZ832
0386.3164.00	Relay 109-1-A-5/2

Table 7-15 Spare Parts List R&S TS-PSM2

7.3.14 R&S TS-PSU

Item Number	Spare Part
1504.4701.02	PSU Power Module (without R&S TS-PAC)
1504.4553.02 (obsolete)	R&S TS-PAC PSU AC Supply (PSU RIO Module + PSU AC/DC Converter)
1504.4553.03 (new version)	R&S TS-PAC PSU AC Supply (PSU RIO Module + PSU AC/DC Converter)

Table 7-16 Spare Parts List R&S TS-PSU



7.3.15 R&S TS-PIO2

Item Number	Spare Part
1504.4801.02	Analog/Digital IO Module 2 (with R&S TS-PDC)

Table 7-17 Spare Parts List R&S TS-PIO2

7.3.16 R&S TS-PHDT

Item Number	Spare Part
1157.9704.02	High-Speed Digital Test Module

Table 7-18 Spare Parts List R&S TS-PHDT

7.3.17 R&S TS-ISC

Item Number	Spare Part
1505.2519.02	TS-PCAL2 ISC Rear I/O Module
1505.2560.02	TS-PKISC ISC Cabling Set

Table 7-19 Spare Parts List R&S TS-ISC

7.3.18 R&S TS-PIO3B

Item Number	Spare Part
1512.4407.02	Digital I/O Module

Table 7-20 Spare Parts List R&S TS-PIO3B

7.3.19 R&S TS-PTR

Item Number	Spare Part
1512.4407.03	Signal Transmission Module

Table 7-21 Spare Parts List R&S TS-PTR

7.3.20 R&S TS-PTRF

Item Number	Spare Part
1512.3800.02	Port Transmission Module

Table 7-22 Spare Parts List R&S TS-PTRF

7.3.21 R&S TS-PRIO4

Item Number	Spare Part
1510.8005.02	Rear Transmission Module

Table 7-23 Spare Parts List R&S TS-PRIO4

7.3.22 R&S TS-PXM1

Item Number	Spare Part
1512.4007.02	Switching Extension Module

Table 7-24 Spare Parts List R&S TS-PXM1



7.3.23 Spare Parts for several Modules

Item Number	Spare Part
0386.3164.00	Relay 109-1-A-5/2
1153.5285.00	Relay SIL05-1A75-71M
1133.7718.00	EMC-Strip

Table 7-25 Spare Parts List for several Modules

8 Service Documents

8.1 Interface Description

8.1.1 Interface Description R&S CompactTSVP TS-PCA3



NOTE:

The interfaces on the Test System Versatile Platform R&S CompactTSVP are described in the “Test System Versatile Platform R&S CompactTSVP TS-PCA3” User Manual in Section 8.

8.1.2 Interface Description R&S PowerTSVP TS-PWA3



NOTE:

The interfaces on the Test System Versatile Platform R&S PowerTSVP are described in the “Test System Versatile Platform R&S PowerTSVP TS-PWA3” User Manual in Section 8.

8.2 Plug-In Cards

8.2.1 Analyzer Module R&S TS-PAM

The interfaces for the Analyzer Module are described in the “Analyzer Module R&S TS-PAM” User Manual.

8.2.2 Digital Functional Test Module R&S TS-PDFT

The interfaces for the Digital Functional Test Module are described in the “Digital Functional Test Module R&S TS-PDFT” User Manual.

8.2.3 Arbitrary Function Generator Module R&S TS-PFG

The interfaces for the Arbitrary Function Generator Module are described in the “Arbitrary Function Generator Module R&S TS-PFG” User Manual.

8.2.4 InCircuit Test Module R&S TS-PICT

The interfaces for the InCircuit Test Module are described in the “InCircuit Test Module R&S TS-PICT” User Manual.

8.2.5 Matrix Module B R&S TS-PMB

The interfaces for the Matrix Module B are described in the “Matrix Module B R&S TS-PMB” User Manual.

8.2.6 Source and Measurement Module R&S TS-PSAM

The interfaces for the Source and Measurement Module are described in the “Source and Measurement Module R&S TS-PSAM” User Manual.

8.2.7 Power Switch Module R&S TS-PSM1

The interfaces for the Power Switch Module are described in the “Power Switch Module R&S TS-PSM1” User Manual.

8.2.8 Switch/Multiplex Module 2 R&S TS-PSM2

The interfaces for the Switch/Multiplex Module are described in the “Switch/Multiplex Module 2 R&S TS-PSM2” User Manual.



8.2.9 Power Supply/Load Module R&S TS-PSU

The interfaces for the Power Supply/Load Module are described in the "Power Supply/Load Module R&S TS-PSU" User Manual.

8.2.10 Analog/Digital IO Module 2 R&S TS-PIO2

The interfaces for the Analog/Digital IO Module 2 are described in the "Analog/Digital IO Module 2 R&S TS-PIO2" User Manual.

8.2.11 High-Speed Digital Test Module R&S TS-PHDT

The interfaces for the High-Speed Digital Test Module are described in the "High-Speed Digital Test Module R&S TS-PHDT" User Manual.

8.2.12 Calibration Module (Rear IO-Module) R&S TS-PCAL2

The interfaces for the Calibration Module are described in the "In-System Calibration R&S TS-ISC" User Manual".



A Appendix

A.1 SFT Report Example

S E L F T E S T R E P O R T

```

System Name:          TSVP Qualification TP3a
Date:                2003-05-21
Time:                09:40:19
User Name:           Administrator
SFT Support DLL Version: SFT 01.20
SFT Support DLL:     C:\PROGRA~1\GTSI\Bin\sft.dll
Report style:        Report only errors
Fixture present:     no
Manual interventions: no
Suppress dialogs:    yes
  
```

Overall status: passed

Number of Test Cases failed: 0

Component Status Summary

```

Information:          passed
Basic Tests:          passed
pict:                 passed
pfg:                  passed
pdf:                  passed
pys:                  passed
  
```

Component Name: Information

Component Status: passed

=====

Test Case Name: Loop Count

Test Case Status: passed

Result:

Loop Counter: 1

```

Component Name:      Basic Tests
SFT DLL Version:     SFTSTSV 01.02
SFT DLL Name:        SFTSTSV
  
```

Component Status: passed

=====

Test Case Name: Extern Voltage

Test Case Status: passed

=====

Test Case Name: Configuration

Test Case Status: passed

Result:



TS-PSAM Driver Revision: Driver: rpsam 2.43, Compiler: CVI 5.50, Components: IVIEngine 1.62,
VISA-Spec 2.20

TS-PSAM Firmware Revision: Rohde & Schwarz,TS PSAM,338931/002,01.00

TS-PSAM Hardware Code: 0

TS-PSAM Slot Number: 0

=====
Test Case Name: BusIsolation
Test Case Status: passed

=====
Test Case Name: DCS Basic Test
Test Case Status: passed

=====
Test Case Name: DCS Relayfunction HI LO
Test Case Status: passed

=====
Test Case Name: DCS Relayfunction SHI
Test Case Status: passed

=====
Test Case Name: DCS Relayfunction SENSE
Test Case Status: passed

=====
Test Case Name: Relayfunction GND
Test Case Status: passed

=====
Test Case Name: MU Relayfunction HI
Test Case Status: passed

=====
Test Case Name: MU Relayfunction LO
Test Case Status: passed

=====
Test Case Name: MU Relayfunction SHI
Test Case Status: passed

=====
Test Case Name: DCH Relays
Test Case Status: passed

=====
Test Case Name: MU DC Voltage
Test Case Status: passed

=====
Test Case Name: MU DC Current
Test Case Status: passed

=====
Test Case Name: MU RMS to DC Converter
Test Case Status: passed

=====
Test Case Name: MU Analog Trigger
Test Case Status: passed

=====
Test Case Name: MU AC Coupling
Test Case Status: passed
=====

```
Test Case Name:      DCH
Test Case Status:   passed
```

```
=====  
Test Case Name:      Trigger Bus
Test Case Status:   passed
```

```
=====  
Test Case Name:      40 MHz Counter
Test Case Status:   passed
```

```
=====  
Test Case Name:      Relays Multiplexer
Test Case Status:   skipped
```

```
Comment:
  Self test board required.
```

```
=====  
Test Case Name:      External Trigger
Test Case Status:   skipped
```

```
Comment:
  Self test board required.
```

```
*****
Component Name:      pict
Hardware Code:       0
Resource Descriptor:  PXI2::11::0::INSTR
Slot Number:         7
Driver Version:      Driver: rspict 1.01, Compiler: CVI 5.50, Components: IVIEngine 1.62,
VISA-Spec 2.20
Firmware Version:
SFT DLL Version:     SFTMPICT 01.01
SFT DLL Name:        sftmpict.dll
```

```
Component Status:   passed
```

```
=====  
Test Case Name:      Initialization
Test Case Status:   passed
```

```
=====  
Test Case Name:      Device self test
Test Case Status:   passed
```

```
=====  
Test Case Name:      Configuration
Test Case Status:   passed
```

```
Comment:
  Option string is 'Simulate=0,RangeCheck=1'.
```

```
=====  
Test Case Name:      BusIsolation
Test Case Status:   passed
```

```
=====  
Test Case Name:      Matrix Relays
Test Case Status:   passed
```

```
*****
Component Name:      pfg
Hardware Code:       0
Resource Descriptor:  PXI3::15::0::INSTR
Slot Number:         8
Driver Version:      Driver: rspfg 2.00, Compiler: CVI 5.50, Components: IVIEngine 1.62,
```



```
VISA-Spec 2.20
Firmware Version:          REV: 514
SFT DLL Version:          SFTMPFG 01.04
SFT DLL Name:             C:\Program Files\gts1\develop\libraries\sftmpfg\sftmpfg.dll
Component Status:         passed
```

```
=====
Test Case Name:           Initialization
Test Case Status:         passed
```

```
=====
Test Case Name:           Device self test
Test Case Status:         passed
```

```
=====
Test Case Name:           Configuration
Test Case Status:         passed
```

```
Comment:
  Option string is 'Simulate=0,RangeCheck=1'.
```

```
=====
Test Case Name:           Coupling Relays
Test Case Status:         passed
```

```
=====
Test Case Name:           BusIsolation
Test Case Status:         passed
```

```
=====
Test Case Name:           Matrix Relays
Test Case Status:         passed
```

```
=====
Test Case Name:           Ground Relays
Test Case Status:         passed
```

```
=====
Test Case Name:           Channel Connect Relay
Test Case Status:         passed
```

```
=====
Test Case Name:           Function Generator
Test Case Status:         passed
```

```
=====
Test Case Name:           Front Connector
Test Case Status:         skipped
```

```
Comment:
  Self test board required.
```

```
*****
Component Name:           pdft
Hardware Code:            0
Resource Descriptor:      PXI3::13::0::INSTR
Slot Number:              11
Driver Version:           Driver: rspdft 1.00, Compiler: CVI 5.50, Components: IVIEngine 1.62,
VISA-Spec 2.20
Firmware Version:         Rohde & Schwarz,-,-
SFT DLL Version:          SFTMPDFT 01.00
SFT DLL Name:             sftmpdft.dll
```

```
Component Status:         passed
=====
Test Case Name:           Initialization
Test Case Status:         passed
```

```
=====
Test Case Name:          Device self test
Test Case Status:       passed
```

```
=====
Test Case Name:          Configuration
Test Case Status:       passed
Comment:
  Option string is 'Simulate=0,RangeCheck=1,DriverSetup=ie:1'.
```

```
=====
Test Case Name:          Stimulus Response Pattern
Test Case Status:       passed
```

```
=====
Test Case Name:          Aux Relays
Test Case Status:       skipped
```

```
Comment:
  Self test board required.
```

```
*****
Component Name:          psys
Hardware Code:           1
Resource Descriptor:     CAN0::0::5::15
Slot Number:             15
Driver Version:          Driver: rspsys 1.04, Compiler: CVI 5.50, Components: IVIEngine 1.62,
VISA-Spec 2.20
Firmware Version:        Rohde & Schwarz,TS-PSYS1,1,10001/004,01.00,01.00
SFT DLL Version:         SFTMPSYS 01.00
SFT DLL Name:            sftmpsys.dll

Component Status:        passed
```

```
=====
Test Case Name:          Initialization
Test Case Status:       passed
```

```
=====
Test Case Name:          Device self test
Test Case Status:       passed
```

```
=====
Test Case Name:          Configuration
Test Case Status:       passed
```

```
Comment:
  Instrument Model: TS-PSYS1
  Option string is 'Simulate=0,RangeCheck=1'
  Resource Descriptor for second CAN-Port: CAN0::0::5::15
```

```
=====
Test Case Name:          HW State
Test Case Status:       passed
```

```
=====
Test Case Name:          Voltage Source
Test Case Status:       skipped
```

```
Comment:
  Self test board required.
```

```
=====
Test Case Name:          Digital Input/Output
Test Case Status:       skipped
```

```
Comment:
```



Self test board required.

=====
Test Case Name: Temperature measurement
Test Case Status: skipped

Comment:
 Self test board required.

=====
Test Case Name: SYNC Signal
Test Case Status: skipped

Comment:
 Self test board required.

=====
Test Case Name: Trigger Lines
Test Case Status: skipped

Comment:
 Self test board required.

=====
Test Case Name: CAN-Bus Loopback
Test Case Status: skipped

Comment:
 Self test board required.