ROHDE&SCHWARZ

# SERVICE MANUAL


## Test System Versatile Platform

## R&S®CompactTSVP TS-PCA3

## R&S®PowerTSVP TS-PWA3

**Note**

# Service Manual

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

5th Issue / 08.06 / GB 1152.3914.22



**ROHDE & SCHWARZ** GmbH & Co. KG
Corporate Headquarters
Mühldorfstr. 15
D-81671 München

Telephone: ...49 (0)89/4129-13774
Fax: ...49 (0)89/4129-13777

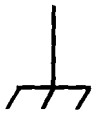
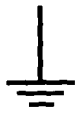
Printed in the Federal Republic of Germany. Errors excepted, subject to technical change without notice.

# Safety Instructions

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

continued overleaf

# Safety Instructions

10. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.
11. Lithium batteries must not be exposed to high temperatures or fire.

    Keep batteries away from children.

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

    Lithium batteries are suitable for environmentally friendly disposal or specialized recycling. Dispose of them in appropriate containers only.

    Do not short-circuit the battery.
12. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.
13. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.
14. The outside of the instrument is suitably cleaned using a soft, lint-free dustcloth. Never use solvents such as thinners, acetone or similar, as they may damage the front panel labeling or plastic parts.
15. Any additional safety instructions given in this manual are also to be observed.

**Additional safety instructions:**

- Any alteration to the basic equipment is prohibited, unless carried out by persons authorized to do so according to section 9 of these safety instructions.
- 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.

# CERTIFICATE

## DQS GmbH

**Deutsche Gesellschaft zur Zertifizierung von Managementsystemen**

hereby certifies that the company

## Rohde & Schwarz GmbH & Co. KG

Mühldorfstrasse 15
D-81671 München

with the production sites as listed in the annex

for the scope
Design and Development, Production, Sales, Services of Electronic-Measurement and Communication-Equipment and Systems

has implemented and maintains a

## Quality Management System.

An audit, documented in a report, has verified that this quality management system fulfills the requirements of the following standard:

## DIN EN ISO 9001 : 2000

December 2000 edition

**The quality management system of the sites marked with (*) in the annex fulfills the requirements set out by the international and German Road Traffic Regulations**
including the approval objects as listed in the appendix.

| | |
|---|---|
| This certificate is valid until | 2008-01-23 |
| Certificate Registration No. | 001954 QM/ST |
| Frankfurt am Main | 2005-01-24 |

This certificate is based on a quality audit in cooperation with the CETECOM ICT Services GmbH as a Notified Body under the Scope of the EC directive 99/5/EC.
It was verified by the Notified Body that the supplementary requirements of the Annex V of the European Concil Directive 99/5/EC are fulfilled.

Ass. iur. M. Drechsel
Dipl.-Ing. S. Heinloth
MANAGING DIRECTORS

Senior Executive Officer of CETECOM ICT Services GmbH
Dipl.-Ing. J. Schirra

DQS is member of: IQNet THE INTERNATIONAL CERTIFICATION NETWORK

D-60433 Frankfurt am Main, August-Schanz-Straße 21

Deutscher Akkreditierungs Rat DAR
TGA-ZM-02-90
KBA-ZM-A 00023-95

# Appendix to Certificate Registration No.: 001954 QM/ST

## Rohde & Schwarz GmbH & Co. KG

Mühldorfstrasse 15
D-81671 München

The international and German Road Traffic Law
was audited regarding the following approval objects:

## No.: 22 Electrical/Electronic Sub Assembly

This appendix (as of 2005-01-24) is only valid in connection
with the above-mentioned certificate.

# Annex to Certificate Registration No.: 001954 QM ST

## Rohde & Schwarz GmbH & Co. KG

Mühldorfstrasse 15
D-81671 München

| Organizational unit/site | Scope |
|---|---|
| **ROHDE & SCHWARZ GmbH & Co. KG**<br>Service Centre Cologne<br>**ROHDE & SCHWARZ Systems GmbH**<br>Graf-Zeppelin-Strasse 18<br>D-51147 Köln | Technical services in the field of measuring/communication techniques maintenance/repair calibration training technical documentation<br>Development, production, systems |
| **Rohde & Schwarz FTK GmbH**<br>Wendenschloßstrasse 168<br>D-12557 Berlin | Design and Development, Production and Sale of Communication Equipment, Installations and systems |
| **Rohde & Schwarz GmbH & Co. KG**<br>Kaikenrieder Strasse 27<br>D-94244 Teisnach | Design and Development, Production, Sales, Services of Electronic-Measurement and Communication-Equipment and Systems |
| **Rohde & Schwarz závod Vimperk s.r.o.**<br>Spidrova 49<br>CZE-38501 Vimperk<br>Tschechische Republik | Design and Development, Production, Sales, Services of Electronic-Measurement and Communication-Equipment and Systems |
| (*) **Rohde & Schwarz GmbH & Co. KG**<br>Mühldorfstrasse 15<br>81671 München | Design and Development, Production, Sales, Services of Electronic-Measurement and Communication-Equipment and Systems |
| (*) **Rohde & Schwarz Messgerätebau GmbH**<br>Riedbachstrasse 58<br>D-87700 Memmingen | Design and Development, Production, Sales, Services of Electronic-Measurement and Communication-Equipment and Systems |

This annex (as of 2005-01-24)is only valid in connection with the above-mentioned certificate.

# Support Center

**Telephone Europe:** **+49 180 512 42 42**

**Telephone worldwide:** **+49 89 4129 13774**

**Fax:** **+49 89 4129 13777**

**e-mail: customersupport@rohde-schwarz.com**

If you have any technical queries about this Rohde & Schwarz equipment, our Hotline at the Support Center of Rohde & Schwarz Vertriebs-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.

ROHDE & SCHWARZ

# Content



5th Issue 08.06

5th Issue 08.06

5th Issue 08.06

5th Issue 08.06

5th Issue 08.06

5th Issue 08.06

5th Issue 08.06

# Figures



5th Issue 08.06

5th Issue 08.06

# Tables



5th Issue 08.06

5th Issue 08.06

# 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 .

5th Issue 08.06

## 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.**

5th Issue 08.06

## 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.**

5th Issue 08.06

## 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 |

5th Issue 08.06

# 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** |

5th Issue 08.06

## 2.2 Service Questionnaire

To be able to process technical questions or orders for spare parts as quickly as possibly, 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 seperate PDF-file.

5th Issue 08.06

## (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:**

5th Issue 08.06

### 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** .

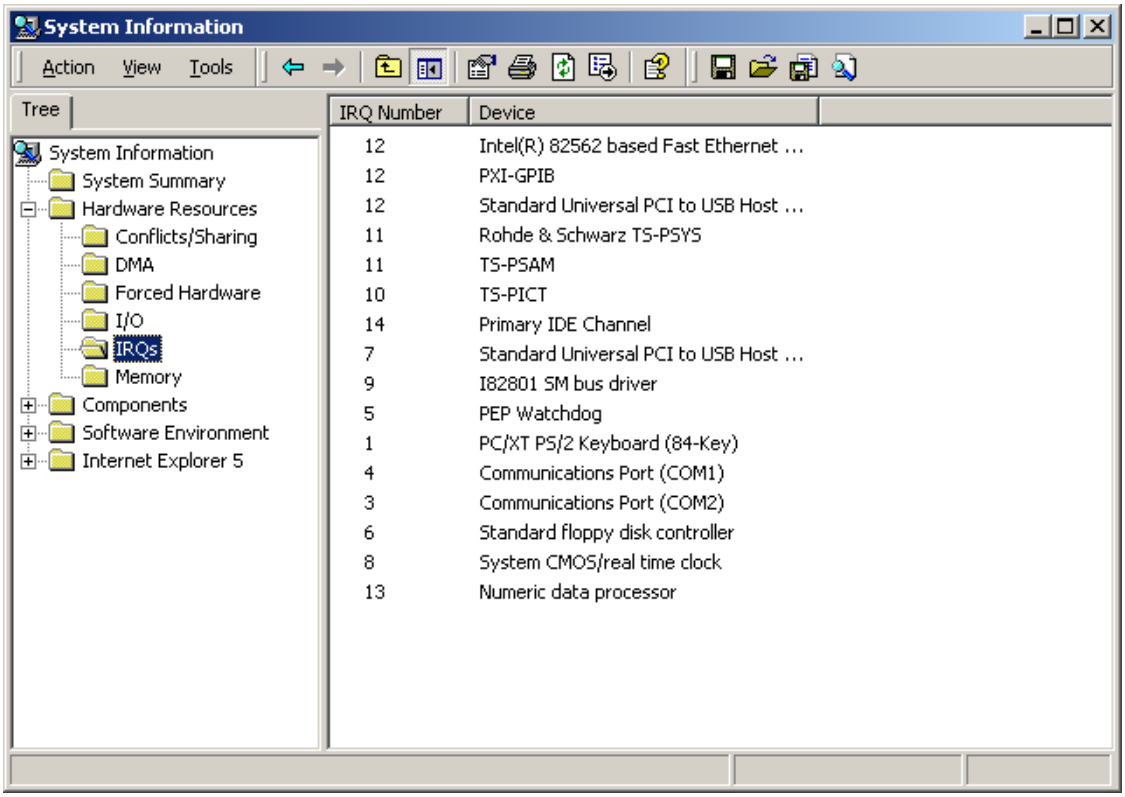



**Figure 2-1** System Information

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.

5th Issue 08.06

5th Issue 08.06

# 4 Self Test

## 4.1 Function

### 4.1.1 System overview

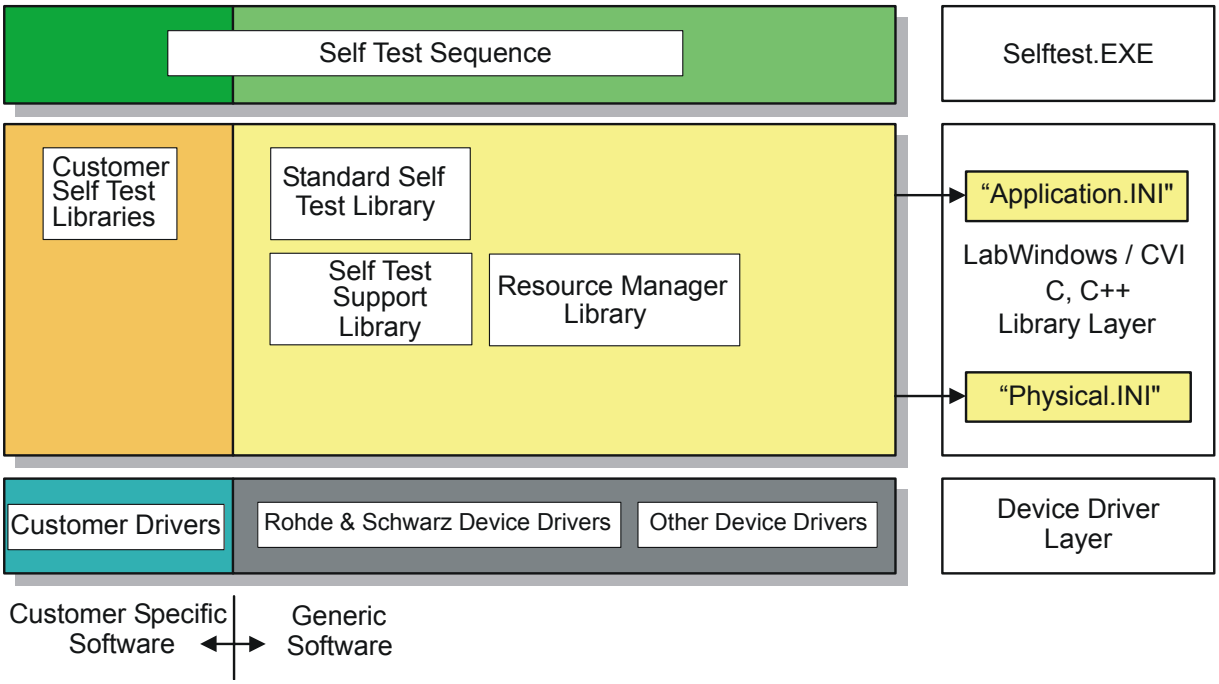



**Bild 4-1** SFT Software Overview

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.

5th Issue 08.06

**HINWEIS:**

**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`

**HINWEIS:**

**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:

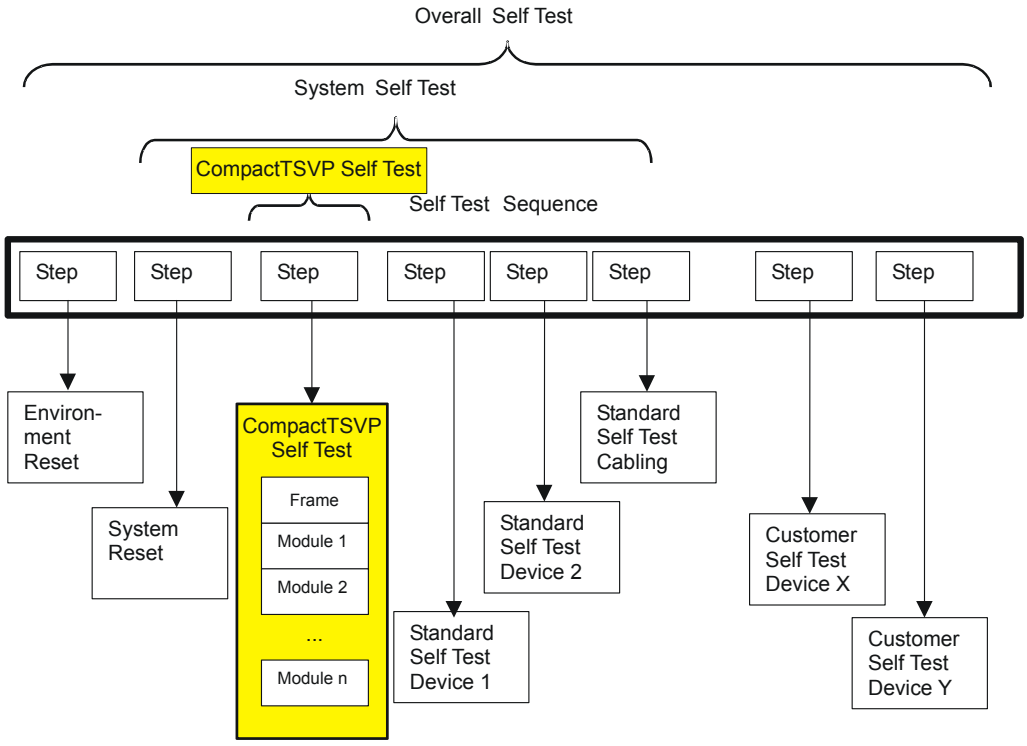



**Bild 4-2** Self Test Sequence

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

5th Issue 08.06

## 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. Bild 4-3 shows the connection of the R&S TS-PSAM to the analog bus.

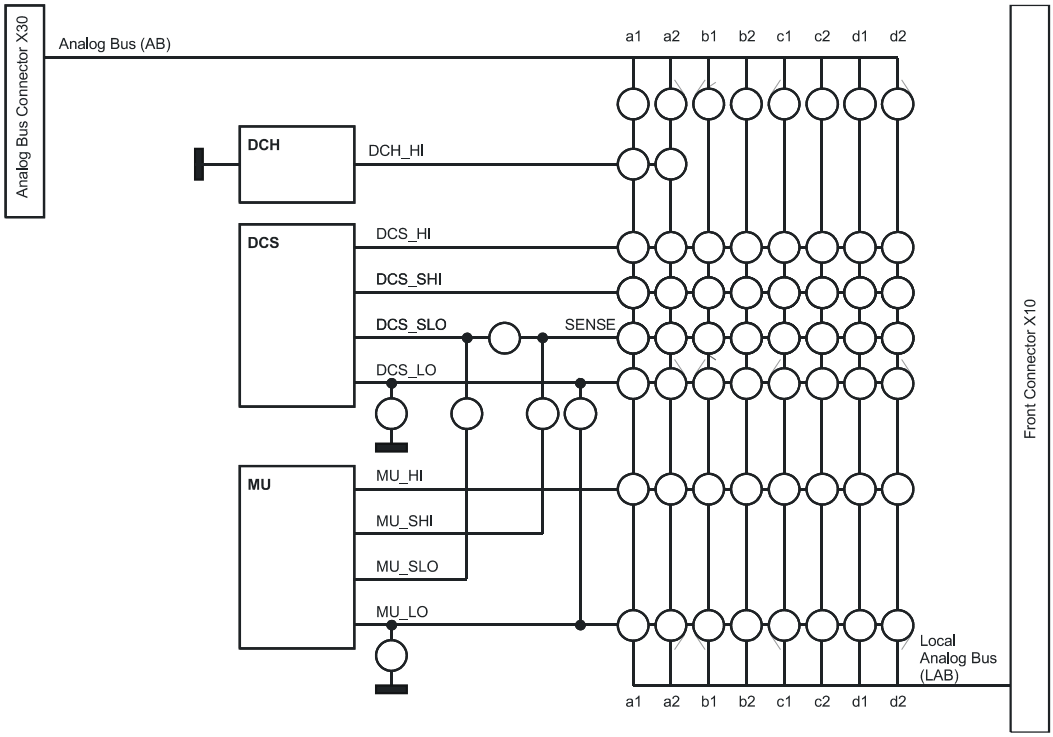



**Bild 4-3** Connection of R&S TS-PSAM to Analog Bus

## 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**.

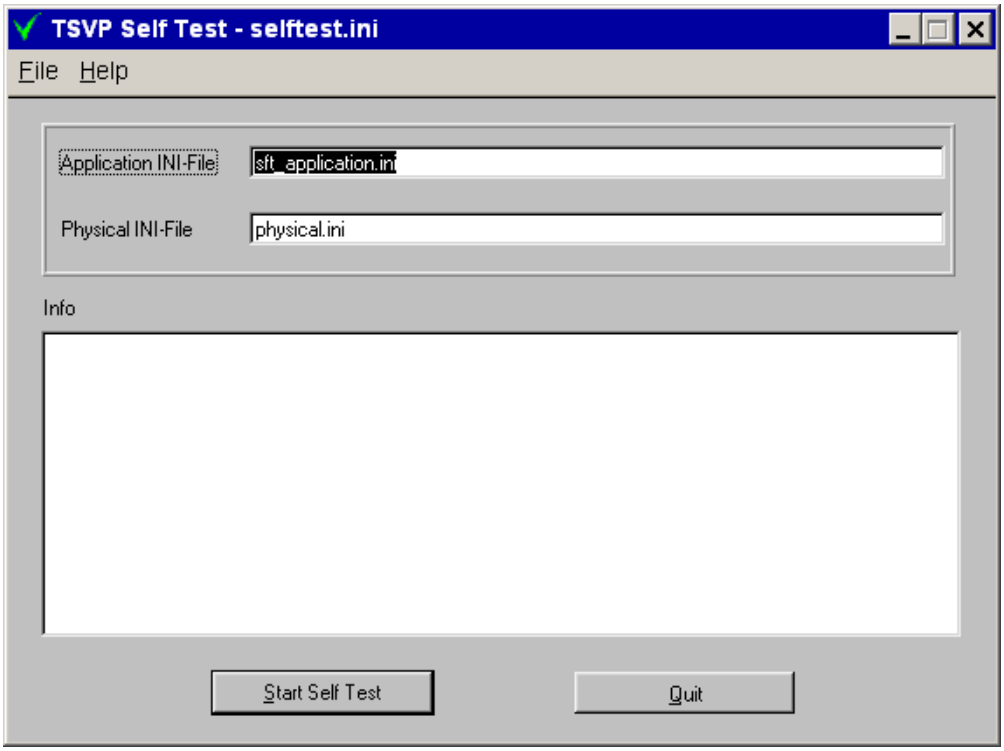



**Bild 4-4** Self Test Start Screen

**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 Bild 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 ).

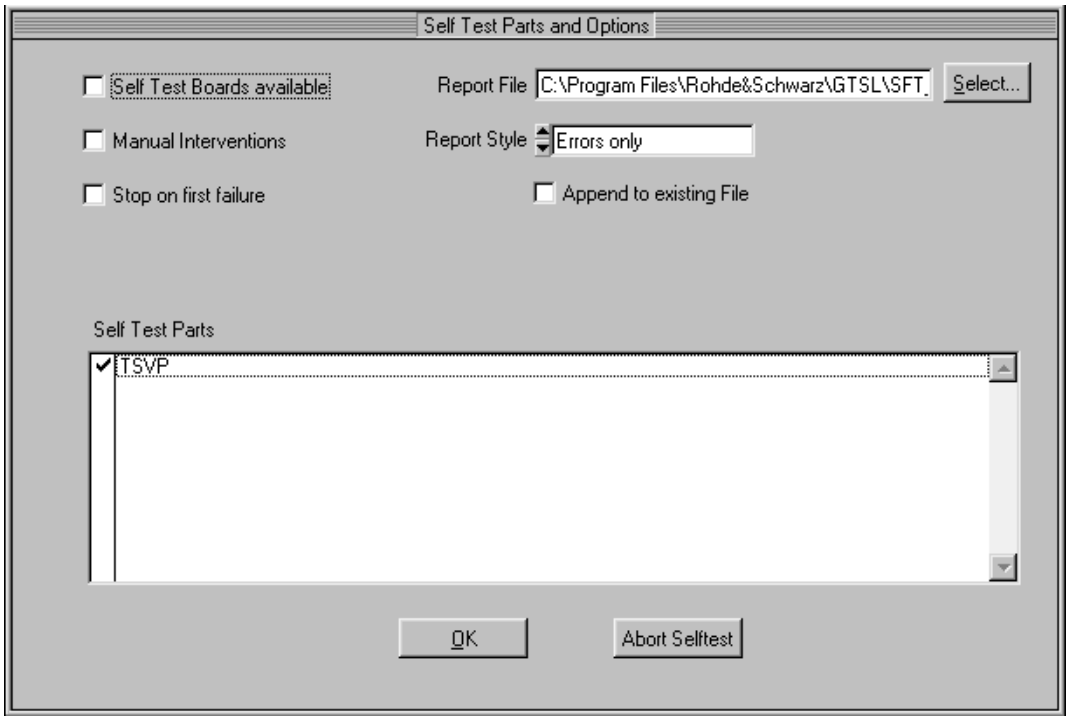



**Bild 4-5** Self Test Parts and Options

**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.

**HINWEIS:**

**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.

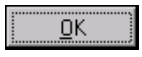

The location and file name of the test report are selected using the **Select...** button.

**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.

**HINWEIS:**

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

5th Issue 08.06

☑ 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 Bild 4-6 ).

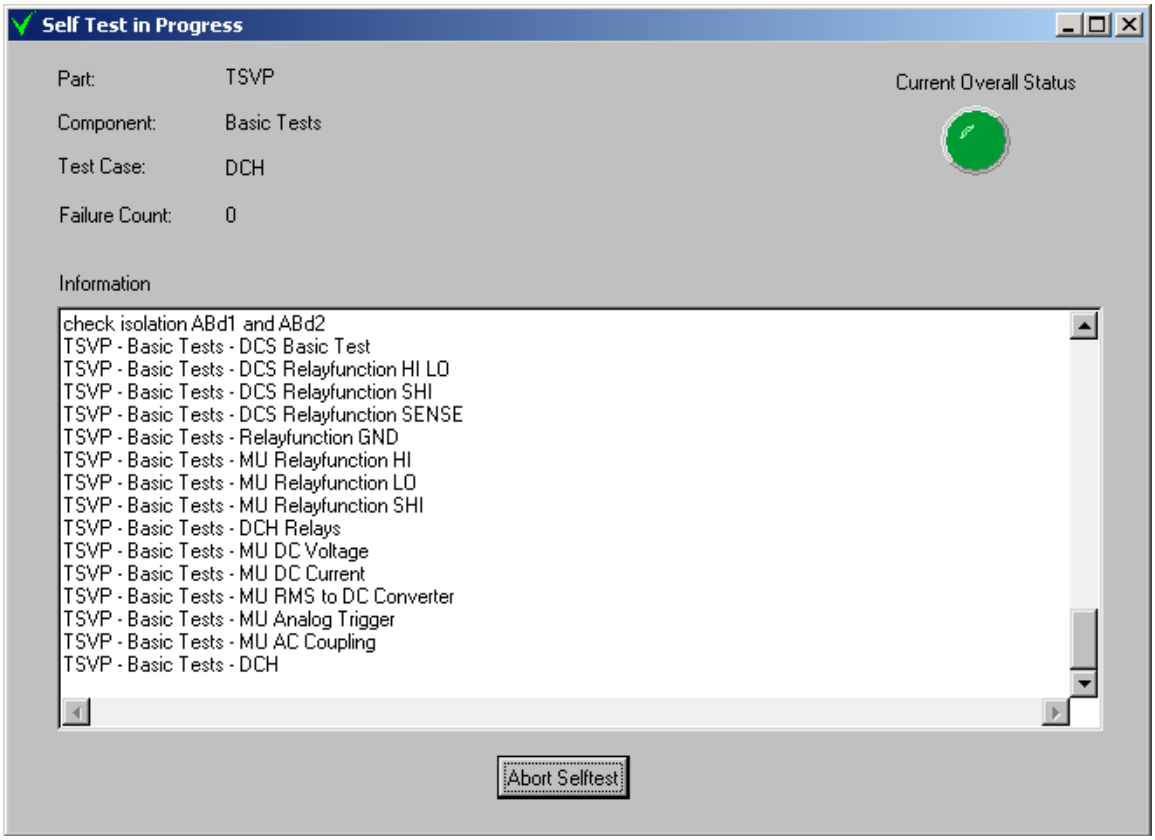



**Bild 4-6** Self Test in Progress

**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 Bild 4-7 and Bild 4-8 ).

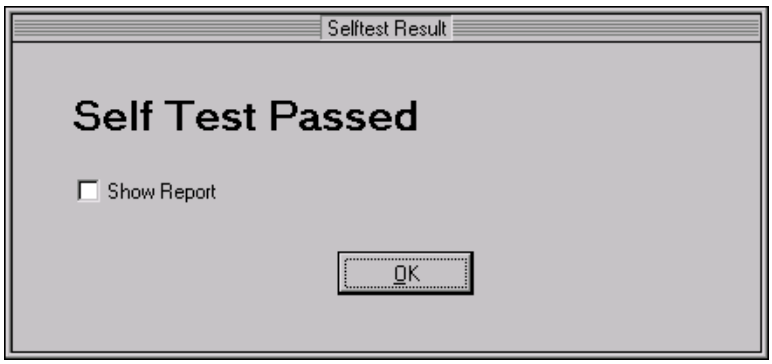



**Bild 4-7** Self Test Result Passed


**Bild 4-8** Self Test Result Failed

5th Issue 08.06

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

5th Issue 08.06

## 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       = rspsam
DriverDll          = rspsam.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        = rspsys
DriverDll           = rspsys.dll
DriverOption        = Simulate=0
SFTDll              = sftmpsys.dll
SFTPrefix           = SFTMPSYS

;[device->psm1]
;Description         = "TS-PSM1, Slot 16"
;Type                = PSM1
;ResourceDesc        = CAN0::0::1::16
;DriverPrefix        = rspsm1
;DriverDll           = rspsm1.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.

**HINWEIS:**

**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 ).**

5th Issue 08.06

## 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 rspsm1_InitWithOptions. | The driver function `rspsm1_InitWithOptions` 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:<br>Ch1com - LABa1; Ch1no - LABb1;<br>Ch2com - LABa2; Ch2no - LABb2;<br>Ch3com - LABc1; Ch3no - LABd1;<br>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. |

5th Issue 08.06

| 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:<br>Ch5com - LABa1; Ch5no - LABb1;<br>Ch6com - LABa2; Ch6no - LABb2;<br>Ch7com - LABc1; Ch7no - LABd1;<br>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:<br>Ch9com - LABa1; Ch9no - LABb1;<br>Ch10com - LABa2; Ch10no - LABb2;<br>Ch11com - LABc1; Ch11no - LABd1;<br>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:<br>Ch13com - LABa1; Ch13no - LABb1;<br>Ch14com - LABa2; Ch14no - LABb2;<br>Ch15com - LABc1; Ch15no - LABd1;<br>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:<br>IL1com - LABc1; IL1no - LABb2;<br>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:<br>LPBA - LABa1; LPBB - LABb2;<br>LPBC - LABc1; LPBD - LABd2 |
| | | All analog buses are tested as described above. |
| | | |
| **Device SFT** | Starts the Device Self Test. | Starts the function `rspsm1_self_test`. |
| | | |
| **Configuration** | Reads the configuration of the module (driver version and firmware version). | Starts the function `getConfiguration`. |
| | | |
| **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 `rspsm1_reset()`. |
| | | |
| **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 `rspsm1_reset()`. |
| | | |
| **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.<br>(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.<br>(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?<br>Yes -> Test OK<br>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.<br>(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 µA gives a threshold of the 500 kOhm. If the insulation resis-

5th Issue 08.06

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 |
|---|---|
| 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 (Kx and Ky). Then, Kx and Ky 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 Px. If on all lines Px no connection is found, a coupling relay is probably defective.

The measurements are repeated for all bus lines ABx.

### 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 - LABx (PSAM) - ABx - LABx <Kx> Px <Ky> LABy - 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 |
| LABx | HI line on local analog bus R&S TS-PAM |
| Kx | Matrix relay in the HI line |

5th Issue 08.06

| 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 (Kx and Ky). Then, Kx and Ky 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 - LABx (PSAM) - ABx - LABx <Kx> LABy - ABy - LABy (PSAM) - DMM_LO

The contact resistance is measured and recorded for the relay Kx. Then, Kx 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:

ABax - Py <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.

5th Issue 08.06

#### 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.

5th Issue 08.06

### 4.6.3 Source and Measurement Module R&S TS-PSAM

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

- 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 rspsam_InitWithOptions. | The driver function `rspsam_InitWithOptions` is started. |
| | | |
| **Configuration** | Reads the configuration of the module (firmware version, slot number, hardware code). | The function `getConfiguration` 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. (Refline(ABa1) - ABb1, Refline(ABa1) - ABb2, Refline(ABa1) - ABc1, Refline(ABa1) - ABc2, Refline(ABa1) - ABd1, Refline(ABa1) - ABd2) |
| | | At the end of the test case, all coupling and matrix relays are opened again by calling the function `rspmb_reset()`. |
| | | |
| **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. |

| Test Case | Description | Test Sequence |
|---|---|---|
| | | |
| | | 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 `rspmb_reset()`. |
| | | |
| **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 µA 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. |
| | | The connection DCS_LO <--> GND is opened. |
| | | DCS_HI is switched to ABa1. |

| Test Case | Description | Test Sequence |
|---|---|---|
| | | 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 µA. |
| | | 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 XTIx 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 XTI1. |
| | | 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 XTI2. |
| | | 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 rspfg_InitWithOptions. | The driver function `rspfg_InitWithOptions` is started. |
| | | |
| **Device SFT** | Starts the Device Self Test. | The function `rspfg_self_test` is started. |
| | | |
| **Configuration** | Reads the configuration of the module (firmware version, slot number, hardware code). | Starts the function `getConfiguration`. |
| | | |
| **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.<br>If the measurement is OK, then ABa1 is the Refline. |
| | | Coupling relay ABa1 <--> LABa1 is closed. |
| | | |
| | | All bus lines are measured against the Refline. |

| Test Case | Description | Test Sequence |
|---|---|---|
| | | 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.<br>Refline(ABa1) - ABb1, Refline(ABa1) - ABb2,<br>Refline(ABa1) - ABc1, Refline(ABa1) - ABc2,<br>Refline(ABa1) - ABd1, Refline(ABa1) - ABd2 |
| | | At the end of the test case, all coupling and matrix relays are opened again by calling the function `rspfg_reset()`. |
| | | |
| **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 `rspfg1_reset()`. |
| | | |
| **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 toABa2. |
| | | 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.<br>(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 rspict_InitWithOptions. | The driver function `rspict_InitWithOptions` is started. |
| | | |
| **Device SFT** | Starts the Device Self Test. | The function `rspict_self_test` is started. |
| | | |
| **Configuration** | Reads the configuration of the module (firmware version, slot number, hardware code). | The function `getConfiguration` 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 µA. |
| | | 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 |
| | | |
| | | MU_HI is switched to ABa2. |

| Testcase | Description | Test Sequence |
|---|---|---|
| | | 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:<br>DC: +5 V, 0 V, -5 V<br>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.<br>AC: 1 µA, 2 µA<br>DC: 20 µA, 200 µA, 2 mA, 20 mA, 50 mA, 100 mA, 200mA<br>The reference resistance (3.3 kOhm) is inserted on the R&S TS-PICT for the three smallest ranges (1 µA, 2 µA, 20 µA). |
| | | The results are compared with their limits and recorded in the SFT Report. |
| | | |
| **Check AOS Out-Res** | 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)<br>Output resistance:<br>0 Ohm<br>10 Ohm<br>100 Ohm<br>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. |

### 4.6.6 Digital Functional Test Module R&S TS-PDFT

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

- Initialization
- Device self test
- Configuration
- Check RS232 Interface
- Check CAN Bus
- Check PWM
- Check Static Pattern
- Check Level
- Check Dynamic Pattern
- Check Aux Relais
- Check Remaining DIN / DOUT lines

| Test Case | Description | Test Sequence |
|---|---|---|
| **INIT** | Initializes the module with the function rspdft_InitWithOptions. | The driver function `rspdft_InitWithOptions` is started. |
| | | |
| **Device SFT** | Starts the Device Self Test. | The function `rspdft_self_test` is started. |
| | | |
| **Configuration** | Reads the configuration of the module (firmware version, slot number, hardware code). | The function `getConfiguration` is started. |
| | | |
| **Check RS232 Interface** | This test case is not yet implemented. | |
| | | |
| **Check CAN Bus** | This test case is not yet implemented. | |
| | | |
| **Check PWM** | This test case is not yet implemented. | |
| | | |
| **Check Static Pattern** | Runs a static pattern test. | A pattern is generated. |
| | | The mode is configured. |
| | | The outputs (DOUT) are configured.<br>5.0 V<br>500 mA |

5th Issue 08.06

| Test Case | Description | Test Sequence |
|---|---|---|
| | | The inputs (DIN) are configured.<br>threshold1 = 2.0 V<br>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. |
| | | The inputs (DIN) are read and the result stored in an array. |
| | | This test is now repeated with the following pattern:<br>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<br>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):<br>9.0 V<br>500 mA |
| | | The inputs (DIN) are configured.<br>threshold1 = 9.5 V<br>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. |

| Test Case | Description | Test Sequence |
|---|---|---|
| | | The inputs (DIN) are configured.<br>threshold1 = 10.0 V<br>threshold2 = 9.6 V |
| | | The inputs (DIN) are read and the result stored in an array. |
| | | The outputs (DOUT) are configured.<br>3.3V (TTL Mode) |
| | | The inputs (DIN) are configured.<br>threshold1 = 3.8 V<br>threshold2 = 2.8 V |
| | | The inputs (DIN) are read and the result stored in an array. |
| | | The inputs (DIN) are configured.<br>threshold1 = 4.9 V<br>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 AUX Relais** | Tests all AUX relays<br>(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. |

| Test Case | Description | Test Sequence |
|---|---|---|
| | | 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) |

### 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`.

5th Issue 08.06

### 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 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.

#### 4.6.7.5.2 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 |

5th Issue 08.06

| Signal | Comment |
|---|---|
| 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 (Kx and Ky). Then, Kx and Ky 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 CHzn. If on all lines CHzn no connection is found, there is probably a defective coupling relay.

The measurements are repeated for all bus lines ABx.

### 4.6.7.7 Coupling Relays Bus Lines C, D

The function of the coupling relay of the four bus lines ABc1, ABc2 , ABd1 and ABd2 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 - LABx (PSAM) - ABx -  LABx <Kx> CHzn <Ky> LABy - 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 |
| LABx | HI line on local analog bus R&S TS-PAM |
| Kx | Matrix relay in the HI line |
| CHzn | Device connection R&S TS-PAM |
| 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 (Kx and Ky). Then, Kx and Ky 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 ABx.

### 4.6.7.9 Matrix Relays Bus Lines C, D

The function of the matrix relay of the bus lines ABc1, ABc2, ABd1 and ABd2 is tested. The test procedure is the same as in Section 4.6.7.8

5th Issue 08.06

### 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
```

5th Issue 08.06

#### 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 `CHx_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 `CHx_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 CHx_LO and the offset error measured in each range.

The following settings are selected:

| | |
|---|---|
| Input impedance: | 200 mV to 5 V: 10 MΩ;<br>10 V to100 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 CHx_LO with GND
  - For each oscilloscope channel
    - Connect CHx_LO with CHxy_HI
    - For each measurement range
      - Set range
      - Carry out measurement
    - Disconnect CHx_LO from CHxy_HI
  - Disconnect CHx_LO from GND

5th Issue 08.06

### 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 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.

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 CHx_LO with GND
  - Connect CHx_LO with the four channels CHxy_HI
  - For each combination of oscilloscope channels
    * Configure channels

5th Issue 08.06

* Carry out measurement

– Disconnect CHx_LO from the four channels CHxy_HI
– Disconnect CHx_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.

5th Issue 08.06

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.

#### 4.6.7.16.2 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 CHx_LO with GND
  - For each oscilloscope channel
    - Connect UREFxy with CHxy_HI
    - For each voltage
      - Set range
      - Set DAC
      - Carry out measurement
    - Disconnect UREFxy from CHxy_HI
  - Disconnect CHx_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

5th Issue 08.06

### 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 µA. 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 MΩ |
| Filter: | off |
| Observation time: | 500 µs |
| 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 µA |

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 `CHx_LO` with the analog bus
    * Connect `CHxy_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 `CHxy_HI` from the analog bus
    * Disconnect `CHx_LO` from the analog bus

5th Issue 08.06

### 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 XTIx and trigger outputs XTOx. In the self-test board, there are the following connections:

```
XTO1 -> XTI2
XTO2 -> XTI1
```

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

The following settings are selected:

| | |
|---|---|
| Range: | 100 V |
| Input impedance: | 1 MΩ |
| Filter: | off |
| Observation time: | 500 µs |
| 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 XTOx
  - Configure trigger output and activate
  - Configure trigger signal
  - Set trigger source (path x: Software; path y: XTIy)
  - Start measurement path x
  - Start measurement path y
  - Trigger path x by software and thus generate trigger signal on XTOx (path y is triggered by XTIy)
  - 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
```

5th Issue 08.06

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 CHx_LO with GND
  - For each oscilloscope channel
    * Connect CHx_LO with CHxy_HI
    * For each input of the input multiplexer
      - Connect DCS_HI with the corresponding analog bus line
      - Connect CHxy_HIz with CHxy_HI
      - Set voltage and current limit for contact measurement
      - Carry out contact measurement
      - Disconnect CHxy_HIz from CHxy_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 CHx_LO from CHxy_HI
  - Disconnect CHx_LO from GND

### 4.6.7.24 CHx_LO to CHx_LO1 Relay

#### 4.6.7.24.1 Description

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

The relays between CHx_LO and CHx_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 CHx_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 rspsys_InitWithOptions. | The driver function `rspsys_InitWithOptions` is started. |
| **Voltage Source** | The supply voltages are checked. | The following supply voltages are measured:<br>• 3,3 V<br>• 5 V<br>• +12 V<br>• -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.) | • Output DOUT1 is set.<br>Inputs DIN1 and DIN3 must be 1. Inputs DIN2 and DIN4 must be 0.<br>• Output DOUT2 is set.<br>Inputs DIN2 and DIN4 must be 1. Inputs DIN1 and DIN3 must be 0.<br>• Output DOUT3 is set.<br>Inputs DIN1 and DIN3 must be 1. Inputs DIN2 and DIN4 must be 0.<br>• Output DOUT4 is set.<br>Inputs DIN2 and DIN4 must be 1. Inputs DIN1 and DIN3 must be 0. |
| **Check temperature** | Measures voltage TEMP_OUT. (The test can only be carried out with the self test adapter connected.) | The temperature is read as attribute `RSPSYS_ATTR_HW_STATE_TEMP` 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. |

5th Issue 08.06

## 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 µA gives a threshold of the 500 kOhm. If the insulation resis-

5th Issue 08.06

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.

#### 4.6.9.5.2 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 |
|---|---|
| LABy (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 (Kx and Ky). Then Kx and Ky 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 CHx_y. If no connection is found on any lines CHx_y, a coupling relay is probably faulty.

The measurements are repeated for all bus lines ABx.

### 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 - 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-PSU |
| Kx | Matrix relay in the HI line |
| CHzn | R&S TS-PSU device connection |
| Ky | Matrix relay in the LO line |
| LABy | LO line on the local analogue bus R&S TS-PSU |
| ABy | LO line on analogue bus |
| LABy (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 (Kx and Ky). Then Kx and Ky 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 ABx.

### 4.6.9.9 Matrix Relays Bus Lines C, D

The function of the matrix relays of bus lines ABc1, ABc2, ABd1 and ABd2 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 `CHx_LO` and `CHx_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 `CHx_LO` and `CHx_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“

5th Issue 08.06

### 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 `CHx_LO` and `CHx_HI` with the analogue bus
- Connect `CHx_SLO` and `CHx_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.

5th Issue 08.06

#### 4.6.9.16.2 Sequence

For each channel

- Connect CHx_LOand 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

5th Issue 08.06

### 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 µs. 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 -> XTI2
XTO2 -> 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

5th Issue 08.06

– 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-

volved 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_LOand 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

5th Issue 08.06

### 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

5th Issue 08.06

### 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 `CHx` with `CHx_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 `CHx` from `CHx_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, Cannel 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:

5th Issue 08.06

```
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`.

5th Issue 08.06

### 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

5th Issue 08.06

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.

#### 4.6.10.5.2 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 |
|---|---|
| ABy | LO line on analogue bus |
| LABy (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 (Kx and Ky). Then Kx and Ky 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.

5th Issue 08.06

#### 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 - 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-PSM2 |
| CHx_y | Channel to R&S TS-PSM2 |
| LABy | LO line on the local analogue bus R&S TS-PSM2 |
| Ky | Coupling relay in the LO line |
| ABy | LO line on analogue bus |
| LABy (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 (Kx and Ky). Then Kx and Ky 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 CHx_y. If no connection is found on any lines CHx_y, a coupling relay is probably faulty.

The measurements are repeated for all bus lines ABx.

### 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.

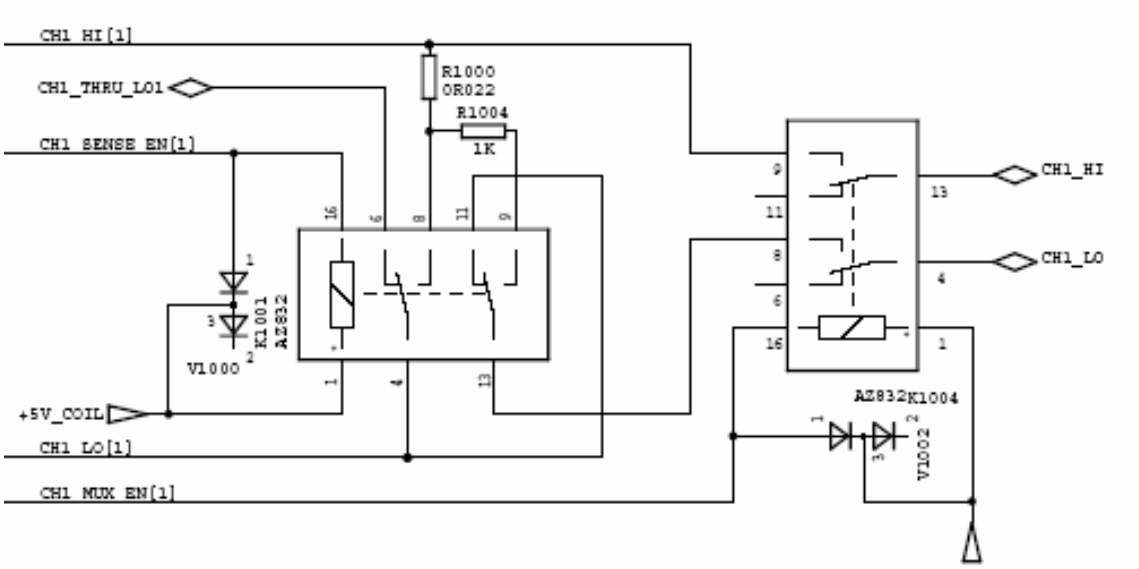



**Bild 4-9** Shunt resistor path

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 `CHx_LOy` and `CHx_LOy_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 bet-

ween 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
```

5th Issue 08.06

#### 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_com`in. 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 `CHx_HIy` and `CHx_LOy`.

The contact resistance between `CHx_THRU_LO1` and `CHx_LO1` is measured in this test case. The isolation measurement is not possible with this signal path. (When the relay is activated, `CHx_LO1` is also disconnected from the multiplexer relay.) This contact is demonstrated to be isolated, however, if the contact measurement between `CHx_HIy` and `CHx_LOy` is successful (mechanics of the relay).

The following signal paths are set up for contact measurement between `CHx_HIy` and `CHx_LOy`:

```
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 CHx_THRU_LO1 and CHx_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 CHx_HIy and CHx_LOy:

- 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 betweenCHx_THRU_LO1 and CHx_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`.

5th Issue 08.06

### 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 µA gives a threshold of the 500 kOhm. If the insulation resis-

5th Issue 08.06

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.

#### 4.6.11.8.2 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 |

5th Issue 08.06

| Signal | Note |
|---|---|
| LABy (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 (Kx and Ky). Then Kx and Ky 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 CHx_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.

5th Issue 08.06

### 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 - LABx (PSAM) - ABx <Kx> LABx - CHx_IN - 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 analog bus R&S TS-PSAM |
| ABx | HI line on analog bus |
| Kx | Coupling relay in the HI line |
| LABx | HI line on the local analog bus R&S TS-PIO2 |
| CHx_HI | Channel to R&S TS-PIO2 |
| LABy | LO line on the local analog bus R&S TS-PIO2 |
| Ky | Coupling relay in the LO line |
| ABy | LO line on analog bus |
| LABy (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 (Kx and Ky). Then Kx and Ky 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
```

5th Issue 08.06

#### 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`

5th Issue 08.06

### 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 and the connection to the reference resistor are 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
  - Disconnect analog bus line from 100 Ohm reference
  - If voltage values are within the valid range
    * Perform voltage measurement (V_iso)
  - 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<br>- Coupling relays not switching<br>- K111 not switching<br>- 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

5th Issue 08.06

### 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

5th Issue 08.06

  - 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 `Vout4` 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

5th Issue 08.06

### 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 µs 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

5th Issue 08.06

### 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

5th Issue 08.06

### 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 CHx_IN with CHx_2
- Perform resistance measurement (499 Ohm in the self-test connector)
- Disconnect CHx_IN from CHx_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 CHx_OUT and CHx_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:

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

The voltage on the relay contact is measured via the connection from CHx_IN to CHx_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 voltageV_ul at zero load
  - Connect CHx_OUT with CHx_OUT1
  - Connect CHx_IN with CHx_1
  - Measure voltage V_l under load
  - Disconnect CHx_OUT from CHx_OUT1
  - If the contact measurement was successful
    * Measure voltage V_iso with relay open
  - Disconnect CHx_IN from CHx_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 voltageV_ul at zero load
  - Connect CHx_OUT with CHx_OUT1
  - Connect CHx_IN with CHx_1
  - Measure voltageV_l 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

5th Issue 08.06

### 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

## 4.7 Self Test Report

See appendix A.

5th Issue 08.06

# 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:<br>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:<br>Lights up briefly when the Plug-In Card is accessed via the interface. |
| green | Supply voltage OK:<br>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.

5th Issue 08.06

## 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.

5th Issue 08.06

# 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 suatably 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.

5th Issue 08.06

### 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 kΩ and 1 MΩ 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.

5th Issue 08.06

## 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.

5th Issue 08.06

### 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.

5th Issue 08.06

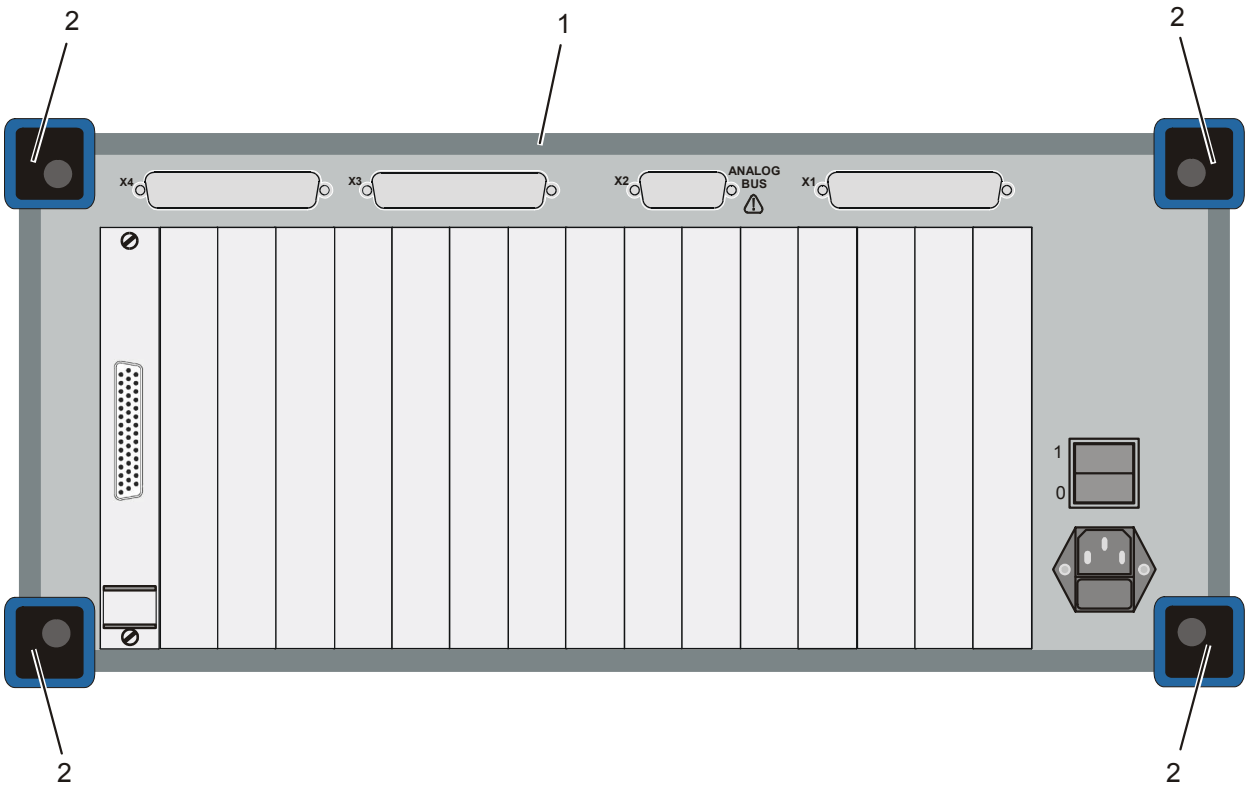



**Figure 6-1** R&S CompactTSVP / R&S PowerTSVP Rear View

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 covered or stored in suitable packaging. Electrical or electronic modules are to be stored in anti-static foil.

5th Issue 08.06

# 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

5th Issue 08.06

## 7.3 Spare Parts Modules

### 7.3.1 R&S TS-PAM

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

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

5th Issue 08.06

### 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

5th Issue 08.06

### 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-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 7-13** Spare Parts List R&S TS-PSM1

5th Issue 08.06

### 7.3.12 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 7-14** Spare Parts List R&S TS-PSM2

### 7.3.13 R&S TS-PSU

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

**Table 7-15** Spare Parts List R&S TS-PSU

### 7.3.14 R&S TS-PIO2

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

**Table 7-16** Spare Parts List R&S TS-PIO2

### 7.3.15 R&S TS-PHDT

| Item Number | Spare Part |
|---|---|
| 1157.9704.02 | High-Speed Digital Test Module |

**Table 7-17** Spare Parts List R&S TS-PHDT

### 7.3.16 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 7-18** Spare Parts List for several Modules

5th Issue 08.06

# 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.**

5th Issue 08.06

## 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 ModuleR&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.

5th Issue 08.06

### 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 discribed 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 discribed in the "High-Speed Digital Test Module R&S TS-PHDT" User Manual.

5th Issue 08.06

5th Issue 08.06

# 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\GTSL\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
pdft:                       passed
psys:                       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:            SFTSTSVP 01.02
SFT DLL Name:               SFTSTSVP

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: rspsam 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\gtsl\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-PSYS1,1,100001/004,01.00,01.00
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-PSYS11
  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.
```