R&S®RTO2000
Digital Oscilloscope
Service Manual

1332973102

Service Manual

Version 05

ROHDE&SCHWARZ

This manual describes the following R&S RTO models:

- R&S®RTO2002 (1329.7002K02)
- R&S®RTO2004 (1329.7002K04)
- R&S®RTO2012 (1329.7002K12)
- R&S®RTO2014 (1329.7002K14)
- R&S®RTO2022 (1329.7002K22)
- R&S®RTO2024 (1329.7002K24)
- R&S®RTO2032 (1329.7002K32)
- R&S®RTO2034 (1329.7002K34)
- R&S®RTO2044 (1329.7002K44)
- R&S®RTO2064 (1329.7002K64)

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1332.9731.02 | Version 05 | R&S®RTO2000

The following abbreviations are used throughout this manual: R&S®RTO 2000 is abbreviated as R&S RTO.

Basic Safety Instructions

Always read through and comply with the following safety instructions!

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

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

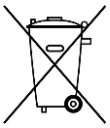
The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and, in some cases, a basic knowledge of English.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

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

Safety labels on products

The following safety labels are used on products to warn against risks and dangers.

Symbol	Meaning	Symbol	Meaning
	Notice, general danger location Observe product documentation		ON/OFF Power
	Caution when handling heavy equipment		Standby indication
	Danger of electric shock		Direct current (DC)

Symbol	Meaning	Symbol	Meaning
	Caution Hot surface		Alternating current (AC)
	Protective conductor terminal To identify any terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault, or the terminal of a protective earth		Direct/alternating current (DC/AC)
	Earth (Ground)		Class II Equipment to identify equipment meeting the safety requirements specified for Class II equipment (device protected by double or reinforced insulation)
	Frame or chassis Ground terminal		EU labeling for batteries and accumulators For additional information, see section Waste disposal/Environmental protection , item 1.
	Be careful when handling electrostatic sensitive devices		EU labeling for separate collection of electrical and electronic devices For additional information, see section Waste disposal/Environmental protection , item 2.
	Warning Laser radiation For additional information, see section Operation , item 7.		

Signal words and their meaning

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

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Indicates information considered important, but not hazard-related, e.g. messages relating to property damage.
In the product documentation, the word ATTENTION is used synonymously.

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

Operating states and operating positions

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

1. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products: predefined operating position is always with the housing floor facing down, IP protection 2X, use only indoors, max. operating altitude 2000 m above sea level, max. transport altitude 4500 m above sea level. A tolerance of ±10 % shall apply to the nominal voltage and ±5 % to the nominal frequency, overvoltage category 2, pollution degree 2.
2. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer s installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves). An installation that is not carried out as described in the product documentation could result in personal injury or even death.
3. Do not place the product on heat-generating devices such as radiators or fan heaters. The ambient temperature must not exceed the maximum temperature specified in the product documentation or in the data sheet. Product overheating can cause electric shock, fire and/or serious personal injury or even death.

Electrical safety

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

1. Prior to switching on the product, always ensure that the nominal voltage setting on the product matches the nominal voltage of the mains-supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
2. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with a protective conductor contact and protective conductor.
3. Intentionally breaking the protective conductor either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
4. If there is no power switch for disconnecting the product from the mains, or if the power switch is not suitable for this purpose, use the plug of the connecting cable to disconnect the product from the mains. In such cases, always ensure that the power plug is easily reachable and accessible at all times. For example, if the power plug is the disconnecting device, the length of the connecting cable must not exceed 3 m. Functional or electronic switches are not suitable for providing disconnection from the AC supply network. If products without power switches are integrated into racks or systems, the disconnecting device must be provided at the system level.
5. Never use the product if the power cable is damaged. Check the power cables on a regular basis to ensure that they are in proper operating condition. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by, for example, tripping over the cable or suffering an electric shock.

6. The product may be operated only from TN/TT supply networks fuse-protected with max. 16 A (higher fuse only after consulting with the Rohde & Schwarz group of companies).
7. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket provided for this purpose. Otherwise, sparks that result in fire and/or injuries may occur.
8. Do not overload any sockets, extension cords or connector strips doing so can cause fire or electric shocks.
9. For measurements in circuits with voltages V_{rms} > 30 V, suitable measures (e.g. appropriate measuring equipment, fuse protection, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
10. Ensure that the connections with information technology equipment, e.g. PCs or other industrial computers, comply with the IEC 60950-1 / EN 60950-1 or IEC 61010-1 / EN 61010-1 standards that apply in each case.
11. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
12. If a product is to be permanently installed, the connection between the protective conductor terminal on site and the product s protective conductor must be made first before any other connection is made. The product may be installed and connected only by a licensed electrician.
13. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fuse-protected in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.
14. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the person operating the product will be exposed to the danger of an electric shock.
15. Any object that is not designed to be placed in the openings of the housing must not be used for this purpose. Doing so can cause short circuits inside the product and/or electric shocks, fire or injuries.
16. Unless specified otherwise, products are not liquid-proof (see also section Operating states and operating positions , item 1). Therefore, the equipment must be protected against penetration by liquids. If the necessary precautions are not taken, the user may suffer electric shock or the product itself may be damaged, which can also lead to personal injury.
17. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product has been moved from a cold to a warm environment. Penetration by water increases the risk of electric shock.
18. Prior to cleaning the product, disconnect it completely from the power supply (e.g. AC supply network or battery). Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluents for cellulose lacquers.

Operation

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

2. Before you move or transport the product, read and observe the section titled Transport .
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens) such as nickel cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties) when using a Rohde Schwarz product, consult a physician immediately to determine the cause and to prevent health problems or stress.
4. Before you start processing the product mechanically and/or thermally, or before you take it apart, be sure to read and pay special attention to the section titled Waste disposal/Environmental protection , item 1.
5. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn babies require increased protection, pregnant women must be protected by appropriate measures. Persons with pacemakers may also be exposed to risks from electromagnetic radiation. The employer/operator must evaluate workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the potential danger.
6. Should a fire occur, the product may release hazardous substances (gases, fluids, etc.) that can cause health problems. Therefore, suitable measures must be taken, e.g. protective masks and protective clothing must be worn.
7. Laser products are given warning labels that are standardized according to their laser class. Lasers can cause biological harm due to the properties of their radiation and due to their extremely concentrated electromagnetic power. If a laser product (e.g. a CD/DVD drive) is integrated into a Rohde Schwarz product, absolutely no other settings or functions may be used as described in the product documentation. The objective is to prevent personal injury (e.g. due to laser beams).
8. EMC classes (in line with EN 55011/CISPR 11, and analogously with EN 55022/CISPR 22, EN 55032/CISPR 32)
   - Class A equipment:
     Equipment suitable for use in all environments except residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings
     Note: Class A equipment is intended for use in an industrial environment. This equipment may cause radio disturbances in residential environments, due to possible conducted as well as radiated disturbances. In this case, the operator may be required to take appropriate measures to eliminate these disturbances.
   - Class B equipment:
     Equipment suitable for use in residential environments and environments that are directly connected to a low-voltage supply network that supplies residential buildings

Repair and service

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

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

Batteries and rechargeable batteries/cells

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

1. Cells must not be taken apart or crushed.
2. Cells or batteries must not be exposed to heat or fire. Storage in direct sunlight must be avoided. Keep cells and batteries clean and dry. Clean soiled connectors using a dry, clean cloth.
3. Cells or batteries must not be short-circuited. Cells or batteries must not be stored in a box or in a drawer where they can short-circuit each other, or where they can be short-circuited by other conductive materials. Cells and batteries must not be removed from their original packaging until they are ready to be used.
4. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.
5. If a cell develops a leak, the fluid must not be allowed to come into contact with the skin or eyes. If contact occurs, wash the affected area with plenty of water and seek medical aid.
6. Improperly replacing or charging cells or batteries that contain alkaline electrolytes (e.g. lithium cells) can cause explosions. Replace cells or batteries only with the matching Rohde Schwarz type (see parts list) in order to ensure the safety of the product.
7. Cells and batteries must be recycled and kept separate from residual waste. Rechargeable batteries and normal batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.
8. Follow the transport stipulations of the carrier (IATA-DGR, IMDG-Code, ADR, RID) when returning lithium batteries to Rohde Schwarz subsidiaries.

Transport

1. The product may be very heavy. Therefore, the product must be handled with care. In some cases, the user may require a suitable means of lifting or moving the product (e.g. with a lift-truck) to avoid back or other physical injuries.
2. Handles on the products are designed exclusively to enable personnel to transport the product. It is therefore not permissible to use handles to fasten the product to or on transport equipment such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport or lifting. Observe the safety regulations of the manufacturer of the means of transport or lifting. Noncompliance can result in personal injury or material damage.

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

Waste disposal/Environmental protection

1. Specially marked equipment has a battery or accumulator that must not be disposed of with unsorted municipal waste, but must be collected separately. It may only be disposed of at a suitable collection point or via a Rohde Schwarz customer service center.
2. Waste electrical and electronic equipment must not be disposed of with unsorted municipal waste, but must be collected separately.
   Rohde Schwarz GmbH Co. KG has developed a disposal concept and takes full responsibility for take-back obligations and disposal obligations for manufacturers within the EU. Contact your Rohde Schwarz customer service center for environmentally responsible disposal of the product.
3. If products or their components are mechanically and/or thermally processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.
4. If handling the product releases hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation. The improper disposal of hazardous substances or fuels can cause health problems and lead to environmental damage.

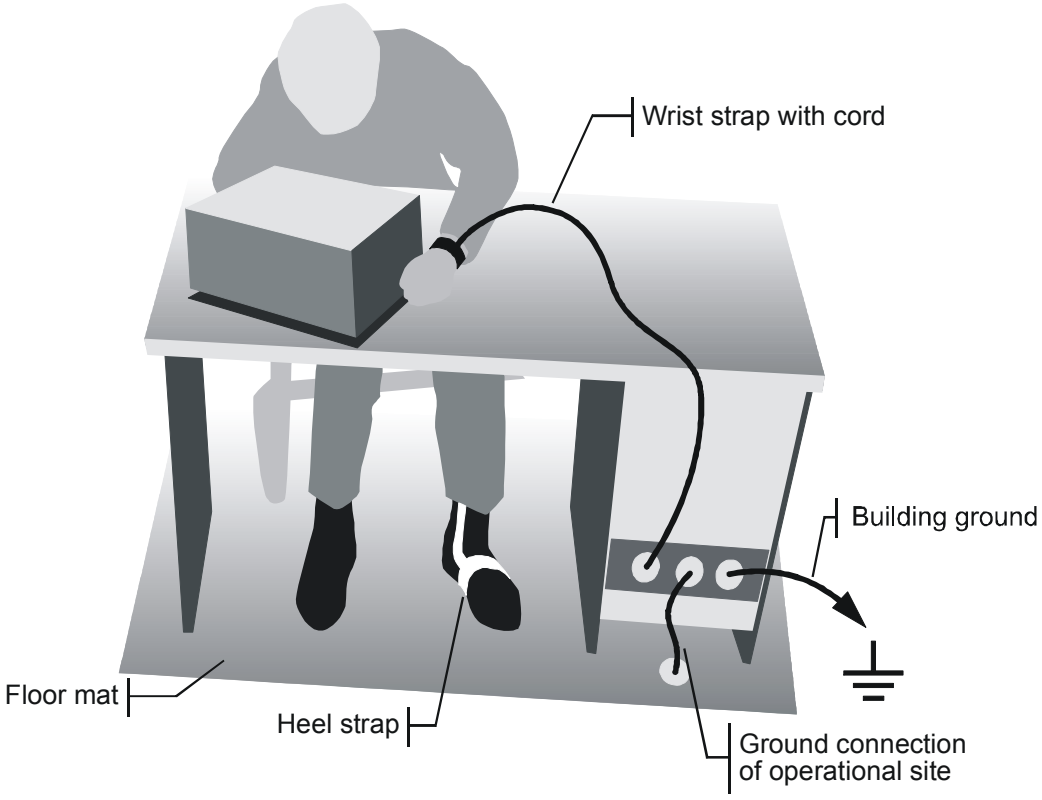
For additional information about environmental protection, visit the Rohde & Schwarz website.

Instructions for Electrostatic Discharge Protection

NOTICE

Risk of damaging electronic components

To avoid damage of electronic components, the operational site must be protected against electrostatic discharge (ESD).



The following two methods of ESD protection may be used together or separately:

- Wrist strap with cord to ground connection
- Conductive floor mat and heel strap combination

Procedure for servicing and repairs

This section contains information on shipping an instrument or module to your service center.

Please contact your local Rohde & Schwarz service center if your equipment needs to be serviced or repaired. You can find the current address of your representative at www.rohde-schwarz.com.

Shipping the instrument or module

We require the following information in order to answer your inquiry quickly and correctly and to determine whether the warranty is still valid for your product:

- Instrument model
- Serial number
- Firmware version
- Does the instrument have to be returned with this firmware
- Detailed error description in case of repair
- Indication of desired calibration
- Contact person for questions

In many countries, an RMA process is available (pickup and delivery of your product). For details, contact your local representative.

When shipping the product, ensure that there is sufficient mechanical and antistatic protection.

- Where possible, use the original packaging to transport or ship the product. The front and rear protective covers prevent damage to the operating elements and the connectors.
- If you do not use the original packaging, ensure sufficient padding to prevent the product from moving around inside the box. Wrap antistatic film around the product to protect it from electrostatic charging.
- Comply with the relevant safety and security measures for products with batteries.

As the manufacturer, Rohde & Schwarz can ensure that your instruments perform optimally throughout their service life by regularly calibrating them on its own measurement systems. Rohde & Schwarz calibration includes preventative measures such as adjustments. The calibration documentation fulfills ISO 17025 requirements.

Contents

1 Documentation Overview

This section provides an overview of the R&S RTO user documentation.

1.1 Manuals and Instrument Help

You find the manuals on the product page at:

www.rohde-schwarz.com/manual/rto

Getting started manual

Introduces the R&S RTO and describes how to set up and start working with the instrument, and describes basic operations. A printed English version is included in the delivery. Editions in other languages are available on the product website.

Instrument help

The help offers quick, context-sensitive access to the complete information for the firmware basic functionality and applications.

User manual (Instrument)

Describes all instrument functions in detail. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance and instrument interfaces. Includes the contents of the getting started manual.

The *online version* of the user manual provides the complete contents for immediate display on the internet.

Manuals for compliance test options

For compliance test options, extra test procedure manual are available. Test fixtures are described in printed manuals, which are delivered with the fixture.

- The following test procedure manuals are available:
  - USB 2.0 Compliance Tests for R&S RTO
  - Ethernet Compliance Tests for R&S RTO
  - MIPI D-PHY Compliance Tests for R&S RTO
  - DDR3 Compliance Tests for R&S RTO
  - eMMC Compliance Tests for R&S RTO
  - ScopeSuite Automation
- The following test fixture manuals are available:
  - R&S RT-ZF1 USB 2.0 Compliance Test Fixture Set
  - R&S RT-ZF2 Ethernet Compliance Test Fixture Set
  - R&S RT-ZF3 Frequency Converter Board (100BASE-T1)

- R&S RT-ZF4 10BASE-Te Test Fixture
- R&S RT-ZF5 Ethernet Probing Fixture
- R&S RT-ZF6 Frequency Converter Board (1000BASE-T1)

Basic safety instructions

Contains safety instructions, operating conditions and further important information. The printed document is delivered with the instrument.

Instrument security procedures manual

Deals with security issues when working with the R&S RTO in secure areas.

Service Manual

Describes the performance test for checking the rated specifications, module replacement, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists. The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS, https://gloris.rohde-schwarz.com).

1.2 Data Sheet and Brochure

The data sheet contains the technical specifications of the R&S RTO. It also lists the options with their order numbers and optional accessories. The brochure provides an overview of the instrument and deals with the specific characteristics.

See www.rohde-schwarz.com/brochure-datasheet/rto

1.3 Release Notes, Open Source Acknowledgment

The release notes list new features, improvements and known issues of the current firmware version, and describe the firmware installation. The open source acknowledgment document provides verbatim license texts of the used open source software. It can also be read directly on the instrument.

See www.rohde-schwarz.com/firmware/rto.

1.4 Application notes, Application cards, Videos

These documents deal with special applications or background information on particular topics.

See www.rohde-schwarz.com/application/rto

2 Performance Test

This chapter provides information on executing performance tests. After an overview of the required equipment, the test procedure and the detailed test goals are described.

At the end of this chapter, templates for test reports are supplied for your convenience.

2.1 Test Equipment

Table 2-1: Equipment for instrument tests

Item	Type of equipment	Recommended characteristics or features	Recommended model	R&S Order No.	Application
1	DC Calibrator	Max. ± 40 V Resolution min. 1 mV Current min. 120 mA (±6 V into 50 Ω) Range accuracy 0.1 V 0.1% +40 µV 1 V 0.1% +400 µV 6 V 0.1% +2.8 mV 40 V 0.1% +16 mV	Keithley Sourcemeter Model 2601A		DC gain accuracy, Offset accuracy
2	Digital multimeter	DC voltage range 0.1 V 0.1% +40 µV AC (RMS) voltage 1 V, 10 kHz 1% Frequency, 1 kHz 1% Resistance: 50 Ω/1 MΩ: 0.1 %	Agilent 34401A		Source meter 0.1 V range calibration, Probe compensation, Input resistance.
3	Signal generator	RF 10 MHz to 6 GHz, power +16 dBm	R&S SMB100A Opt. SMB-B106 or higher	1406.6000.02 1407.2909.02	Analog bandwidth, Ext. trigger Crosstalk
4	Power sensor	1 MHz to 6 GHz < 0.15 dB	R&S NRP-Z91	1168.8004.02	Analog bandwidth, 10 MHz Ref. (OCXO)
5	Power meter		R&S NRP	1143.8500.02	Analog bandwidth, 10 MHz Ref. (OCXO)
6	Power splitter	DC to 1 GHz	Agilent 11667A		Ext. trigger
7	Frequency counter	1 GHz < 2*10-9	Fluke PM6681 option 9624		Reference frequency accuracy.

Item	Type of equipment	Recommended characteristics or features	Recommended model	R&S Order No.	Application
8	Adapter	Female SMA to male BNC			Analog bandwidth
9	Attenuator	SMA, 50 Ω, -6 dB			Analog bandwidth
10	Active probe	10:1 attenuation	R&S®RT-ZS10 R&S®RT-ZS20 R&S®RT-ZS30	1410.4080.02 1410.3502.02 1410.4309.02	Probe identification
11	Passive probe	10:1 attenuation, 10 MΩ	R&S®RT-ZP10	1409.7550.00	Probe identification
12	Feedthrough termination	50 Ω, BNC			Crosstalk
13	SMA 50 Ω termination			5201.1262.00	R&S RTO-B7 pulse source

Table 2-2: Equipment for Waveform Generator Tests (option R&S RTO-B6)

Item	Type of equipment	Recommended characteristics or features	Recommended model	R&S Order No.	Application
1w	Digital multimeter	Voltage measurement DC up to ±12 V AC up to 4.5 V RMS	Agilent 34410A		RTO-B6 Sinewave Level RTO-B6 DC Offset Level
2w	BNC feedthrough termination	Impedance 50 Ω		0844.9352.02	RTO-B6 Sinewave Level RTO-B6 DC Offset Level
3w	Adapter BNC (m) to dual banana (f)				RTO-B6 Sinewave Level RTO-B6 DC Offset Level
4w	Banana cable				RTO-B6 Sinewave Level RTO-B6 DC Offset Level RTO-B6 Pattern Generator Level
5w	Clamp-type test probe	4 mm banana (f)	Hirschmann Kleps 30		RTO-B6 Pattern Generator Level
6w	Power meter		R&S NRP2	1144.1374.02	RTO-B6 Sinewave Level
7w	Power sensor	Frequency 10 kHz -100 MHz Level -36 dBm to +20 dBm	NRP-Z91	1168.8004.02	RTO-B6 Sinewave Level
8w	Adapter N (f) to BNC (m)	Impedance 50 Ω			RTO-B6 Pattern Generator Level

2.2 Performance Tests R&S RTO

2.2.1 Test Instructions

To make sure that rated specifications are maintained, the following preparations are required prior to checking the rated characteristics:

- Allow for a minimum warm-up time of 30 minutes at ambient temperature.
- Carry out all internal adjustments.
- The values are specified in the data sheet. Additional uncertainties introduced by the measurement equipment must be taken into account when checking the rated values.

Inputs for settings during measurements are shown as follows:

- [KEY]: Press a key on the front panel, e.g. [Meas].
- "User interface element": Tap a setting on the touch screen (tab, menu, item in selection list)
- Successive entries are separated by :, e.g. [Meas] : Setup : Main Measurement "Mean" : State "On" : Source "CH1"

2.2.2 Reference Frequency Accuracy

Test equipment:
- Frequency counter (see Table 2-1, item. 7)

Test setup:
► Connect AUX OUT (SMA connector) of the R&S RTO to the input of the frequency counter.

R&S RTO settings:
- [Preset]
- [Horizontal] : Skew : AUX OUT : check box "1 GHz Reference ON"]

The 1 GHz reference oscillator signal is output to the [Aux Out] connector. The level at [Aux Out] is approx. -2 dBm into 50 Ω load (500 mV peak-peak).

Measurement:
1. Set frequency counter to appropriate resolution.
2. Read frequency counter display.

Reference frequency out of tolerance

If the reference frequency is out of outgoing tolerance, adjust the frequency of the reference oscillator (see Chapter 3.3, "Adjusting the Reference Oscillator", on page 66).

Adjust frequency as close as possible to 1 GHz.

2.2.3 Input Resistance

Test equipment:
- Digital multimeter (see Table 2-1, item 2)
  Resistance measurement uncertainty 0.1%, 50 Ω to 1 MΩ

Test setup:
► Connect multimeter to CH1 input of the R&S RTO.

Multimeter settings:
► Resistance measurement

Note: Agilent 34401A: set range manually to 10 MΩ.

R&S RTO settings: for 1 MΩ input resistance measurement:

1. [Preset]
2. [Ch1] : 1 MΩ DC : Scale (refer to measurement settings below) : Offset 0 V

Measurement:
► Set the vertical scale as follows and read the resistance display at a time:
- 10 V / div
- 1 V / div
- 100 mV / div

R&S RTO settings: for 50 Ω input resistance measurement:

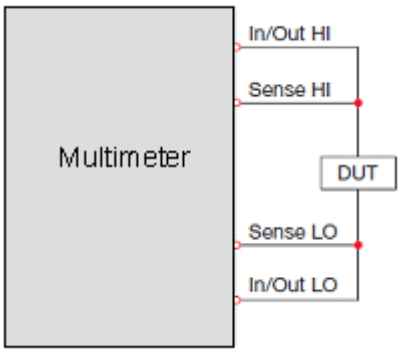
1. [Preset]
2. [Ch1] : 50 Ω DC: Scale (refer to table below) : Offset 0 V

Multimeter settings:
► Agilent 34401A: set range manually to 100 Ω.

Measurement:
► Set the vertical scale as follows and read the resistance display at a time:
- 1 V / div
- 200 mV / div
- 100 mV / div

Test cable connection

The resistance of the test cables must be taken into account. For best results, use a 4-wire connection and connect sense lines as close as possible to the R&S RTO input.



Measurement: Repeat all measurements with the remaining channels.

2.2.4 DC Gain Accuracy

Required calibration voltage accuracy

The required accuracy of the calibrator voltage is stated in the table below. Whenever the required accuracy is not within the specification of the used DC calibrator, the voltage setting must be verified using the digital multimeter (see Table 2-1, item 2). The actual voltage (DMM reading) is taken into account in the accuracy calculation. The Keithley 2601A does not meet the required accuracy with voltage settings of less than 60 mV!

Calibrator Noise

The output **peak** noise of the calibrator must not exceed 10% of the DC voltage setting. The Keithley 2601 source meter does not meet this specification with low voltage settings. It is mandatory to add low ESR ceramic capacitors (recommended 2x22 µF) across the source meter output, preferably as close as possible to the R&S RTO input.

Test equipment:

- DC Calibrator (see Table 2-1, item 1).
  Voltage: ±40 V unloaded, ±4.5 V into 50 Ω.
- Optional (see note above): Digital multimeter (see Table 2-1, item 2).

Test setup:

1. Connect calibrator output to CH1 input of the R&S RTO.
2. Connect digital multimeter (DMM) in parallel with the calibrator output .

Calibrator settings:

► DC Voltage (refer to tables below)

R&S RTO settings: for 1 MΩ DC gain accuracy measurement:

1. [Preset]
2. [Horizontal] : 10 ms / div
3. [Acquisition] : "Ch1": Mode "High res" : "Setup" tab : Record length 1kSa
4. [Meas] : Setup : Main Measurement "Mean" : State On : Source "CH1"
5. CH1 : 1 MΩ DC : Scale (refer to table below)

Measurement:

Vertical Scale	Calibrator Voltage	Vertical Scale	Calibrator Voltage
10 V / div	±40 V ±160 mV	100 mV / div	±450 mV ±1.8 mV
3.2 V / div	±14.5 V ±60 mV	70 mV / div	±320 mV ±1.3 mV
3 V / div	±13.5 V ±55 mV	32 mV / div	±145 mV ±600 µV
1.1 V / div	±5 V ±20 mV	30 mV / div	±135 mV ±550 µV
1 V / div	±4.5 V ±18 mV	11 mV / div	±50 mV ±200 µV

Vertical Scale	Calibrator Voltage	Vertical Scale	Calibrator Voltage
320 mV / div	±1.45 V ±6 mV	10 mV / div	±45 mV ±180 µV
300 mV / div	±1.35 V ±5.5 mV	3.2 mV / div	±14.5 mV ±60 µV
110 mV / div	±500 mV ±2 mV	3 mV / div	±13.5 mV ±60 µV

Evaluation:

► Read the mean values from R&S RTO display and calculate the DC gain accuracy in % according to the following formula:

DC gain accuracy (%) = 100 x [(RTO_rdg1 – RTO_rdg2) / (CAL_volt1 – CAL_volt2) – 1]

RTO_rdg1 = RTO reading with positive calibrator voltage
RTO_rdg2 = RTO reading with negative calibrator voltage
CAL_volt1 = positive calibrator voltage *
CAL_volt2 = negative calibrator voltage *
* If the DMM is used to verify the calibrator voltage insert the actual voltage = DMM reading in the formula instead of the nominal setting

Measurement:

► Repeat all measurements with the remaining channels.

R&S RTO settings:

for 50 Ω DC gain accuracy measurement:

1. [Preset]
2. [Horizontal] : 10 ms / div
3. [Acquisition] : "Ch1": Mode "High res" : "Setup" tab : Record length 1kSa
4. [Meas] : Setup : Main Measurement "Mean" : State On : Source "CH1"
5. CH1 : 50 Ω DC : Scale (refer to table below)

Measurement:

Vertical Scale	Calibrator Voltage	Vertical Scale	Calibrator Voltage
1 V / div	±4.5 V ±18 mV	100 mV / div	±450 mV ±1.8 mV
570 mV / div	±2.6 V ±10 mV	70 mV / div	±320 mV ±1.3 mV
560 mV / div	±2.5 V ±10 mV	32 mV / div	±145 mV ±600 µV
320 mV / div	±1.45 V ±6 mV	30 mV / div	±135 mV ±550 µV
300 mV / div	±1.35 V ±5.5 mV	11 mV / div	±50 mV ±200 µV
180 mV / div	±810 mV ±3.2 mV	10 mV / div	±45 mV ±180 µV
175 mV / div	±790 mV ±3.2 mV	3.2 mV / div	±14.5 mV ±60 µV
110 mV / div	±500 mV ±2 mV	3 mV / div	±13.5 mV ±60 µV

Evaluation:

► Read the mean values from R&S RTO display and calculate the DC gain accuracy in % according to the following formula:

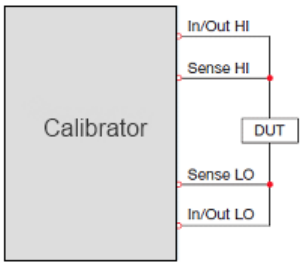
DC gain accuracy (%) = 100 x [(RTO_rdg1 – RTO_rdg2) / (CAL_volt1 – CAL_volt2) – 1]

RTO_rdg1	= RTO reading with positive calibrator voltage
RTO_rdg2	= RTO reading with negative calibrator voltage
CAL_volt1	= positive calibrator voltage *
CAL_volt2	= negative calibrator voltage *
* If the DMM is used to verify the calibrator voltage insert the actual voltage	= DMM reading in the formula instead of the nominal setting.

Test cable connection

The voltage drop on the test cables must be taken into account. For example, a DC resistance of 0.2 Ω results in a -0.4% lower voltage at the 50 Ω R&S RTO input.

For best results use 4-wire connection and connect sense lines as close as possible to the R&S RTO input.



If the calibrator does not support sensing, use a digital voltmeter to control the voltage at the R&S RTO input.

Measurement: ► Repeat all measurements with the remaining channels.

2.2.5 Offset Accuracy

Test equipment:
- DC calibrator (see Table 2-1, item 1)
  Voltage: ±40 V unloaded, ±5 V into 50 Ω

Test setup: ► Connect calibrator output to CH1 input of the R&S RTO

Calibrator settings: ► DC Voltage (refer to tables below)

R&S RTO settings: for 1 MΩ offset accuracy measurement:

1. [Preset]
2. [Horizontal] : 10 ms / div
3. [Acquisition] : "Ch1": Mode "High res" : "Setup" tab : Record length 1kSa
4. [Meas] : Setup : Main Measurement "Mean" : State On : Source "CH1"
5. CH1 : 1 MΩ DC : Scale (refer to table below) : Offset (refer to table below)

Measurement:

Vertical Scale	Offset & Calibrator Voltage	Vertical Scale	Offset & Calibrator Voltage
10 V / div	0 V	100 mV / div	0 V
	+40 V		+0.5 V
	-40 V		-0.5 V
3 V / div	0 V	30 mV / div	0 V
	+40 V		+0.5 V
	-40 V		-0.5 V
1 V / div	0 V	10 mV / div	0 V
	+5 V		+1 V
	-5 V		-1 V
300 mV / div	0 V	3 mV / div	0 V
	+5 V		+1 V
	-5 V		-1 V

Evaluation:

► Read the mean values from R&S RTO display.

The offset deviation from the set value is equal to the difference between the applied voltage and the mean value reading.

Example:

10 mV / div, offset & calibrator voltage +1 V, mean value reading 995 mV

offset deviation = 1000 mV -995 mV = +5 mV

the actual offset voltage is 1005 mV

The horizontal gridline at the center of the screen is always equal to the actual offset voltage, in this example 1005 mV. Hence the trace of the applied 1000 mV voltage is seen 5mV (1/2 division) below the center line.

► Repeat all measurements with the remaining channels.

R&S RTO settings:

for 50 Ω offset accuracy measurement:

1. [Preset]
2. [Horizontal] : 10 ms / div
3. [Acquisition] : "Ch1": Mode "High res" : "Setup" tab : Record length 1kSa
4. [Meas] : Setup : Main Measurement "Mean" : State On : Source "CH1"
5. CH1 :50 Ω DC : Scale (refer to table below) : Offset (refer to table below)

Measurement:

Vertical Scale	Offset & Calibrator Voltage	Vertical Scale	Offset & Calibrator Voltage
1 V / div	0 V	100 mV / div	0 V
	+5 V		+1 V
	-5 V		-1 V
500 mV / div	0 V	30 mV / div	0 V
	+5 V		+1 V
	-5 V		-1 V
300 mV / div	0 V	10 mV / div	0 V
	+3 V		+1 V
	-3 V		-1 V
150 mV / div	0 V	3 mV / div	0 V
	+3 V		+1 V
	-3 V		-1 V

Evaluation:

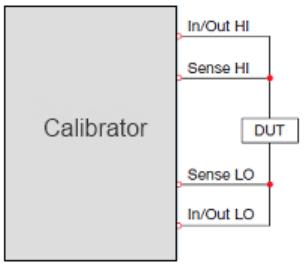
► Read the mean values from R&S RTO display.

The offset deviation from the set value is equal to the difference between the applied voltage and the mean value reading.

Test cable connection

The voltage drop on the test cables must be taken into account. For example, a DC resistance of 0.2 Ω results in a -0.4% lower voltage at the 50 Ω R&S RTO input.

For best results use 4-wire connection and connect sense lines as close as possible to the R&S RTO input.



If the calibrator does not support sensing, use a digital voltmeter to control the voltage at the R&S RTO input.

Measurement:

► Repeat all measurements with the remaining channels

2.2.6 Crosstalk (Channel to Channel Isolation)

2.2.6.1 Crosstalk (all R&S RTO)

Test equipment:

- Signal generator (see Table 2-1, item 3): 10 MHz to 4 GHz
- Feedtrough termination (item 12)

Crosstalk channel 1 to channel 2

Test setup:

► Connect the signal generator to the R&S RTO input Channel 1, with 1 MΩ input impedance use a feedthrough termination at the R&S RTO input.

R&S RTO settings:

1. [Preset]
2. [Ch1] : Scale 10 mV / div, impedance see table below
3. [Ch2] : Scale 10 mV / div, impedance see table below
4. [Trigger] : Source: Ch1
5. [Math] (M1) : Math Setup: Enable math signal : Operator "Mag (FFT)" : Source Ch1Wfm1
6. [Math] (M1) : FFT Setup : Frequency Span 10 MHz : Resol. BW 100 kHz : Center Frequency see table below
7. [Cursor] : Setup : Enable : Source Math1 : select "Track waveform" : in field "X position 1" enter the center frequency (see table below)

Signal generator settings:

1. Level: -17 dBm (-17 dBm into R&S RTO input!)
2. Frequency: see table below

Measurement:

1. Read cursor level "V1": L1 [dBm] (approx. -20 dBm to -17 dBm)
2. [Math] (M1) : Math Setup : Source Ch2Wfm1
3. Read cursor level "V1": L2 [dBm]
4. Calculate isolation Channel 1 to Channel 2: L1/dBm – L2/dBm [dB]

R&S RTO & signal generator settings:

CH1 & CH2 input impedance	R&S RTO model	Signal generator frequency	FFT center frequency
1 MΩ	All models	500 MHz	500 MHz
50 Ω	R&S RTO200x	500 MHz	500 MHz
50 Ω	R&S RTO201x	990 MHz	990 MHz
50 Ω	R&S RTO202x	1990 MHz	1990 MHz
50 Ω	R&S RTO203x	1990 MHz 2990 MHz	1990 MHz 2990 MHz

CH1 & CH2 input impedance	R&S RTO model	Signal generator frequency	FFT center frequency
50 Ω	R&S RTO2044	1990 MHz 4000 MHz	1990 MHz 4000 MHz
50 Ω	R&S RTO2064	1990 MHz 4000 MHz	1990 MHz 4000 MHz

Crosstalk channel 4 to channel 3 (4 channel models only)

On 4-channel instruments, repeat the crosstalk measurement for channel 4 and 3.

Connect the signal generator to the R&S RTO input Channel 4, with 1 MΩ input impedance use a feedthrough termination at the R&S RTO input.

2.2.6.2 Crosstalk - Interleaved Mode (only RTO2044 und RTO2064)

Test equipment:

- Signal generator (see Table 2-1, item 3)
- Feedtrough termination (item 12)

Crosstalk channel 2 to channel 3

Test setup:

1. Connect the signal generator to the R&S RTO input Ch2, with 1 MΩ input impedance use a feedthrough termination at the R&S RTO input.
2. Set the R&S RTO to interleaved mode: Resolution: 50 ps; Sample rate: 20 GSa/s in real-time (RT).

R&S RTO2064: interleaved mode

Ensure that the R&S RTO is running in interleaved mode during all measurements with Resolution: 50 ps; Sample rate: 20 GSa/s in real-time (RT)! To enable the interleaved mode, the adjacent channel must be switched off. Make sure that no measurements, math, trigger etc. are active on deactivated channels.

R&S RTO settings:

1. [Preset]
2. [Ch1] : Signal off
3. [Ch2] : Scale 10 mV / div, impedance see table below
4. [Ch3] : Scale 10 mV / div, impedance see table below
5. [Trigger] : Source: Ch2
6. [Math] (M1) : Math Setup: Enable math signal : Operator "Mag (FFT)" : Source Ch2
7. [Math] (M1) : FFT Setup : Frequency Span 10 MHz : Resol. BW 100 kHz : Center Frequency see table below
8. [Cursor] : Setup : Enable : Source Math1 : select "Track waveform" : in field "X position 1" enter the center frequency (see table below)

9. [Horizontal] : Resolution: 50ps RT (Sample Rate: 20 GSa/s)
   Important: Sample Rate must be set after setting the FFT parameters!

Signal generator settings:

1. Level: -17 dBm (-17 dBm into R&S RTO input!)
2. Frequency: see table below

Measurement:

1. Read cursor level "V1": L2 [dBm] (approx. -20 dBm to -17 dBm)
2. [Math] (M1) : Math Setup : Source Ch3
3. Read cursor level "V1": L3 [dBm]
4. Calculate isolation: channel 2 to channel 3: L2/dBm – L3/dBm [dB]

CH1 & CH2 input impedance	R&S RTO model	Signal generator frequency	FFT center frequency
1 MΩ	All models	500 MHz	500 MHz
50 Ω	RTO204x and instruments with RTO-B204, RTO-B214, RTO-B224, RTO-B234	1990 MHz 4000 MHz	1990 MHz 4000 MHz
	RTO2064 and instruments with RTO-B206, RTO-B216, RTO-B226, RTO-B236, RTO-B246	1990 MHz 4000 MHz 6000 MHz	1990 MHz 4000 MHz 6000 MHz

Crosstalk channel 3 to channel 2

Repeat the crosstalk measurement for channel 3 against channel 2.

2.2.7 Analog Bandwidth

Test equipment:

- Signal generator (see Table 2-1, item 3):
  10 MHz to 4 GHz, +16 dbm, VSWR ≤1.5
- Adapter female SMA to male BNC (item 8)
- SMA cable
- Power meter (item 5) and power sensor (item 4)

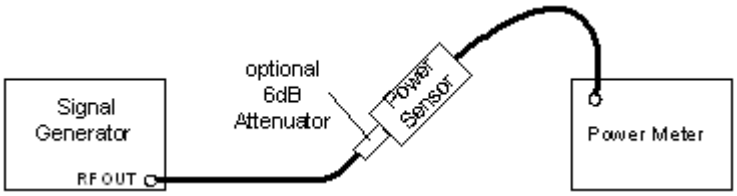
Optional equipment:

- -6dB attenuator SMA (item 9): needed if signal generator's VSWR >1.5

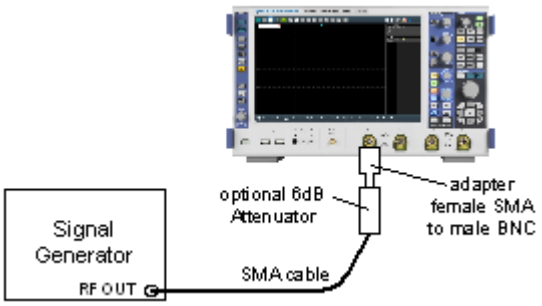
Test setup:

1. Connect the RF output of the signal generator through a SMA cable to the power sensor.
2. Insert a 6 dB attenuator as shown if the signal generator does not meet a VSWR <1.5 at the highest test frequency.

3. Check the level evenness of the signal generator at the highest test frequency referenced to 10 MHz. If required, adjust the level at the highest test frequency accordingly and record the setting.



4. Connect the SMA to BNC adapter directly to the R&S RTO input.
5. Connect the SMA cable (with optional attenuator) to the SMA/BNC adapter.



Standard BNC components (cable, attenuator) are not suitable for frequencies >1 GHz. Use SMA components (as shown) or N components.

R&S RTO settings:

1. [Preset]
2. [Horizontal] : 100 µs / div (10000 cycles)
3. [Meas] : Setup : Main Measurement "StdDev" : State On : Source Ch1
4. [Ch1] : 50 Ω DC : Scale 100 mV / div
5. [Trigger] : Source: Ch1

R&S RTO2064: interleaved mode

Ensure that the R&S RTO is running in interleaved mode during all measurements with Resolution: 50 ps; Sample rate: 20 GSa/s in real-time (RT)! To enable the interleaved mode, the adjacent channel must be switched off. Make sure that no measurements, math, trigger etc. are active on deactivated channels.

Signal generator settings:

1. Level: 600 mV peak-peak (-0.46 dBm) (+5.54 dBm with opt. 6dB attenuator)
2. Frequency: 10 MHz

Reference measurement:

► Read StdDev value from R&S RTO: A_{10MHz}.

Signal generator settings:

- Frequency:

R&S RTO	Frequency setting
R&S RTO2002/2004	600 MHz
R&S RTO2012/2014 and instruments with R&S RTO-B201 upgrade	1 GHz
R&S RTO2022/2024 and instruments with R&S RTO-B202 or B212 upgrade	2 GHz
R&S RTO2032/2034 and instruments with R&S RTO-B203, B213 or B223	3 GHz
R&S RTO2044 and instruments with R&S RTO-B204, B214, B224 or B234 upgrade	4 GHz
R&S RTO2064 and instruments with R&S RTO-B206, B216, B226, B236, B246	6 GHz

- Level: If required, adjust the level as recorded.

R&S RTO settings:

R&S RTO	"Horizontal"
R&S RTO2002/2004	1666.7 ns / div
R&S RTO2012/2014 and instruments with R&S RTO-B201 upgrade	1000 ns / div
R&S RTO2022/2024 and instruments with R&S RTO-B202 or B212 upgrade	500 ps / div
R&S RTO2032/2034 and instruments with R&S RTO-B203, B213 or B223	333.3 ps / div
R&S RTO2044 and instruments with R&S RTO-B204, B214, B224 or B234 upgrade	250 ps / div
R&S RTO2064 and instruments with R&S RTO-B206, B216, B226, B236, B246 upgrade	166.7 ns / div

Bandwidth measurement:

1. Read StdDev value from R&S RTO: A_{BW}
2. Calculate: Attenuation (dB) = 20*log(A_{BW} / A_{10MHz})
3. Repeat the procedure with the settings listed below.

R&S RTO & signal generator settings:

R&S RTO Vertical scale	Signal generator level (with optional 6dB attenuator add +6dB !)		R&S RTO Vertical scale	Signal generator level (with optional 6dB attenuator add +6dB !)
600 mV / div	3.6 V peak-peak (+15.11 dBm) 2 V peak-peak (1) (+10.00 dBm)		100 mV / div	600 mV peak-peak (-0.46 dBm)
320 mV / div	1.92 V peak-peak (+9.65 dBm)		20 mV / div	120 mV peak-peak (-14.44 dBm)
200 mV / div	1.2 V peak-peak (+5.56 dBm)		5 mV / div	30 mV peak-peak (-26.48 dBm)
150 mV / div	900 mV peak-peak (+3.06 dBm)		1 mV / div	6 mV peak-peak (-40.46 dBm)
(1) With the 6 dB attenuator in use and a maximum generator output of +16 dBm the voltage is limited to 2 V peak-peak. In this case perform the test with a 2V peak-peak signal.				

Measurement:

► Repeat all measurements with the remaining channels.

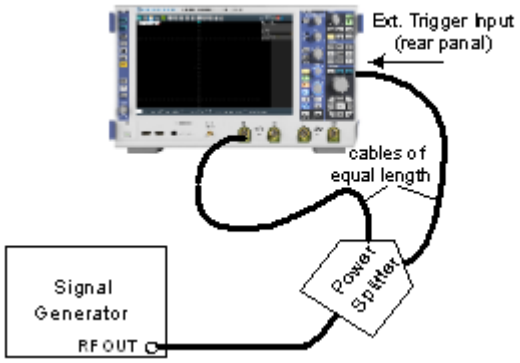
2.2.8 External Trigger Sensitivity

Test equipment:

- Signal generator (Table 2-1, item3)
- Power splitter (item 6)

Test setup: Connect equipment as shown below.

Make sure that the cables from the splitter to the CH1 input and to the external trigger input are of equal length!



R&S RTO settings:

1. [Preset]
2. [Horizontal] : Time scale 300 ps / div: Reference point 50%
3. [Ch1] : 50 Ω DC: Scale 100 mV / div

4. [Trigger] : Source "Ext" : Coupling. 50 Ω DC : Level 0 V : Positive Slope

Signal generator settings:

1. Level: +5.56 dBm nominal *
2. Frequency: 500 MHz

* 600 mV peak to peak at ext. trig. Input. Check peak to peak voltage on screen, adjust signal generator level if necessary.

Measurement:

► Check for trigger.

R&S RTO settings:

1. [Horizontal] : Time scale 3 ns / div: Reference point 50%
2. [Ch1] : 50 Ω DC: Scale 50 mV / div
3. [Trigger] : Source "Ext" : Coupling 50 Ω DC : Level 0 V : Positive Slope

Signal generator settings:

1. Level -0.46 dbm nominal *
2. Frequency 100 MHz

* 300 mV peak to peak at ext. trig. Input. Check peak to peak voltage on screen, adjust signal generator level if necessary.

Measurement:

► Check for trigger.

2.2.9 Probe Compensation

Test equipment:

- Voltmeter (Table 2-1, item 2): Frequency measurement (1 kHz)
  If the voltmeter does not support frequency measurement, use a counter (Table 2-1, item 7)

Test setup:

1. Connect the voltmeter to the probe compensation pins of the R&S RTO.
2. Select ACV measurement.

R&S RTO settings:

No specific settings required

Measurement:

1. Read the AC voltage and frequency from the voltmeter.
2. Calculate: Amplitude = 2 x ACV reading (square wave signal)

2.2.10 10 MHz Reference (with OCXO Option only)

Test equipment:

1. Power meter (Table 2-1, item 5):
2. Power sensor (item 4):

Test setup:

► Connect the power sensor to the REF output of the R&S RTO.

Measurement:

► Read the level indication from power meter.

2.2.11 Probe Identification

2.2.11.1 Passive Probes

Test equipment:
- Passive 10:1 Probe (Table 2-1, item 11)

Test setup: At first do **not** connect the probe to the R&S RTO.

R&S RTO settings:
1. [Preset]
2. [Ch1] : 50 Ω DC : Scale 500 mV / div
3. [Horizontal] : Scale 500 µs / div
4. [Trigger] : Trigger Level : 0.5 V

Measurement:
1. Connect probe to R&S RTO [Ch1] input.
2. Connect probe tip to Probe Compensation signal output.
3. Check display: Square wave with approx. 1 V peak-peak (2 divisions) amplitude. The instrument automatically switches the input impedance to 1 MΩ and adjusts the gain to compensate for the probe attenuation.

Measurement:
► Repeat all measurements with the remaining channels.

2.2.11.2 Active Probes

Test equipment:
- Active 10:1 Probe (Table 2-1, item 10)

Test setup: At first do **not** connect the probe to the R&S RTO.

R&S RTO settings:
1. [Preset]
2. [Ch1] : 1 MΩ DC : Scale 500 mV / div
3. [Horizontal] : Scale 500 µs / div
4. [Trigger] : Trigger Level : 0.5 V

Measurement:
1. Connect probe to R&S RTO Ch1 input.
2. Connect probe tip to Probe Compensation signal output.
3. Check Display: Square wave with approx. 1 V peak-peak (2 divisions) amplitude. The instrument automatically switches the input impedance to 50 Ω and adjusts the gain to compensate for the probe attenuation.

Measurement:
► Repeat all measurements with the remaining channels.

2.2.12 Option R&S RTO-B1, Mixed Signal Option

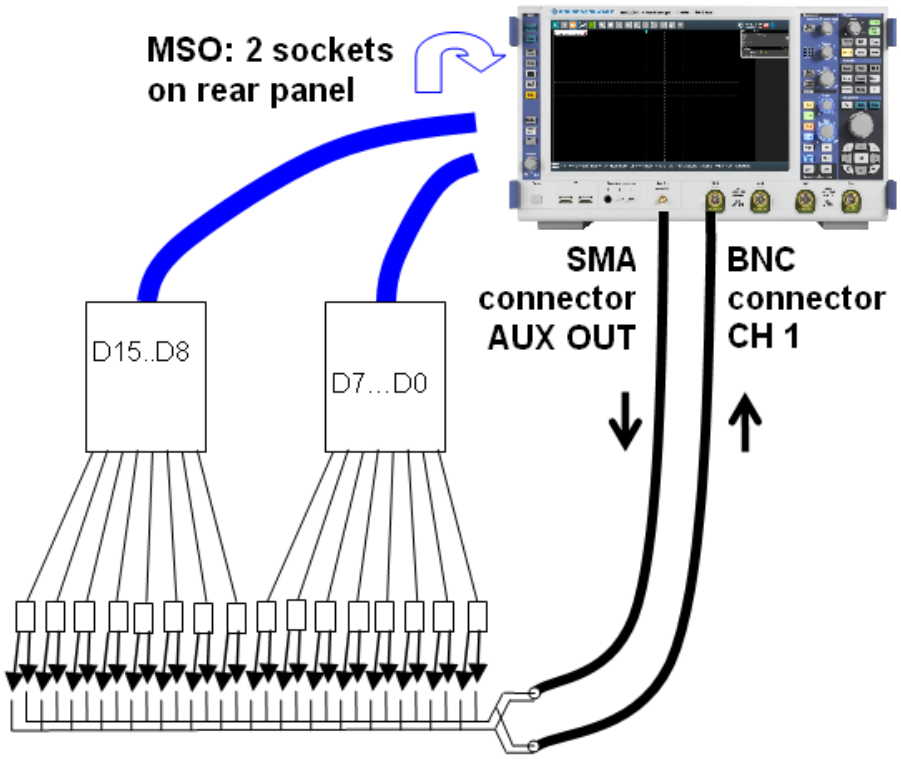
Treshold DC Test

Test equipment:

- Mixed signal option installed
- 2 Logic probes (8 channels each) connected to MSO
- Appropriate number of tip cables
- Service Adaptor: SMA/BNC male to 16x2 connector male (“2.54 mm Berg pins”)

Whenever a logic probe is connected to the RTO the probe performs a self-test automatically. At first both LED of the probe are on then one of them turns off. If two probes are connected one indicates channels D15…D8 the other one D7…D0.

Test setup: Connect the logic probes as shown below



1. Connect the SMA connector of the service adapter at the RTO "AUX output".
2. Connect the BNC output of the service adapter to Channel 1 input of the RTO.
3. Connect all 16 logic probe tips to the service adapter.

R&S RTO settings:

1. [Preset]
2. Perform threshold DC test

Measurement:

1. Enter service password: "File" menu > "Board detection/Maintenance > Service".
2. Select "MSO" Service tab.
3. Press the "Prepare" button.
4. Press the "Selftest" button.

   Now the threshold DC test and calibration is performed.
5. Press the "Show Result Log" button to view the calibration results.

   The MSO calibration results are stored in "SelftestResult_MSOThreshold.log" in path: C:\Documents and Settings\All Users\Application Data\Rohde-Schwarz\RTO\Log.

2.2.13 Option R&S RTO-B6, Waveform Generator

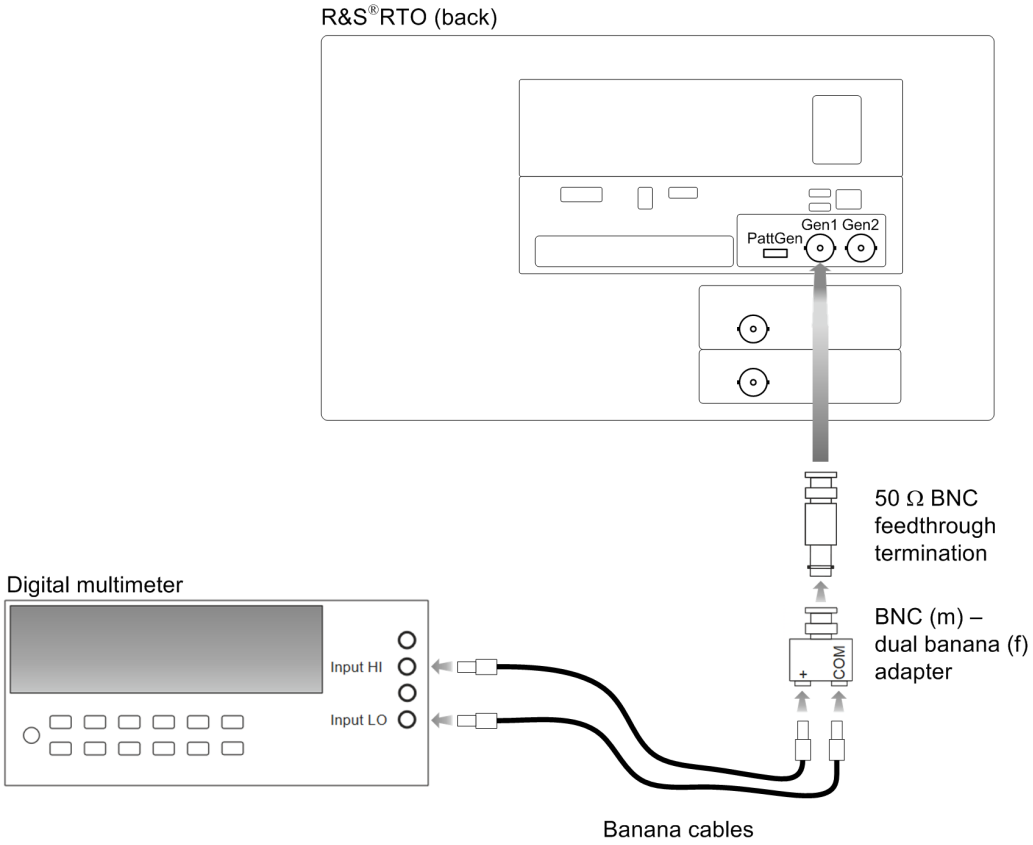
2.2.13.1 Sinewave Level

Test equipment:

- Digital multimeter (see Table 2-2, item 1w)
- BNC feedthrough termination (see Table 2-2, item 2w)
- Adapter BNC (m) to dual banana (f) (see Table 2-2, item 3w)
- 2 banana cables (see Table 2-2, item 4w)

Test setup:

1. Connect BNC feedthrough termination to RTO-B6 output Gen1
2. Connect digital multimeter to BNC feedthrough termination (via cables and adapter)



Multimeter settings: AC voltage measurement, Auto Range

R&S RTO settings:
1. Wave Gen : Setup : Preset Gen1
2. Wave Gen : Setup : Gen1 = Enable, Frequency = 1 kHz, Load = 50 Ω, Amplitude = 6 Vpp

Measurement: Read the voltage [V_{rms}] from the display of the digital multimeter and assign this value to the variable U_{1kHz}

Evaluation: Calculate the amplitude accuracy (in %) according to the following equation:

Amplitude = 6 Vpp

$$Amplitude\ accuracy\ [\%] = 100 \cdot \left| \frac{U_{1kHz} - \frac{Amplitude}{2 \cdot \sqrt{2}}}{\frac{Amplitude}{2 \cdot \sqrt{2}}} \right|$$

Verification: Check the amplitude accuracy against the error margin.

Loop: Repeat all steps from "Test setup" to "Verification" with Amplitude = 4 Vpp and afterwards with RTO-B6 output Gen2.

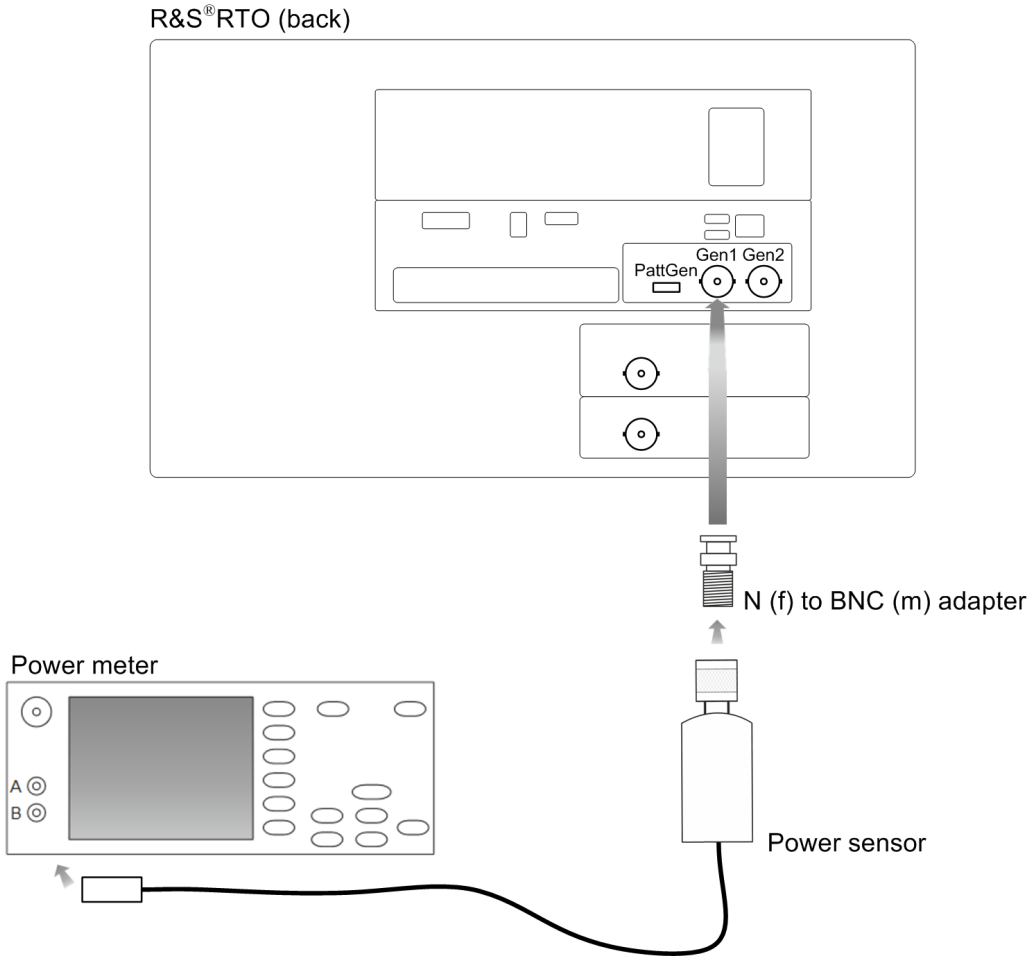
2.2.13.2 Amplitude Flatness

Test equipment:

- Power meter (see Table 2-2, item 6w)
- Power sensor (see Table 2-2, item 7w)
- Adapter N (f) to BNC (m) (see Table 2-2, item 8w)

Test setup:

1. Disconnect power sensor from any loads and execute power sensor zeroing
2. Connect power sensor to RTO-B6 output Gen1 (via adapter)



R&S RTO settings:

1. Wave Gen : Setup : Preset Gen1
2. Wave Gen : Setup : Gen1 = Enable, Load = 50 Ω, Amplitude according to Table 2-3

Measurement:

1. Set RTO-B6 frequency:
2. Wave Gen : Setup : Frequency = 10 kHz
3. Read the power level [dBm] from the power meter and save this value in the variable P_{Ref}

4. Change RTO-B6 frequency according to Table 2-3.
5. Read the power level [dBm] from the power meter and save this value in the variable P_{actual}

Evaluation: Calculate the amplitude flatness (in dB) according to the following equation:

Amplitude flatness [dB] = P_{actual} - P_{Ref}

Verification: Check the amplitude flatness against the error margin.

Loop:
1. Repeat all steps from "R&S RTO settings" to "Verification" with frequency and amplitude according to Table 2-3.
2. Repeat measurement with RTE-B6 output Gen2.

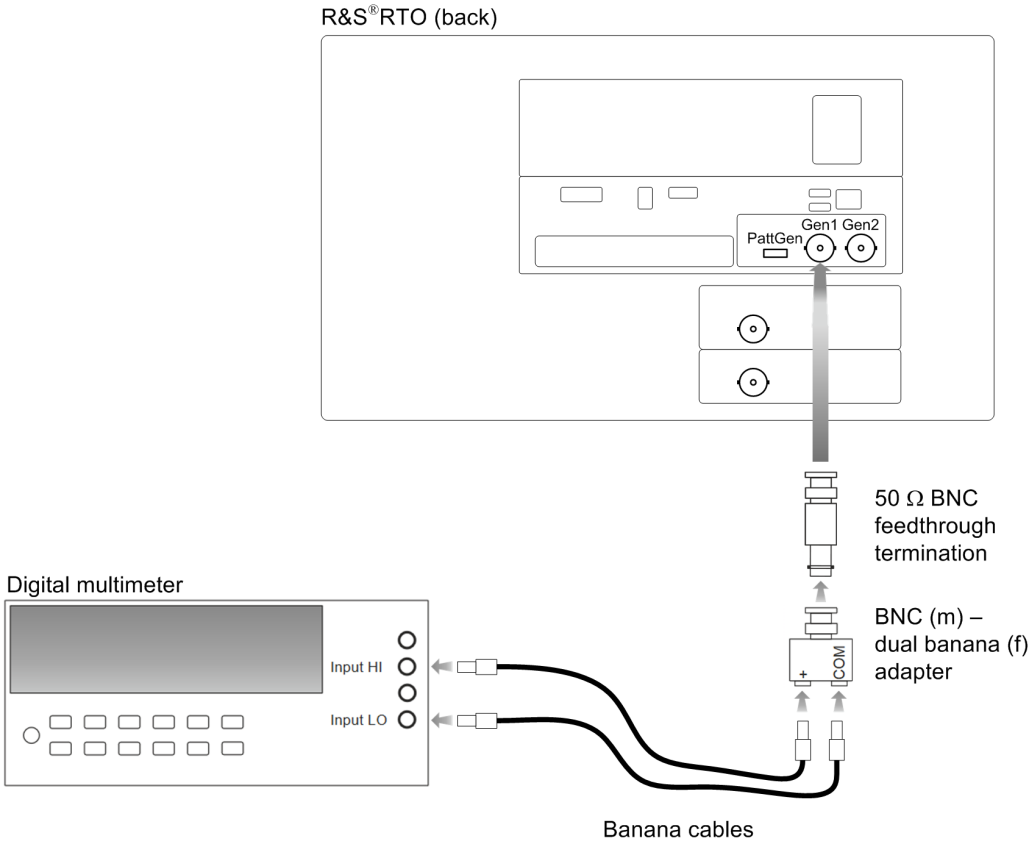
Table 2-3: Frequency response settings

Amplitude	Frequency
6 Vpp	(10 kHz)
	1 MHz
	10 MHz
	35 MHz
	50 MHz
4 Vpp	(10 kHz)
	100 MHz

2.2.13.3 DC Offset Level

Test equipment:
- Digital multimeter (see Table 2-2, item 1w)
- BNC feedthrough termination (see Table 2-2, item 2w)
- Adapter BNC (m) to dual banana (f) (see Table 2-2, item 3w)
- 2 banana cables (see Table 2-2, item 4w)

Test setup:
1. Connect BNC feedthrough termination to RTO-B6 output Gen1
2. Connect Digital multimeter to BNC feedthrough termination (via cables and adapter)



Multimeter settings: DC voltage measurement, Auto Range

R&S RTO settings:
1. Wave Gen : Setup : Preset Gen1
2. Wave Gen : Setup : Gen1 = Enable, Function type = DC

Measurement:
1. Set RTO-B6 DC level:
   Wave Gen : Setup: Load = 50 Ω, DC level according to Table 2-4
2. Read the DC voltage [V] from the display of the digital multimeter and assign this value to the variable U_{actual}

Evaluation: Calculate the amplitude flatness (in dB) according to the following equation:

$$DC\ Offset\ accuracy[mV] = U_{actual} - DC\ level$$

Verification: Check the DC offset accuracy against the error margin.

Loop:
1. Remove BNC feedthrough termination from the test setup and repeat all steps from "R&S RTO settings" to "Verification" with Load = HiZ and DC level according to Table 2-4.

2. Repeat measurement with RTO-B6 output Gen2 (with and without BNC feed-through termination).

Table 2-4: DC Offset Level Settings

Load	DC level
50 Ω	+3.0 V
	+1.5 V
	0 V
	-1.5 V
	-3.0 V
HiZ	+6.0 V
	+3.0 V
	0 V
	-3.0 V
	-6.0 V

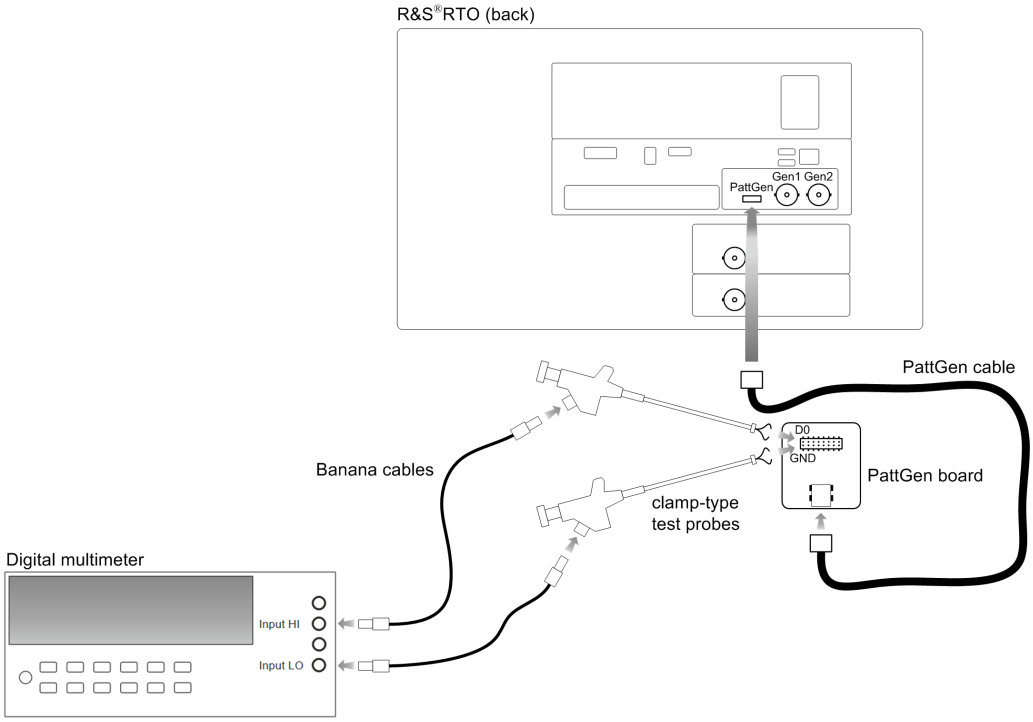
2.2.13.4 Pattern Generator Level

Test equipment:

- Digital multimeter (see Table 2-2, item 1w)
- 2 banana cables (see Table 2-2, item 4w)
- 2 clamp-type test probes (see Table 2-2, item 5w)

Test setup:

1. Connect BNC feedthrough termination to RTO-B6 output Gen1
2. Connect Digital multimeter to PattGen board data pin D0 and GND (via cables and probes)



Multimeter settings: DC voltage measurement, Auto Range

R&S RTO settings:

1. Use a PC to generate a text file PattGen_Test.csv with following content:

```
R&S Pattern Generator File
HLevel= 5.0
Rate= 1
255
255
255
0
0
0
```

2. Wave Gen : Setup : Preset Patt Gen
3. Wave Gen : Setup : PG = Enable, Load pattern file = PattGen_Test.csv

Measurement: Read the DC voltage [V] from the display of the digital multimeter. The voltage should toggle continuously between 0 V and +5 V with a toggle rate of 3 seconds. If the measured voltage is about 0 V, assign this value to the variable U_{Low}, if the voltage is about +5 V, assign this value to the variable U_{High}.

Evaluation: Calculate the pattern generator level accuracy (in V) using the following equations:

U_{Low}*: level accuracy [V]* = U_{Low} – *0 V*

U_{High}*: level accuracy [V]* = U_{High} – *5 V*

Verification: Check the pattern generator level accuracy against the error margin.

2.2.14 Option R&S RTO-B7, Pulse Source

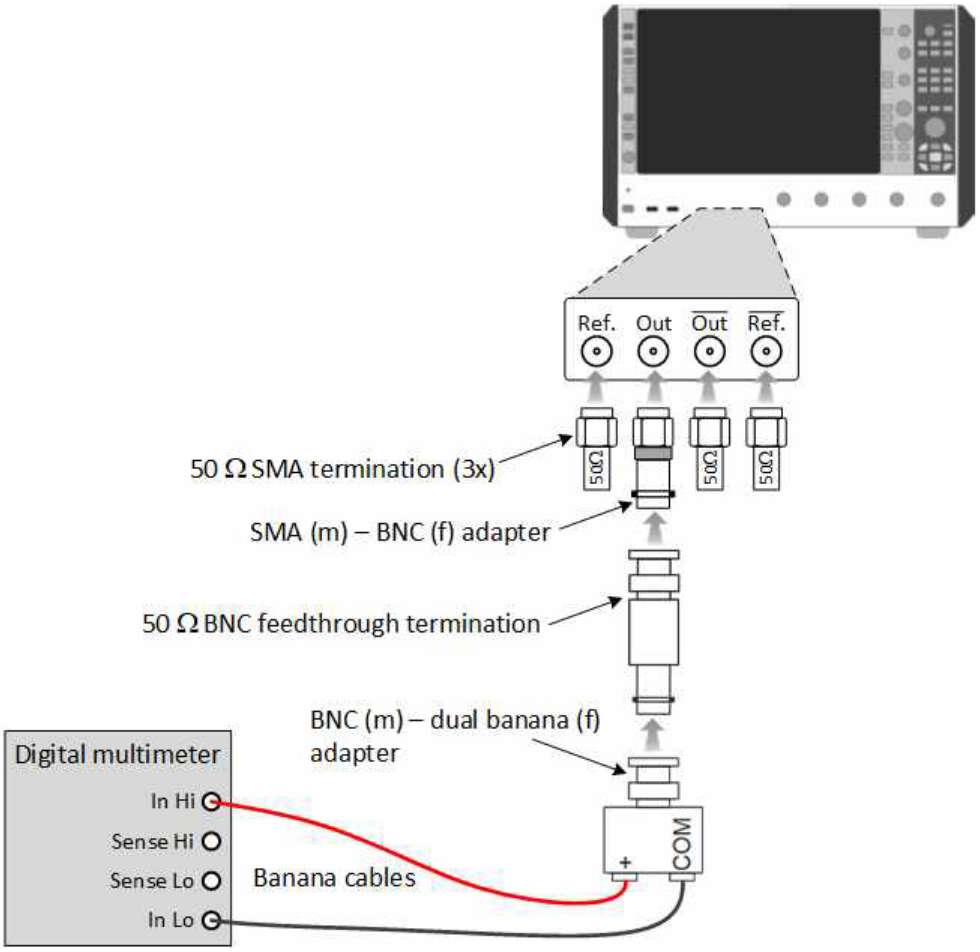
Output DC level

Test equipment:

- Digital multimeter (see Table 2-1, item 2)
- Adapter SMA (m) to BNC (f) (see Table 2-1, item 8)
- BNC feedthrough termination (see ,Table 2-2 item 2w)
- Adapter BNC (m) to dual banana (f) (see Table 2-2, item 3w)
- 2 banana cables (see Table 2-2, item 4w)
- 3 SMA 50 Ω termination (see Table 2-1, item 13)

Test setup:

1. Connect a 50 Ω termination to Ref, $\overline{\text{Out}}$ and $\overline{\text{Ref}}$.
2. Connect Adapter SMA (m) to BNC (f) toR&S RTO-B7 output Out.
3. Connect BNC feedthrough termination to the R&S RTO-B7 via adapter.
4. Connect digital multimeter to BNC feedthrough termination (via cables and adapter).
5. Activate service mode (see Chapter 3.2, "Activating the Service Mode", on page 65).



Multimeter settings: DC voltage measurement, auto range.

R&S RTO settings: Activate service mode (see Chapter 3.2, "Activating the Service Mode", on page 65).

Measurement:

1. Set Output level to -50 mV:
   File : Service : PSC : Output level = -50 mV
2. Set operation mode to DC low:
   File : Service : PSC : Operation Mode : DC low
3. Read the voltage [V] from the display of the digital mulitmeter (= voltage DC_low).
4. Set operation mode to DC high:
   File : Service : PSC : Operation Mode : DC high
5. Read the voltage [V] from the display of the digital mulitmeter (= voltage DC_high).

Evaluation: Check if the measured voltages DC_low and DC_high are within the specified limits.

Loop:

1. Repeat all steps from "Measurement" to "Evaluation" with output level = -60 mV, -70 mV, -80 mV, …, -200 mV.

2. Repeat measurement with digital multimeter connected to R&S RTO-B7 output $\overline{\text{Out}}$ and output Out terminated with 50 Ω.

2.3 Performance Test Report R&S RTO2000

ROHDE&SCHWARZ	Digital Oscilloscope		
	R&S RTO2002	1329.7002K02	
	R&S RTO2004	1329.7002K04	
	R&S RTO2012	1329.7002K12	
	R&S RTO2014	1329.7002K14	
	R&S RTO2022	1329.7002K22	
	R&S RTO2024	1329.7002K24	
	R&S RTO2032	1329.7002K32	
	R&S RTO2034	1329.7002K34	
	R&S RTO2044	1329.7002K44	
	R&S RTO2064	1329.7002K64	
Model:			
Serial number:			
Date:			
Person responsible:			
Signature:			

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

2.3.1 Reference Frequency Accuracy

	DL	Actual		MU
1 GHZ at Aux output (incoming)	10000 Hz		Hz	
1 GHZ at Aux output (outgoing)	5000 Hz		Hz	
With Option B4, OCXO				
1 GHZ at Aux output (incoming)	200 Hz		Hz	
1 GHZ at Aux output (outgoing)	20 Hz		Hz	

2.3.2 Input Resistance

Channel 1; Input Resistance: 1 MΩ

Vertical Scale	DL	Actual		MU
10 V/div	1 MΩ ± 1 %		MΩ	
1 V/div	1 MΩ ± 1 %		MΩ	
100 mV/div	1 MΩ ± 1 %		MΩ	

Channel 1; Input Resistance: 50 Ω

Vertical Scale	DL	Actual		MU
1 V/div	50 Ω ± 1.5 %		Ω	
200 mV/div	50 Ω ± 1.5 %		Ω	
100 mV/div	50 Ω ± 1.5 %		Ω	

Channel 2; Input Resistance: 1 MΩ

Vertical Scale	DL	Actual		MU
10 V/div	1 MΩ ± 1 %		MΩ	
1 V/div	1 MΩ ± 1 %		MΩ	
100 mV/div	1 MΩ ± 1 %		MΩ	

Channel 2; Input Resistance: 50 Ω

Vertical Scale	DL	Actual		MU
1 V/div	50 Ω ± 1.5 %		Ω	
200 mV/div	50 Ω ± 1.5 %		Ω	
100 mV/div	50 Ω ± 1.5 %		Ω	

Channel 3 (only for RTO20x4); Input Resistance: 1 MΩ

Vertical Scale	DL	Actual		MU
10 V/div	1 MΩ ± 1 %		MΩ	
1 V/div	1 MΩ ± 1 %		MΩ	
100 mV/div	1 MΩ ± 1 %		MΩ	

Channel 3 (only for RTO20x4); Input Resistance: 50 Ω

Vertical Scale	DL	Actual		MU
1 V/div	50 Ω ± 1.5 %		Ω	
200 mV/div	50 Ω ± 1.5 %		Ω	
100 mV/div	50 Ω ± 1.5 %		Ω	

Channel 4 (only for RTO20x4); Input Resistance: 1 MΩ

Vertical Scale	DL	Actual		MU
10 V/div	1 MΩ ± 1 %		MΩ	
1 V/div	1 MΩ ± 1 %		MΩ	
100 mV/div	1 MΩ ± 1 %		MΩ	

Channel 4 (only for RTO20x4); Input Resistance: 50 Ω

Vertical Scale	DL	Actual		MU
1 V/div	50 Ω ± 1.5 %		Ω	
200 mV/div	50 Ω ± 1.5 %		Ω	
100 mV/div	50 Ω ± 1.5 %		Ω	

2.3.3 DC Gain Accuracy

Channel 1; Input Resistance: 1 MΩ

Vertical Scale	Calibration Voltage	DL	Actual		MU
10 V/div	± 40.00 V	± 2.0 %		%	
3.2 V/div	± 14.50 V	± 2.0 %		%	
3 V/div	± 13.50 V	± 2.0 %		%	
1.1 V/div	± 5.00 V	± 2.0 %		%	
1.0 V/div	± 4.50 V	± 2.0 %		%	
320 mV/div	± 1.45 V	± 2.0 %		%	
300 mV/div	± 1.35 V	± 2.0 %		%	
110 mV/div	± 500 mV	± 2.0 %		%	
100 mV/div	± 450 mV	± 2.0 %		%	
70 mV/div	± 320 mV	± 2.0 %		%	
32 mV/div	± 145 mV	± 2.0 %		%	

Vertical Scale	Calibration Voltage	DL	Actual		MU
30 mV/div	± 135 mV	± 2.0 %		%	
11 mV/div	± 50 mV	± 2.0 %		%	
10 mV/div	± 45 mV	± 2.0 %		%	
3.2 mV/div	± 14.5 mV	± 2.0 %		%	
3 mV/div	± 13.5 mV	± 2.0 %		%	

Channel 1; Input Resistance: 50 Ω

Vertical Scale	Calibration Voltage	DL	Actual		MU
1 V/div	± 4.5 V	± 1.5 %		%	
570 mV/div	± 2.6 V	± 1.5 %		%	
560 mV/div	± 2.5 V	± 1.5 %		%	
320 mV/div	± 1.45 V	± 1.5 %		%	
300 mV/div	± 1.35 V	± 1.5 %		%	
180 mV/div	± 810 mV	± 1.5 %		%	
175 mV/div	± 790 mV	± 1.5 %		%	
110 mV/div	± 500 mV	± 1.5 %		%	
100 mV/div	± 450 mV	± 1.5 %		%	
70 mV/div	± 320 mV	± 1.5 %		%	
32 mV/div	± 145 mV	± 1.5 %		%	
30 mV/div	± 135 mV	± 1.5 %		%	
11 mV/div	± 50 mV	± 1.5 %		%	
10 mV/div	± 45 mV	± 1.5 %		%	
3.2 mV/div	±14.5 mV	± 2 %		%	
3 mV/div	± 13.5 mV	± 2 %		%	

Channel 2; Input Resistance: 1 MΩ

Vertical Scale	Calibration Voltage	DL	Actual		MU
10 V/div	± 40.00 V	± 2.0 %		%	
3.2 V/div	± 14.50 V	± 2.0 %		%	
3 V/div	± 13.50 V	± 2.0 %		%	
1.1 V/div	± 5.00 V	± 2.0 %		%	
1.0 V/div	± 4.50 V	± 2.0 %		%	
320 mV/div	± 1.45 V	± 2.0 %		%	

Vertical Scale	Calibration Voltage	DL	Actual		MU
300 mV/div	± 1.35 V	± 2.0 %		%	
110 mV/div	± 500 mV	± 2.0 %		%	
100 mV/div	± 450 mV	± 2.0 %		%	
70 mV/div	± 320 mV	± 2.0 %		%	
32 mV/div	± 145 mV	± 2.0 %		%	
30 mV/div	± 135 mV	± 2.0 %		%	
11 mV/div	± 50 mV	± 2.0 %		%	
10 mV/div	± 45 mV	± 2.0 %		%	
3.2 mV/div	± 14.5 mV	± 2.0 %		%	
3 mV/div	± 13.5 mV	± 2.0 %		%	

Channel 2; Input Resistance: 50 Ω

Vertical Scale	Calibration Voltage	DL	Actual		MU
1 V/div	± 4.5 V	± 1.5 %		%	
570 mV/div	± 2.6 V	± 1.5 %		%	
560 mV/div	± 2.5 V	± 1.5 %		%	
320 mV/div	± 1.45 V	± 1.5 %		%	
300 mV/div	± 1.35 V	± 1.5 %		%	
180 mV/div	± 810 mV	± 1.5 %		%	
175 mV/div	± 790 mV	± 1.5 %		%	
110 mV/div	± 500 mV	± 1.5 %		%	
100 mV/div	± 450 mV	± 1.5 %		%	
70 mV/div	± 320 mV	± 1.5 %		%	
32 mV/div	± 145 mV	± 1.5 %		%	
30 mV/div	± 135 mV	± 1.5 %		%	
11 mV/div	± 50 mV	± 1.5 %		%	
10 mV/div	± 45 mV	± 1.5 %		%	
3.2 mV/div	±14.5 mV	± 2 %		%	
3 mV/div	± 13.5 mV	± 2 %		%	

Channel 3 (only for RTO20x4); Input Resistance: 1 MΩ

Vertical Scale	Calibration Voltage	DL	Actual		MU
10 V/div	± 40.00 V	± 2.0 %		%	
3.2 V/div	± 14.50 V	± 2.0 %		%	
3 V/div	± 13.50 V	± 2.0 %		%	
1.1 V/div	± 5.00 V	± 2.0 %		%	
1.0 V/div	± 4.50 V	± 2.0 %		%	
320 mV/div	± 1.45 V	± 2.0 %		%	
300 mV/div	± 1.35 V	± 2.0 %		%	
110 mV/div	± 500 mV	± 2.0 %		%	
100 mV/div	± 450 mV	± 2.0 %		%	
70 mV/div	± 320 mV	± 2.0 %		%	
32 mV/div	± 145 mV	± 2.0 %		%	
30 mV/div	± 135 mV	± 2.0 %		%	
11 mV/div	± 50 mV	± 2.0 %		%	
10 mV/div	± 45 mV	± 2.0 %		%	
3.2 mV/div	± 14.5 mV	± 2.0 %		%	
3 mV/div	± 13.5 mV	± 2.0 %		%	

Channel 3 (only for RTO20x4); Input Resistance: 50 Ω

Vertical Scale	Calibration Voltage	DL	Actual		MU
1 V/div	± 4.5 V	± 1.5 %		%	
570 mV/div	± 2.6 V	± 1.5 %		%	
560 mV/div	± 2.5 V	± 1.5 %		%	
320 mV/div	± 1.45 V	± 1.5 %		%	
300 mV/div	± 1.35 V	± 1.5 %		%	
180 mV/div	± 810 mV	± 1.5 %		%	
175 mV/div	± 790 mV	± 1.5 %		%	
110 mV/div	± 500 mV	± 1.5 %		%	
100 mV/div	± 450 mV	± 1.5 %		%	
70 mV/div	± 320 mV	± 1.5 %		%	
32 mV/div	± 145 mV	± 1.5 %		%	
30 mV/div	± 135 mV	± 1.5 %		%	
11 mV/div	± 50 mV	± 1.5 %		%	

Vertical Scale	Calibration Voltage	DL	Actual		MU
10 mV/div	± 45 mV	± 1.5 %		%	
3.2 mV/div	±14.5 mV	± 2 %		%	
3 mV/div	± 13.5 mV	± 2 %		%	

Channel 4 (only for RTO20x4); Input Resistance: 1 MΩ

Vertical Scale	Calibration Voltage	DL	Actual		MU
10 V/div	± 40.00 V	± 2.0 %		%	
3.2 V/div	± 14.50 V	± 2.0 %		%	
3 V/div	± 13.50 V	± 2.0 %		%	
1.1 V/div	± 5.00 V	± 2.0 %		%	
1.0 V/div	± 4.50 V	± 2.0 %		%	
320 mV/div	± 1.45 V	± 2.0 %		%	
300 mV/div	± 1.35 V	± 2.0 %		%	
110 mV/div	± 500 mV	± 2.0 %		%	
100 mV/div	± 450 mV	± 2.0 %		%	
70 mV/div	± 320 mV	± 2.0 %		%	
32 mV/div	± 145 mV	± 2.0 %		%	
30 mV/div	± 135 mV	± 2.0 %		%	
11 mV/div	± 50 mV	± 2.0 %		%	
10 mV/div	± 45 mV	± 2.0 %		%	
3.2 mV/div	± 14.5 mV	± 2.0 %		%	
3 mV/div	± 13.5 mV	± 2.0 %		%	

Channel 4 (only for RTO20x4); Input Resistance: 50 Ω

Vertical Scale	Calibration Voltage	DL	Actual		MU
1 V/div	± 4.5 V	± 1.5 %		%	
570 mV/div	± 2.6 V	± 1.5 %		%	
560 mV/div	± 2.5 V	± 1.5 %		%	
320 mV/div	± 1.45 V	± 1.5 %		%	
300 mV/div	± 1.35 V	± 1.5 %		%	
180 mV/div	± 810 mV	± 1.5 %		%	
175 mV/div	± 790 mV	± 1.5 %		%	
110 mV/div	± 500 mV	± 1.5 %		%	

Vertical Scale	Calibration Voltage	DL	Actual		MU
100 mV/div	± 450 mV	± 1.5 %		%	
70 mV/div	± 320 mV	± 1.5 %		%	
32 mV/div	± 145 mV	± 1.5 %		%	
30 mV/div	± 135 mV	± 1.5 %		%	
11 mV/div	± 50 mV	± 1.5 %		%	
10 mV/div	± 45 mV	± 1.5 %		%	
3.2 mV/div	±14.5 mV	± 2 %		%	
3 mV/div	± 13.5 mV	± 2 %		%	

2.3.4 Offset Accuracy

Channel 1; Input Resistance: 1 MΩ

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
10 V/div	0 V	1002.50 mV		mV	
10 V/div	+ 40 V	1142.50 mV		mV	
10 V/div	- 40 V	1142.50 mV		mV	
3 V/div	0 V	302.50 mV		mV	
3 V/div	+ 40 V	442.50 mV		mV	
3 V/div	- 40 V	442.50 mV		mV	
1 V/div	0 V	102.50 mV		mV	
1 V/div	+ 5 V	120.00 mV		mV	
1 V/div	- 5 V	120.00 mV		mV	
300 mV/div	0 V	32.50 mV		mV	
300 mV/div	+ 5 V	50.00 mV		mV	
300 mV/div	- 5 V	50.00 mV		mV	
100 mV/div	0 V	12.50 mV		mV	
100 mV/div	+ 0.5 V	14.25 mV		mV	
100 mV/div	- 0.5 V	14.25 mV		mV	

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
30 mV/div	0 V	5.50 mV		mV	
30 mV/div	+ 0.5 V	7.25 mV		mV	
30 mV/div	- 0.5 V	7.25 mV		mV	
10 mV/div	0 V	3.50 mV		mV	
10 mV/div	+ 1 V	7.00 mV		mV	
10 mV/div	- 1 V	7.00 mV		mV	
3 mV/div	0 V	2.80 mV		mV	
3 mV/div	+ 1 V	6.30 mV		mV	
3 mV/div	- 1 V	6.30 mV		mV	

Channel 1; Input Resistance: 50 Ω

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
1 V/div	0 V	102.50 mV		mV	
1 V/div	+ 5 V	120.00 mV		mV	
1 V/div	- 5 V	120.00 mV		mV	
500 mV/div	0 V	52.50 mV		mV	
500 mV/div	+ 5 V	70.00 mV		mV	
500 mV/div	- 5 V	70.00 mV		mV	
300 mV/div	0 V	32.50 mV		mV	
300 mV/div	+ 3 V	43.00 mV		mV	
300 mV/div	- 3 V	43.00 mV		mV	
150 mV/div	0 V	17.50 mV		mV	
150 mV/div	+ 3 V	28.00 mV		mV	
150 mV/div	- 3 V	28.00 mV		mV	
100 mV/div	0 V	12.50 mV		mV	

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
100 mV/div	+ 1 V	16.00 mV		mV	
100 mV/div	- 1 V	16.00 mV		mV	
30 mV/div	0 V	5.50 mV		mV	
30 mV/div	+ 1 V	9.00 mV		mV	
30 mV/div	- 1 V	9.00 mV		mV	
10 mV/div	0 V	3.50 mV		mV	
10 mV/div	+ 1 V	7.00 mV		mV	
10 mV/div	- 1 V	7.00 mV		mV	
3 mV/div	0 V	2.80 mV		mV	
3 mV/div	+ 1 V	6.30 mV		mV	
3 mV/div	- 1 V	6.30 mV		mV	

Channel 2; Input Resistance: 1 MΩ

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
10 V/div	0 V	1002.50 mV		mV	
10 V/div	+ 40 V	1142.50 mV		mV	
10 V/div	- 40 V	1142.50 mV		mV	
3 V/div	0 V	302.50 mV		mV	
3 V/div	+ 40 V	442.50 mV		mV	
3 V/div	- 40 V	442.50 mV		mV	
1 V/div	0 V	102.50 mV		mV	
1 V/div	+ 5 V	120.00 mV		mV	
1 V/div	- 5 V	120.00 mV		mV	
300 mV/div	0 V	32.50 mV		mV	
300 mV/div	+ 5 V	50.00 mV		mV	
300 mV/div	- 5 V	50.00 mV		mV	

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
100 mV/div	0 V	12.50 mV		mV	
100 mV/div	+ 0.5 V	14.25 mV		mV	
100 mV/div	- 0.5 V	14.25 mV		mV	
30 mV/div	0 V	5.50 mV		mV	
30 mV/div	+ 0.5 V	7.25 mV		mV	
30 mV/div	- 0.5 V	7.25 mV		mV	
10 mV/div	0 V	3.50 mV		mV	
10 mV/div	+ 1 V	7.00 mV		mV	
10 mV/div	- 1 V	7.00 mV		mV	
3 mV/div	0 V	2.80 mV		mV	
3 mV/div	+ 1 V	6.30 mV		mV	
3 mV/div	- 1 V	6.30 mV		mV	

Channel 2; Input Resistance: 50 Ω

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
1 V/div	0 V	102.50 mV		mV	
1 V/div	+ 5 V	120.00 mV		mV	
1 V/div	- 5 V	120.00 mV		mV	
500 mV/div	0 V	52.50 mV		mV	
500 mV/div	+ 5 V	70.00 mV		mV	
500 mV/div	- 5 V	70.00 mV		mV	
300 mV/div	0 V	32.50 mV		mV	
300 mV/div	+ 3 V	43.00 mV		mV	
300 mV/div	- 3 V	43.00 mV		mV	
150 mV/div	0 V	17.50 mV		mV	

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
150 mV/div	+ 3 V	28.00 mV		mV	
150 mV/div	- 3 V	28.00 mV		mV	
100 mV/div	0 V	12.50 mV		mV	
100 mV/div	+ 1 V	16.00 mV		mV	
100 mV/div	- 1 V	16.00 mV		mV	
30 mV/div	0 V	5.50 mV		mV	
30 mV/div	+ 1 V	9.00 mV		mV	
30 mV/div	- 1 V	9.00 mV		mV	
10 mV/div	0 V	3.50 mV		mV	
10 mV/div	+ 1 V	7.00 mV		mV	
10 mV/div	- 1 V	7.00 mV		mV	
3 mV/div	0 V	2.80 mV		mV	
3 mV/div	+ 1 V	6.30 mV		mV	
3 mV/div	- 1 V	6.30 mV		mV	

Channel 3 (only for RTO20x4); Input Resistance: 1 MΩ

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
10 V/div	0 V	1002.50 mV		mV	
10 V/div	+ 40 V	1142.50 mV		mV	
10 V/div	- 40 V	1142.50 mV		mV	
3 V/div	0 V	302.50 mV		mV	
3 V/div	+ 40 V	442.50 mV		mV	
3 V/div	- 40 V	442.50 mV		mV	
1 V/div	0 V	102.50 mV		mV	
1 V/div	+ 5 V	120.00 mV		mV	
1 V/div	- 5 V	120.00 mV		mV	

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
300 mV/div	0 V	32.50 mV		mV	
300 mV/div	+ 5 V	50.00 mV		mV	
300 mV/div	- 5 V	50.00 mV		mV	
100 mV/div	0 V	12.50 mV		mV	
100 mV/div	+ 0.5 V	14.25 mV		mV	
100 mV/div	- 0.5 V	14.25 mV		mV	
30 mV/div	0 V	5.50 mV		mV	
30 mV/div	+ 0.5 V	7.25 mV		mV	
30 mV/div	- 0.5 V	7.25 mV		mV	
10 mV/div	0 V	3.50 mV		mV	
10 mV/div	+ 1 V	7.00 mV		mV	
10 mV/div	- 1 V	7.00 mV		mV	
3 mV/div	0 V	2.80 mV		mV	
3 mV/div	+ 1 V	6.30 mV		mV	
3 mV/div	- 1 V	6.30 mV		mV	

Channel 3 (only for RTO20x4); Input Resistance: 50 Ω

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
1 V/div	0 V	102.50 mV		mV	
1 V/div	+ 5 V	120.00 mV		mV	
1 V/div	- 5 V	120.00 mV		mV	
500 mV/div	0 V	52.50 mV		mV	
500 mV/div	+ 5 V	70.00 mV		mV	
500 mV/div	- 5 V	70.00 mV		mV	
300 mV/div	0 V	32.50 mV		mV	

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
300 mV/div	+ 3 V	43.00 mV		mV	
300 mV/div	- 3 V	43.00 mV		mV	
150 mV/div	0 V	17.50 mV		mV	
150 mV/div	+ 3 V	28.00 mV		mV	
150 mV/div	- 3 V	28.00 mV		mV	
100 mV/div	0 V	12.50 mV		mV	
100 mV/div	+ 1 V	16.00 mV		mV	
100 mV/div	- 1 V	16.00 mV		mV	
30 mV/div	0 V	5.50 mV		mV	
30 mV/div	+ 1 V	9.00 mV		mV	
30 mV/div	- 1 V	9.00 mV		mV	
10 mV/div	0 V	3.50 mV		mV	
10 mV/div	+ 1 V	7.00 mV		mV	
10 mV/div	- 1 V	7.00 mV		mV	
3 mV/div	0 V	2.80 mV		mV	
3 mV/div	+ 1 V	6.30 mV		mV	
3 mV/div	- 1 V	6.30 mV		mV	

Channel 4 (only for RTO20x4); Input Resistance: 1 MΩ

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
10 V/div	0 V	1002.50 mV		mV	
10 V/div	+ 40 V	1142.50 mV		mV	
10 V/div	- 40 V	1142.50 mV		mV	
3 V/div	0 V	302.50 mV		mV	
3 V/div	+ 40 V	442.50 mV		mV	
3 V/div	- 40 V	442.50 mV		mV	

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
1 V/div	0 V	102.50 mV		mV	
1 V/div	+ 5 V	120.00 mV		mV	
1 V/div	- 5 V	120.00 mV		mV	
300 mV/div	0 V	32.50 mV		mV	
300 mV/div	+ 5 V	50.00 mV		mV	
300 mV/div	- 5 V	50.00 mV		mV	
100 mV/div	0 V	12.50 mV		mV	
100 mV/div	+ 0.5 V	14.25 mV		mV	
100 mV/div	- 0.5 V	14.25 mV		mV	
30 mV/div	0 V	5.50 mV		mV	
30 mV/div	+ 0.5 V	7.25 mV		mV	
30 mV/div	- 0.5 V	7.25 mV		mV	
10 mV/div	0 V	3.50 mV		mV	
10 mV/div	+ 1 V	7.00 mV		mV	
10 mV/div	- 1 V	7.00 mV		mV	
3 mV/div	0 V	2.80 mV		mV	
3 mV/div	+ 1 V	6.30 mV		mV	
3 mV/div	- 1 V	6.30 mV		mV	

Channel 4 (only for RTO20x4); Input Resistance: 50 Ω

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
1 V/div	0 V	102.50 mV		mV	
1 V/div	+ 5 V	120.00 mV		mV	
1 V/div	- 5 V	120.00 mV		mV	
500 mV/div	0 V	52.50 mV		mV	

Vertical Scale	Offset and Calibration Voltage	DL	Actual		MU
500 mV/div	+ 5 V	70.00 mV		mV	
500 mV/div	- 5 V	70.00 mV		mV	
300 mV/div	0 V	32.50 mV		mV	
300 mV/div	+ 3 V	43.00 mV		mV	
300 mV/div	- 3 V	43.00 mV		mV	
150 mV/div	0 V	17.50 mV		mV	
150 mV/div	+ 3 V	28.00 mV		mV	
150 mV/div	- 3 V	28.00 mV		mV	
100 mV/div	0 V	12.50 mV		mV	
100 mV/div	+ 1 V	16.00 mV		mV	
100 mV/div	- 1 V	16.00 mV		mV	
30 mV/div	0 V	5.50 mV		mV	
30 mV/div	+ 1 V	9.00 mV		mV	
30 mV/div	- 1 V	9.00 mV		mV	
10 mV/div	0 V	3.50 mV		mV	
10 mV/div	+ 1 V	7.00 mV		mV	
10 mV/div	- 1 V	7.00 mV		mV	
3 mV/div	0 V	2.80 mV		mV	
3 mV/div	+ 1 V	6.30 mV		mV	
3 mV/div	- 1 V	6.30 mV		mV	

2.3.5 Crosstalk

Channel 1 to Channel 2, Input Resistance: 50 Ω

R&S RTO2002 and R&S RTO2004

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
500 MHz	500 MHz	60 dB		dB	

R&S RTO2012 and R&S RTO2014

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
990 MHz	990 MHz	60 dB		dB	

R&S RTO2022 and R&S RTO2024

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
1990 MHz	1990 MHz	60 dB		dB	

R&S RTO2032 and R&S RTO2034

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
1990 MHz	1990 MHz	60 dB		dB	
2990 MHz	2990 MHz	50 dB		dB	

R&S RTO2044 and R&S RTO2064

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
1990 MHz	1990 MHz	60 dB		dB	
4000 MHz	4000 MHz	50 dB		dB	

Channel 1 to Channel 2, Input Resistance: 1 MΩ

R&S RTO20xx (all models)

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
500 MHz	500 MHz	60 dB		dB	

Channel 4 to Channel 3, Input Resistance: 50 Ω

R&S RTO2004

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
500 MHz	500 MHz	60 dB		dB	

R&S RTO2014

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
990 MHz	990 MHz	60 dB		dB	

R&S RTO2024

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
1990 MHz	1990 MHz	60 dB		dB	

R&S RTO2032 and R&S RTO2034

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
1990 MHz	1990 MHz	60 dB		dB	
2990 MHz	2990 MHz	50 dB		dB	

R&S RTO2044 and R&S RTO2064

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
1990 MHz	1990 MHz	60 dB		dB	
4000 MHz	4000 MHz	50 dB		dB	

Channel 4 to Channel 3, Input Resistance: 1 MΩ

R&S RTO20xx (all models)

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
500 MHz	500 MHz	60 dB		dB	

2.3.6 Crosstalk – Interleaved Mode (only RTO2044 and RTO2046)

Channel 2 to Channel 3, Input Resistance: 50 Ω

R&S RTO2044 and R&S RTO2064

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
1990 MHz	1990 MHz	60 dB		dB	
4000 MHz	4000 MHz	50 dB		dB	
6000 MHz	6000 MHz	40 dB		dB	

Channel 2 to Channel 3, Input Resistance: 1 MΩ

R&S RTO2044 and R&S RTO2064

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
500 MHz	500 MHz	60 dB		dB	

Channel 3 to Channel 2, Input Resistance: 50 Ω

R&S RTO2044 and R&S RTO2064

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
1990 MHz	1990 MHz	60 dB		dB	
4000 MHz	4000 MHz	50 dB		dB	
6000 MHz	6000 MHz	40 dB		dB	

Channel 3 to Channel 2, Input Resistance: 1 MΩ

R&S RTO2044 and R&S RTO2064

FFT Center Frequency	Signal Generator Frequency	DLL	Actual		MU
500 MHz	500 MHz	60 dB		dB	

2.3.7 Analog Bandwidth

- Reference value taken at 10 MHz for every measurement
- For RTO2002 and RTO2004, the generator frequency is set to 600 MHz

- For RTO2012, RTO2014 and instruments upgraded with RTO-B201, the generator frequency is set to 1 GHz
- For RTO2022 , RTO2024 and instruments upgraded with RTO-B202 or RTO-B212, the generator frequency is set to 2 GHz
- For RTO2032, RTO2034 and instruments upgraded with RTO-B203, RTO-B213 or RTO-B223 the generator frequency is set to 3 GHz
- For RTO2044 and instruments upgraded with RTO-B204, RTO-B214, RTO-B224 or RTO-B234 the generator frequency is set to 4 GHz
- For RTO2064 and instruments upgraded with RTO-B206, RTO-B216, RTO-B226, RTO-B236 or RTO-B246 the generator frequency is set to 6 GHz

Channel 1:

Vertical Scale	Level Signal generator peak to peak	DLL	Actual		MU
600 mV/div	2.00 V	- 3.00 dB		dB	
320 mV/div	1.92 V	- 3.00 dB		dB	
200 mV/div	1.2 V	- 3.00 dB		dB	
100 mV/div	900 mV	- 3.00 dB		dB	
50 mV/div	600 mV	- 3.00 dB		dB	
20 mV/div	120 mV	- 3.00 dB		dB	
5 mV/div	30 mV	- 3.00 dB		dB	
1 mV/div	6 mV	- 3.00 dB		dB	

Channel 2:

Vertical Scale	Level Signal generator peak to peak	DLL	Actual		MU
600 mV/div	2.00 V	- 3.00 dB		dB	
320 mV/div	1.92 V	- 3.00 dB		dB	
200 mV/div	1.2 V	- 3.00 dB		dB	
100 mV/div	900 mV	- 3.00 dB		dB	
50 mV/div	600 mV	- 3.00 dB		dB	
20 mV/div	120 mV	- 3.00 dB		dB	
5 mV/div	30 mV	- 3.00 dB		dB	
1 mV/div	6 mV	- 3.00 dB		dB	

Channel 3 (only for RTO20x4):

Vertical Scale	Level Signal generator peak to peak	DLL	Actual		MU
600 mV/div	2.00 V	- 3.00 dB		dB	
320 mV/div	1.92 V	- 3.00 dB		dB	
200 mV/div	1.2 V	- 3.00 dB		dB	
100 mV/div	900 mV	- 3.00 dB		dB	
50 mV/div	600 mV	- 3.00 dB		dB	
20 mV/div	120 mV	- 3.00 dB		dB	
5 mV/div	30 mV	- 3.00 dB		dB	
1 mV/div	6 mV	- 3.00 dB		dB	

Channel 4 (only for RTO20x4):

Vertical Scale	Level Signal generator peak to peak	DLL	Actual		MU
600 mV/div	2.00 V	- 3.00 dB		dB	
320 mV/div	1.92 V	- 3.00 dB		dB	
200 mV/div	1.2 V	- 3.00 dB		dB	
100 mV/div	900 mV	- 3.00 dB		dB	
50 mV/div	600 mV	- 3.00 dB		dB	
20 mV/div	120 mV	- 3.00 dB		dB	
5 mV/div	30 mV	- 3.00 dB		dB	
1 mV/div	6 mV	- 3.00 dB		dB	

2.3.8 External Trigger Sensitivity

Frequency Signal Generator	Level Signal at Ext. Trigger Input peak to peak		Actual		MU
500 MHz	600 mV	triggered			
100 MHz	300 mV	triggered			

2.3.9 Probe Compensation

		DL	Actual		MU
Voltage	1 V	5 %		%	
Frequency	1 kHz	1 %		%	

2.3.10 10 MHz Reference with B4

	DLL	Actual		MU
Level at REF OUT	7.00 dBm		dBm	

2.3.11 Probe Identification

Identification of Passive Probe

Channel 1

		Actual
Identification	Pass / Fail	

Channel 2

		Actual
Identification	Pass / Fail	

Channel 3 (only for RTO20x4

		Actual
Identification	Pass / Fail	

Channel 4 (only for RTO20x4

		Actual
Identification	Pass / Fail	

Identification of Active Probe

Channel 1

		Actual
Identification	Pass / Fail	

Channel 2

		Actual
Identification	Pass / Fail	

Channel 3 (only for RTO20x4

		Actual
Identification	Pass / Fail	

Channel 4 (only for RTO20x4

		Actual
Identification	Pass / Fail	

2.3.12 Option R&S RTO-B1, Mixed Signal Option

Logic probe threshold test

Channel D1

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D2

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D3

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D4

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D5

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D6

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D7

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D8

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D9

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D10

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D11

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D12

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D13

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D14

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

Channel D15

Threshold	Start Condition	Stop Condition	DLL	DUL	Actual		MU
4 V	high	low	3.780 V	4.220 V		V	
4 V	low	high	3.780 V	4.220 V		V	
0 V	high	low	- 0.100 V	0.100 V		V	
0 V	low	high	- 0.100 V	0.100 V		V	
- 4 V	high	low	- 4.220 V	- 3.780 V		V	
- 4 V	low	high	- 4.220 V	- 3.780 V		V	

2.3.13 Option R&S RTO-B6, Waveform Generator

2.3.13.1 Sinewave Level

GEN1; 50 Ω feedthrough termination installed at GEN1

Amplitude	U_{1kHz}		DL	Actual		MU
6 Vpp		V_{rms}	1%		%	
4 Vpp		V_{rms}	1%		%	

GEN2; 50 Ω feedthrough termination installed at GEN2

Amplitude	U_{1kHz}		DL	Actual		MU
6 Vpp		V_{rms}	1%		%	
4 Vpp		V_{rms}	1%		%	

2.3.13.2 Amplitude Flatness

GEN1; 6 Vpp; Power sensor installed at GEN1

Frequency	Absolute level P_{Ref}		DL
10 kHz		dBm	19.54 dBm ± 0.086 dB

Frequency	Absolute level P_{actual}		Amplitude flatness		DL	MU
1 MHz		dBm		dB	≤ ± 0.3 dB	
10 MHz		dBm		dB	≤ ± 0.3 dB	
35 MHz		dBm		dB	≤ ± 0.3 dB	
50 MHz		dBm		dB	≤ ± 0.3 dB	

GEN1; 4 Vpp; Power sensor installed at GEN1

Frequency	Absolute level P_{Ref}		DL
10 kHz		dBm	16.02 dBm ± 0.086 dB

Frequency	Absolute level P_{actual}		Amplitude flatness		DL	MU
100 MHz		dBm		dB	≤ ± 0.5 dB	

GEN2; 6 Vpp; Power sensor installed at GEN2

Frequency	Absolute level P_{Ref}		DL
10 kHz		dBm	19.54 dBm ± 0.086 dB

Frequency	Absolute level P_{actual}		Amplitude flatness		DL	MU
1 MHz		dBm		dB	≤ ± 0.3 dB	
10 MHz		dBm		dB	≤ ± 0.3 dB	
35 MHz		dBm		dB	≤ ± 0.3 dB	
50 MHz		dBm		dB	≤ ± 0.3 dB	

GEN2; 4 Vpp; Power sensor installed at GEN2

Frequency	Absolute level P_{Ref}		DL
10 kHz		dBm	16.02 dBm ± 0.086 dB

Frequency	Absolute level P_{actual}		Amplitude flatness		DL	MU
100 MHz		dBm		dB	≤ ± 0.5 dB	

2.3.13.3 DC Offset Level

GEN1; 50 Ω feedthrough termination installed at GEN1

DC level	U_{actual}		DL		Actual		MU
+3.0 V		V	± (2% of commanded DC voltage + 2mV)	± 62 mV		mV	
+1.5 V		V		± 32 mV		mV	
0 V		V		± 2 mV		mV	
-1.5 V		V		± 32 mV		mV	
-3.0 V		V		± 62 mV		mV	

GEN1; no load installed at GEN1

DC level	U_{actual}		DL		Actual		MU
+6.0 V		V	± (2% of commanded DC voltage + 2mV)	± 122 mV		mV	
+3.0 V		V		± 62 mV		mV	
0 V		V		± 2 mV		mV	
-3.0 V		V		± 62 mV		mV	
-6.0 V		V		± 122 mV		mV	

GEN2; 50 Ω feedthrough termination installed at GEN2

DC level	U_{actual}		DL		Actual		MU
+3.0 V		V	± (2% of commanded DC voltage + 2mV)	± 62 mV		mV	
+1.5 V		V		± 32 mV		mV	
0 V		V		± 2 mV		mV	
-1.5 V		V		± 32 mV		mV	
-3.0 V		V		± 62 mV		mV	

GEN2; no load installed at GEN2

DC level	U_{actual}		DL		Actual		MU
+6.0 V		V	± (2% of commanded DC voltage + 2mV)	± 122 mV		mV	
+3.0 V		V		± 62 mV		mV	
0 V		V		± 2 mV		mV	
-3.0 V		V		± 62 mV		mV	
-6.0 V		V		± 122 mV		mV	

2.3.13.4 Pattern Generator Level

Variable	Measured voltage		DL	Actual		MU
U_{Low}		V	-20 mV / +100 mV		mV	
U_{High}		V	± 50 mV		mV	

2.3.14 Option R&S RTO-B7, Pulse Source

Output DC level - Output Out

Output level	Voltage DC_low		DL		Voltage DC_high		DL		MU
-50 mV		mV	-66.0 mV	-34.0 mV		mV	-10 mV	10 mV	
-60 mV		mV	-76.2 mV	-43.8 mV		mV	-10 mV	10 mV	
-70 mV		mV	-86.4 mV	-53.6 mV		mV	-10 mV	10 mV	
-80 mV		mV	-96.6 mV	-63.4 mV		mV	-10 mV	10 mV	
-90 mV		mV	-106.8 mV	-73.2 mV		mV	-10 mV	10 mV	
-100 mV		mV	-117.0 mV	-83.0 mV		mV	-10 mV	10 mV	
-110 mV		mV	-127.2 mV	-92.8 mV		mV	-10 mV	10 mV	
-120 mV		mV	-137.4 mV	-102.6 mV		mV	-10 mV	10 mV	
-130 mV		mV	-147.6 mV	-112.4 mV		mV	-10 mV	10 mV	
-140 mV		mV	-157.8 mV	-122.2 mV		mV	-10 mV	10 mV	
-150mV		mV	-168.0 mV	-132.0 mV		mV	-10 mV	10 mV	
-160 mV		mV	-178.2 mV	-141.8 mV		mV	-10 mV	10 mV	
-170 mV		mV	-188.4 mV	-151.6 mV		mV	-10 mV	10 mV	
-180 mV		mV	-198.6 mV	-161.4 mV		mV	-10 mV	10 mV	
-190 mV		mV	-208.8 mV	-171.2 mV		mV	-10 mV	10 mV	
-200 mV		mV	-219.0 mV	-181.0 mV		mV	-10 mV	10 mV	

Output DC level - Output $\overline{\text{Out}}$

Output level	Voltage DC_low		DL		Voltage DC_high		DL		MU
-50 mV		mV	-10 mV	10 mV		mV	-66.0 mV	-34.0 mV	
-60 mV		mV	-10 mV	10 mV		mV	-76.2 mV	-43.8 mV	
-70 mV		mV	-10 mV	10 mV		mV	-86.4 mV	-53.6 mV	
-80 mV		mV	-10 mV	10 mV		mV	-96.6 mV	-63.4 mV	
-90 mV		mV	-10 mV	10 mV		mV	-106.8 mV	-73.2 mV	
-100 mV		mV	-10 mV	10 mV		mV	-117.0 mV	-83.0 mV	
-110 mV		mV	-10 mV	10 mV		mV	-127.2 mV	-92.8 mV	
-120 mV		mV	-10 mV	10 mV		mV	-137.4 mV	-102.6 mV	
-130 mV		mV	-10 mV	10 mV		mV	-147.6 mV	-112.4 mV	
-140 mV		mV	-10 mV	10 mV		mV	-157.8 mV	-122.2 mV	
-150mV		mV	-10 mV	10 mV		mV	-168.0 mV	-132.0 mV	
-160 mV		mV	-10 mV	10 mV		mV	-178.2 mV	-141.8 mV	
-170 mV		mV	-10 mV	10 mV		mV	-188.4 mV	-151.6 mV	
-180 mV		mV	-10 mV	10 mV		mV	-198.6 mV	-161.4 mV	
-190 mV		mV	-10 mV	10 mV		mV	-208.8 mV	-171.2 mV	
-200 mV		mV	-10 mV	10 mV		mV	-219.0 mV	-181.0 mV	

3 Adjustment

3.1 Self-alignment

The R&S RTO is equipped with an internal self-alignment procedure. Within this self-alignment, a horizontal alignment as well as a vertical alignment is performed. Therefore the internal Calibration generator is used. Depending on the parameter tested, the calibration generator will source an appropriat RF signal.

During the horizontal alignment the AD Converter and the time delay of the input channels are adjusted.

During the vertical alignment the following settings are adjusted:

- Gain & Offset of VGA (variable gain amplifier)
- Gain & Offset of Buffer Amplifier
- ADC linearity
- Filter Gain

3.1.1 Performing the Internal Self-Alignment

1. "File" menu : "Selfalignment".
2. Tap "Start Alignment".

3.1.2 Self-alignment Results

The calibration results are shown on the "Results" tab.

3.2 Activating the Service Mode

The R&S RTO offers some adjustments, which are protected by a service password.

To activate the service mode of the R&S RTO, enter the service password **894129**:

1. "File" menu : "Maintenance".
2. Select "Service" tab.
3. Enter the password "894129" and press [Enter].

If no external keyboard is connected, double-click into the password field. The on-screen keyboard appears to enter the password on the touchscreen.

Now a new entry "Service" in the "File" menu is visible. The service menu allows you to:

- Adjust the reference oscillator, see Chapter 3.3, "Adjusting the Reference Oscillator", on page 66.
- Performing the threshold DC adjustment, see Chapter 3.4, "Performing the Threshold DC Adjustment (Threshold Value of the Logic Probes)", on page 68.

3.3 Adjusting the Reference Oscillator

NOTICE

Risk of erroneous measurement results

Adjustment must be carried out exclusively by qualified personnel since any change can considerably affect the instrument's measurement accuracy.

3.3.1 Test Equipment

Item	Type of equipment	Recommended characteristics or features	Recommended model	R&S Order No.	Application
7	Frequency counter	1 GHz < 2*10-9	Fluke PM6681 option 9624		Reference frequency accuracy

3.3.2 Adjustment Procedure

This procedure requires a service password, see Chapter 3.2, "Activating the Service Mode", on page 65.

Test setup:

► Connect AUX OUT (SMA connector) of the R&S RTO to the input of the frequency counter.

R&S RTO settings:

1. Press the [Preset] key.
2. Select "Horizontal" menu : Time Base : Reference: Aux out: check box "1 GHz Reference ON".

The 1 GHz reference oscillator signal is output to the [AUX OUT] connector. The level at [AUX OUT] is approx. -2 dBm into 50 Ω load (500 mV peak-peak).

Frequency counter settings

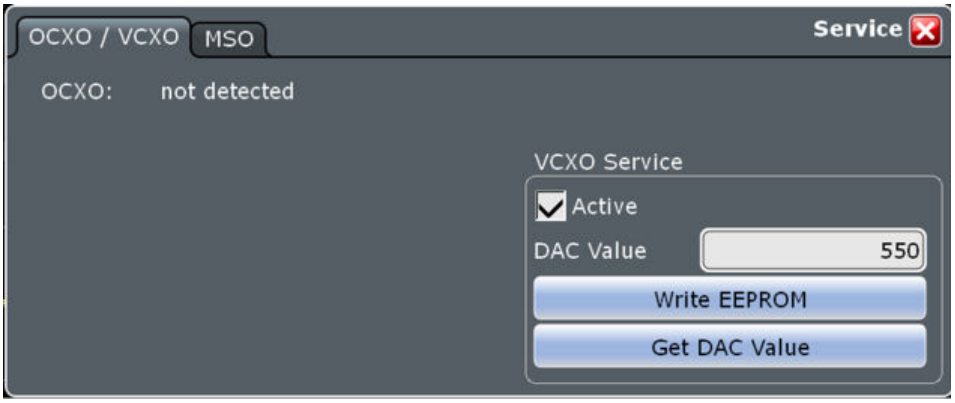
1. Set the frequency counter to the appropriate resolution.
2. Read the frequency counter display.

Adjustment:

The internal reference oscillator is tuned by the voltage from the potentiometer. The wiper of this potentiometer is controlled by a 10-bit register.

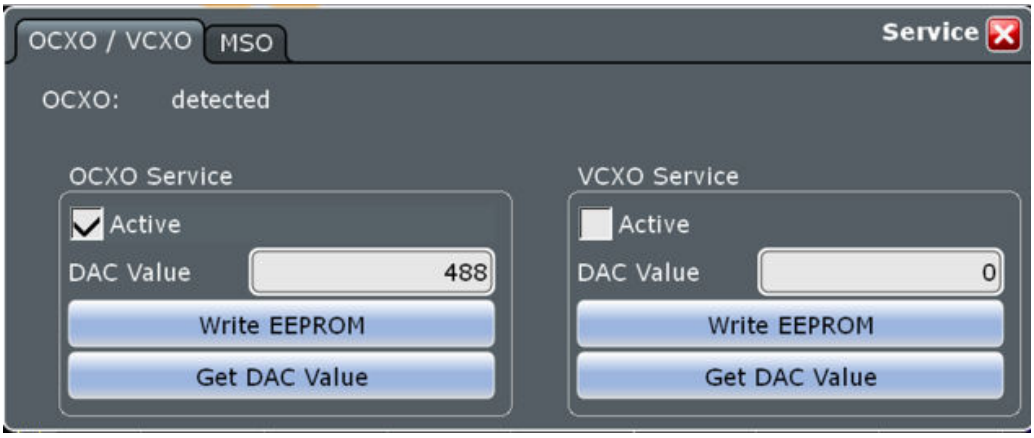
To change the reference frequency

1. Enter service password: File : Maintenance : Service.
2. Select "Service OCXO / VCXO" tab.
3. If **no R&S RTO-B4** (OCXO option) is installed, the following dialog box is shown:



   a) Activate the adjustment procedure by selecting "VCXO Service": "Active" and then select "Get DAC Value" to determine the current DAC value of the corresponding reference oscillator.
   b) Adjust the frequency of the internal reference oscillator as close as possible to 1 GHz by tuning the DAC value.
   c) Save the updated DAC value by selecting "Write EEPROM".

4. If **R&S RTO-B4** (OCXO option) **is installed**, the following dialog box is shown:



a) Activate the adjustment procedure by selecting "OCXO Service": "Active" and then select "Get DAC Value" to determine the current DAC value of the corresponding reference oscillator.
b) Adjust the frequency of the internal reference oscillator as close as possible to 1 GHz by tuning the DAC value.
c) Save the updated DAC value by selecting "Write EEPROM".

3.4 Performing the Threshold DC Adjustment (Threshold Value of the Logic Probes)

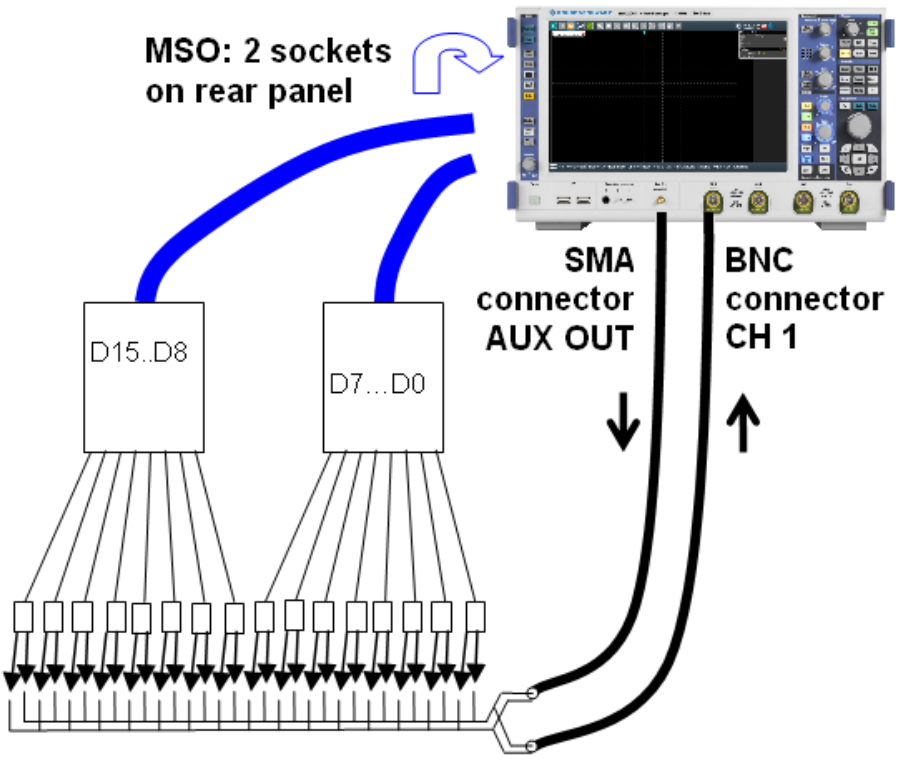
Test Equipment

1. Mixed signal option (MSO) is installed
2. 2 Logic probes (8 channels each) are connected to MSO
3. Service Adaptor: SMA/BNC male to 16x2 connector male (“2.54 mm Berg pins”)
4. Appropriate number of tip cables is connected to the service adapter

Test Setup

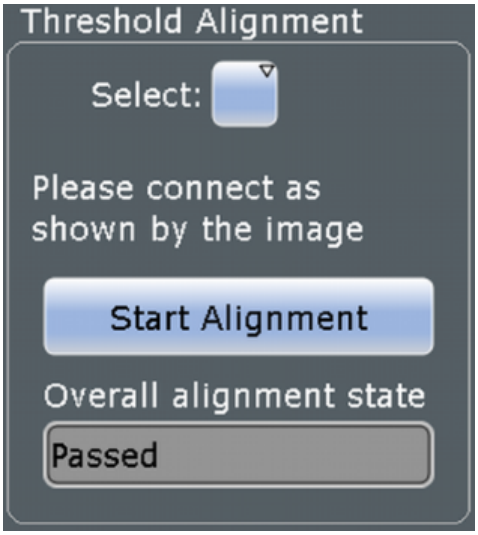
Connect the MSO probe via the Service Adapter as shown in the graphic below.

1. Connect MSO Probes to the Service Adapter.
2. Connect the Service Adapter SMA connector to the SMA "AUX out" output of the RTO.
3. Connect the Service Adapter BNC connector to Channel 1 of the RTO



R&S RTO Settings

1. [PRESET]
2. Enter service password: "File" menu > "Board detection/Maintenance > Service".
3. Select "MSO" tab.
4. Activate the adjustment procedure by selecting the MSO Probe "select ""MSO Probe"
5. Start the adjustment procedure by selecting the MSO Probe.
6. Activate the adjustment procedure by selecting "Start Alignment ".


Threshold Alignment
Select:
Please connect as
shown by the image
Start Alignment
Overall alignment state
Passed

4 Repair

The following chapter describes how to replace modules in the R&S RTO. The general procedures to open and complete the instrument are described in the introduction. For all descriptions, the numbers in parenthesis refer to the elements indicated in the graphics.

WARNING

Risk of electric shock

With the casing open, you can touch current-carrying components and suffer an electric shock. Before opening the casing, make sure that the instrument is switched off and disconnected from all power supplies. Read all safety instructions at the beginning of this manual carefully!

4.1 Functional Description

4.1.1 Frontend

The frontend of the RTO is the analog part of the oscilloscope.

The signal passes from the BNC connector at the input channel through the various stages of attenuators and amplifiers to an 8 bit 10 GSamples A/D converter to digitalize the input signal.

There are two different input paths depending on the impedance setting of the instrument. For safety reasons, the 50 Ohm input paths are overload protected. If the input voltage exceeds 5 Volt, the input is switched off.

The frontend is equipped with an internal calibration source of different signal types and frequences. This internal calibration source is used for the internal channel alignment and selftest.

An internal VCO of 100 MHz is used to generate all clocks for the R&S RTO. If an OCXO option is installed, the 10 MHz OCXO equipped on the board synchronizes the 100MHz VCO with the aid of a PLL.

The frontend is also equipped with a USB hub to connect the USB busses of the active probes as well as the two front USBs.

4.1.2 Mainboard

The output signals of the frontend A/D converter are the input signals of the mainboard, which represents the digital part of the R&S RTO. At the mainboard, the converted digital measurement signals are processed at the RTC ASIC and recorded into the

trace memory. The digital mainboard generates pixelized images for visualization, and transmits the images to the computer.

In addition, various mathematical operations, measurement functions, and analysis functions can be applied to the measurement signals. They are computed in the RTC ASIC or the controller unit.

The digital mainboard consists of the following functional circuits:

- AFC FPGA (analog frontend controller)
- CTC FPGA (channel trigger controller)
- RTC ASIC (recording trigger controller)
- Trace memory (flash, DDR2, DDR3)
- SPI interfaces for controlling the frontend and mainboard
- AXT (analog external trigger, digital circuit)
- Temperature and fan speed controller

The mainboard also provides the connection for the GPIB option R&S RTO-B10 GPIB and the MSO option R&S RTO-B1.

4.1.3 Front Unit

The front unit consists of the following parts:

- Plastic casing panel which accommodates the LCD with capacitive touchscreen
- R&S RTO front unit with the front panel controller (FPC)
- Rotary knobs
- Keyboard mat

4.1.4 CPU Board

The CPU board (LPW11) contains all necessary components on one board: processor, RAM (SIMM modules), I/O devices, lithium battery, LCD graphics controller, external DVI interface (monitor), controller for SATA hard disk, LAN, USB interfaces, and display port.

4.1.5 Power Supply

The power supply module provides DC voltages: +12.2 V and 12.2 V standby.

In standby operation, it only supplies the 12.2V standby voltage for the oven of the OCXO and the CPU Board.

It can be switched off by means of the power switch on the rear panel. The power supply module is a primary clocked switching power supply.

4.2 Opening the Instrument

NOTICE

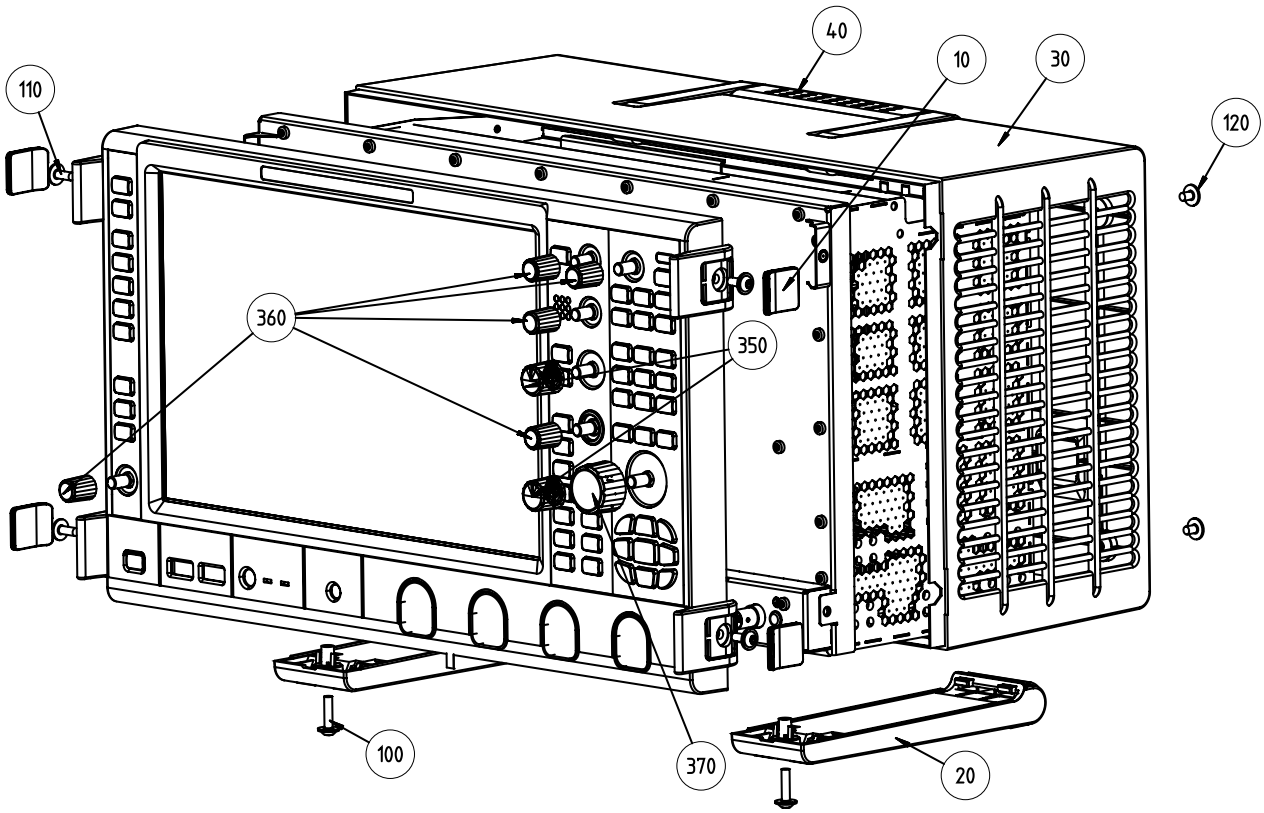
Instrument damage caused by electrostatic discharge

Electrostatic discharge (ESD) can damage the electronic components of the instrument and the device under test (DUT). Electrostatic discharge is most likely to occur when you connect or disconnect a DUT or test fixture to the instrument's test ports. To prevent electrostatic discharge, use a wrist strap and cord and connect yourself to the ground, or use a conductive floor mat and heel strap combination.

⚠ WARNING

Risk of electric shock

With the casing open, you can touch current-carrying components and suffer an electric shock. Before opening the casing, make sure that the instrument is switched off and disconnected from all power supplies. Read all safety instructions at the beginning of this manual carefully!



4.2.1 Removing the Casing

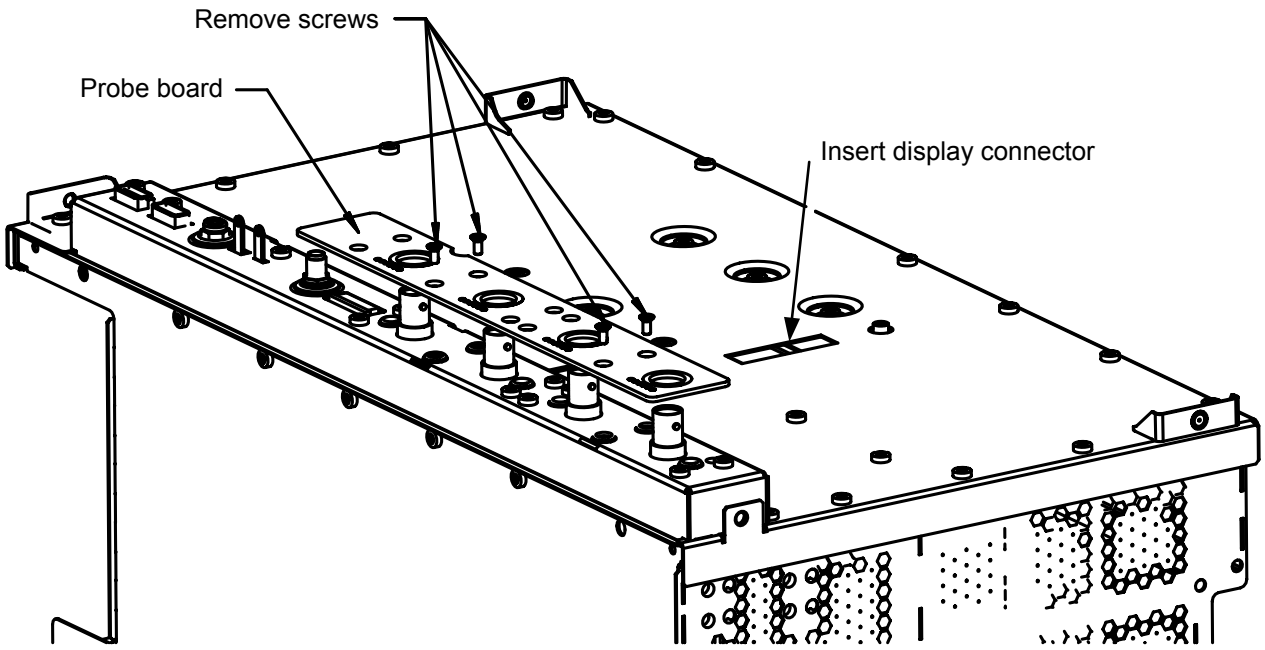
1. Switch off the instrument and disconnect the power plug.
2. Unscrew the 4 screws (120) at the rear of the instrument casing.
3. Remove the two R&S RTO base boards (20) by unscrewing two screws (100).
4. Slide off the casing (30) to the rear.

4.2.2 Removing the Front Unit

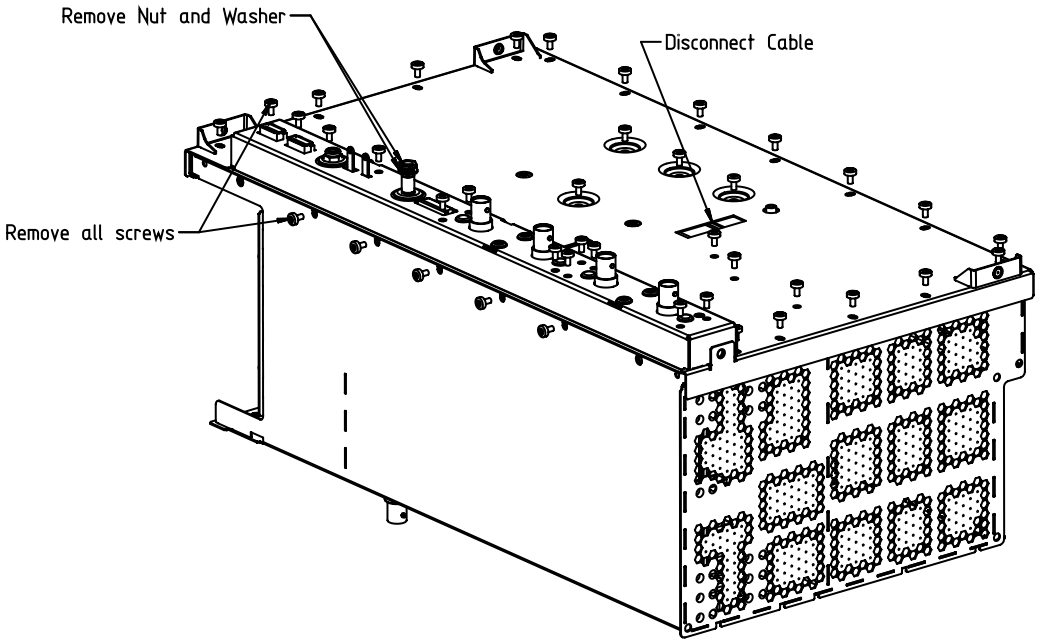
1. Switch off the instrument at the mains and disconnect the power plug.
2. Remove the two R&S RTO base boards (20) by unscrewing screws (100) and then sliding the base boards to the rear.
3. Remove the 4 pillars by removing first the covers (10) followed by the screws (110).
4. Slide off the front unit.

There is a connector from the front unit to the mainboard above channel 4; therefore start removing the front unit by gently pulling on both sides.

4.2.3 Removing the Probe Adaptation Board

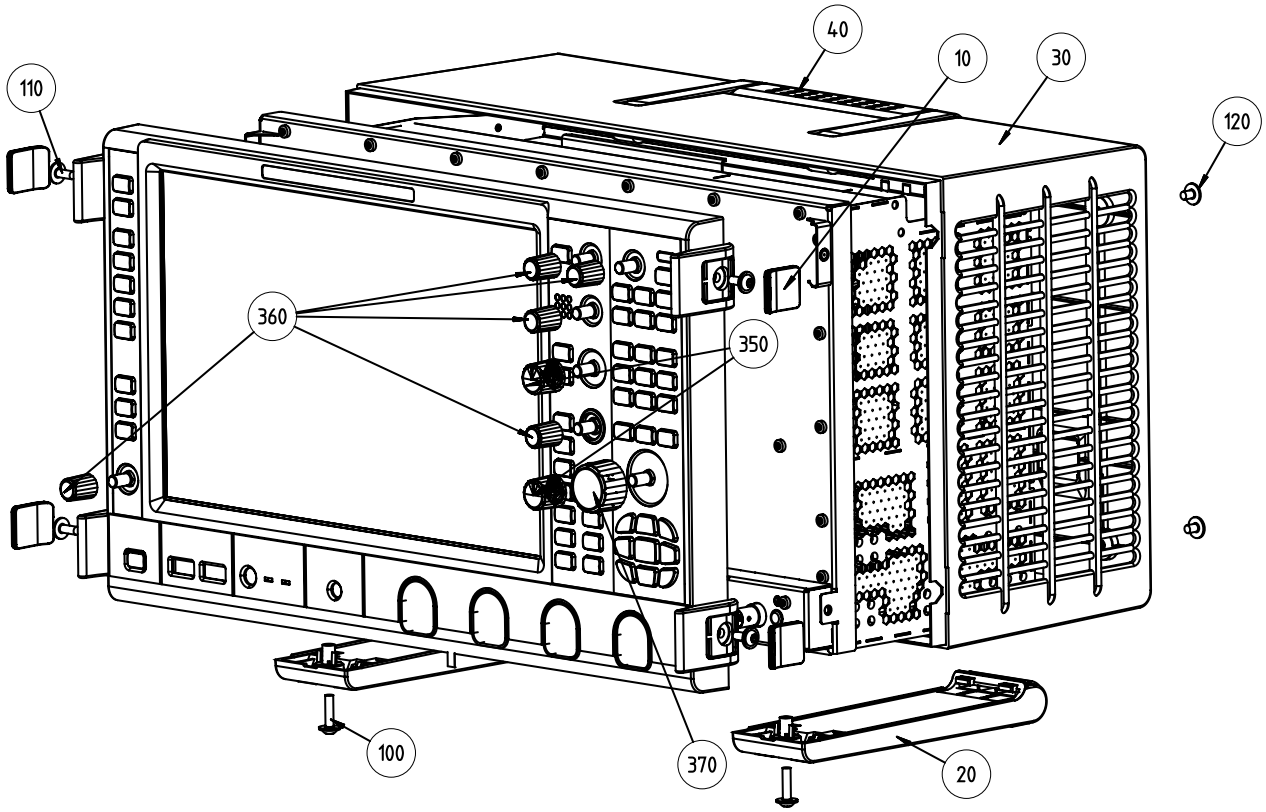


4.2.4 Removing the Mounting Trough



The cable can be disconnected after the mounting through is removed.

4.3 Completing the Instrument



4.3.1 Reassembling the Mounting Trough

Before fitting the mounting trough to the internal frame, make sure the airflow foam is inserted and positioned correctly to avoid temperature overstress of the mainboard.

1. Put the instrument on its rear feet and place the mounting trough on the internal metal frame.
2. Fit all screws as shown in Chapter 4.2.4, "Removing the Mounting Trough", on page 75.

4.3.2 Reassembling the Probe Adaptation Board

► Mount the probe board and make sure the connector is placed correctly on the frontend. For the correct position of the probe adaptation board refer to Chapter 4.2.3, "Removing the Probe Adaptation Board", on page 74.

4.3.3 Reassembling the Front Unit

1. Put the instrument on its rear feet, hold the front unit to the main frame and make sure it is connected to the mainboard correctly.
2. Mount the 4 pillars to the instrument by the screws (110) and finally fit the covers (10).
3. Reconnect the cable from the RTO base to the front unit.

4.3.4 Reassembling the Casing

1. Slide back the casing (30) and fasten it with 4 screws (120) at the rear.
2. Mount the R&S RTO baseboards by fastening the screws (100).

4.4 Module Replacement

WARNING

Danger of injury during module replacement

Any adjustments, replacement of parts, maintenance or repair must be carried out exclusively by technical personnel authorized by Rohde & Schwarz.

Observe the safety instructions for units with a removable casing.

Follow the step-by-step instructions for module replacement carefully to avoid injury and to help ensure safe operation.

After module replacement, a UCS-Test is recommended. Perform also BIOS and firmware update if needed. Self test and self-alignment are mandatory.

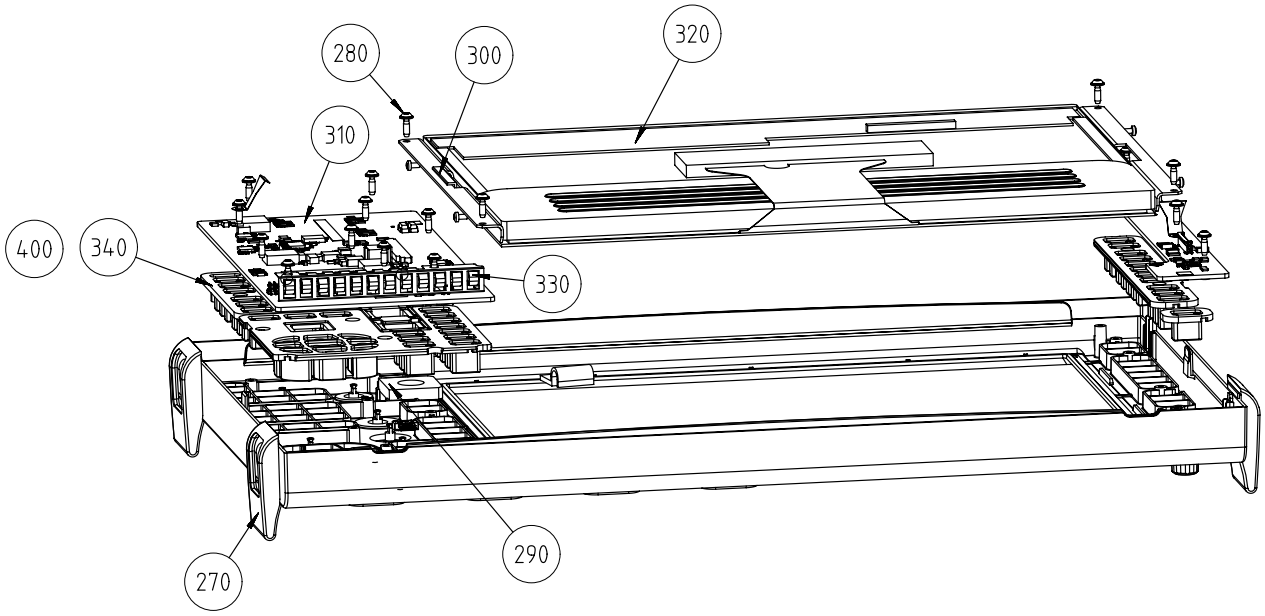
4.4.1 Front Unit

The front unit/frame of the 2 and 4 channel instruments differ mechanically. The type labels must be ordered and attached separately depending on the instrument type.

The front unit consists of:

- Printed front frame which differs for each unit (650, 660)
- Silicon switching mat (340, 400)
- Front panel PCB (310)

- Touchscreen display (320)
- Cables (flex strip cable W10, display cable W20 and USB cable W40)
- Knobs (350, 360, 370)
- Spring (351)
- Screws (380)



4.4.2 Replacing the Display

4.4.2.1 Removing the Defective Display

1. Switch off the instrument and disconnect the power plug.
2. Remove the front unit. See Chapter 4.2.2, "Removing the Front Unit", on page 74.
3. Unplug the cables 260, 380 and 390.
4. Remove 4 screws (280).
5. Remove the display.

4.4.2.2 Installing the New Display

Before fitting the new display, make sure that the rubber sealing is undamaged and positioned correctly in the front frame.

1. Insert the new display unit.
2. Reuse the display holder and cables if not obvious damaged.

3. Complete the instrument. See Chapter 4.3, "Completing the Instrument", on page 76.

4.4.3 Replacing the Front Unit PCB

The front unit PCB consists of two PCBs and the probe adaption board.

4.4.3.1 Removing the Defective Front Unit PCB

1. Switch off the instrument and disconnect the power plug.
2. Remove the front unit. See Chapter 4.2.2, "Removing the Front Unit", on page 74.
3. Remove all front knobs.
4. Remove the display unit as described in Chapter 4.4.2, "Replacing the Display", on page 78.
5. Remove the shielding springs.
6. Unscrew and remove both front unit PCBs.

4.4.3.2 Installing the New Front Unit PCB

Before you install the new front panel PCB, check if the speaker sealing (340) as well as the silicon switching mats are positioned correctly.

1. Place new front panel PCBs.
2. Place the spring (330).
3. Fasten the screws.

   Note: Make sure the PCBs are placed correctly.
4. Reassemble the display unit and cables as described in Chapter 4.4.3, "Replacing the Front Unit PCB", on page 79.
5. Reassemble the front unit to the instrument. See Chapter 4.3.3, "Reassembling the Front Unit", on page 77.

4.4.3.3 Putting into Operation

1. Switch on the instrument and wait until it is fully booted. Do not switch off the power during this initial boot process.

During the application, start the instrument checks the software version of the FPC (Front Panel controller). If the version does not fit the current firmware, the FPC is updated automatically.

If the FPC cannot be updated, you get an error message:

- Cannot flash FPC controller
- Implausible SW version

2. In those cases, switch of the instrument by the rear power switch and reboot the instrument again.

4.4.4 Replacing the Silicone Switching Mat

Removing the defective switching mat

1. Switch off the instrument and disconnect the power plug.
2. Remove the front unit. See Chapter 4.2.2, "Removing the Front Unit", on page 74.
3. Remove the front unit PCB. See Chapter 4.4.3, "Replacing the Front Unit PCB", on page 79.
4. Remove the switching mat.

4.4.5 Connecting Board

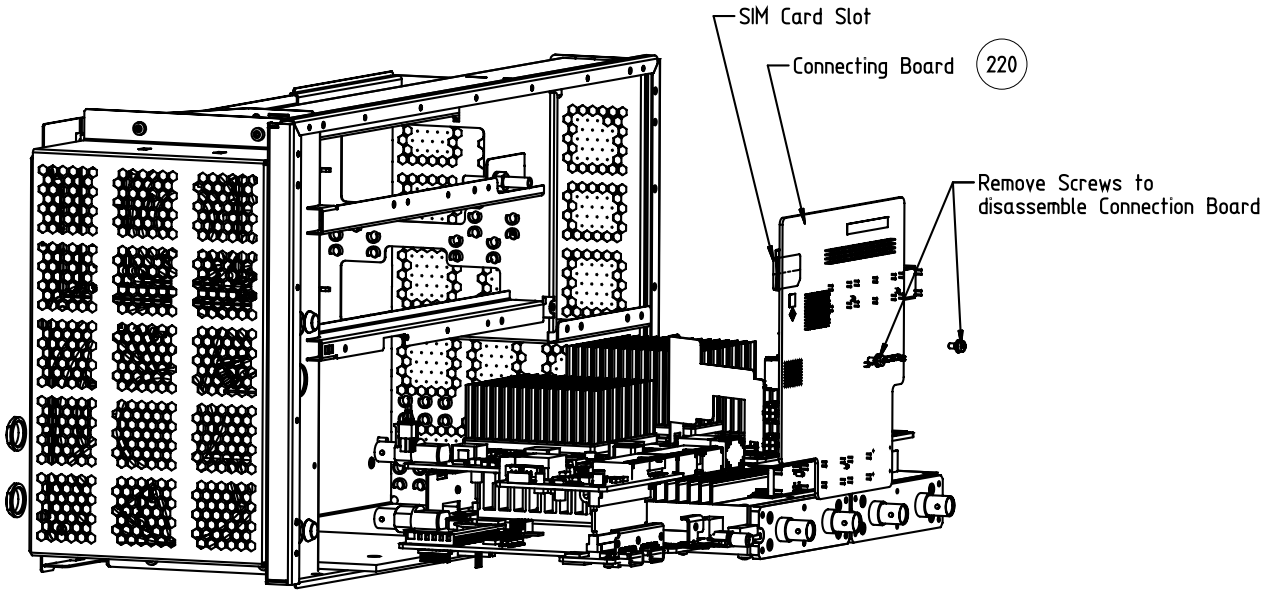


Figure 4-1: Connecting board

4.4.5.1 Removing the Defective Connecting Board

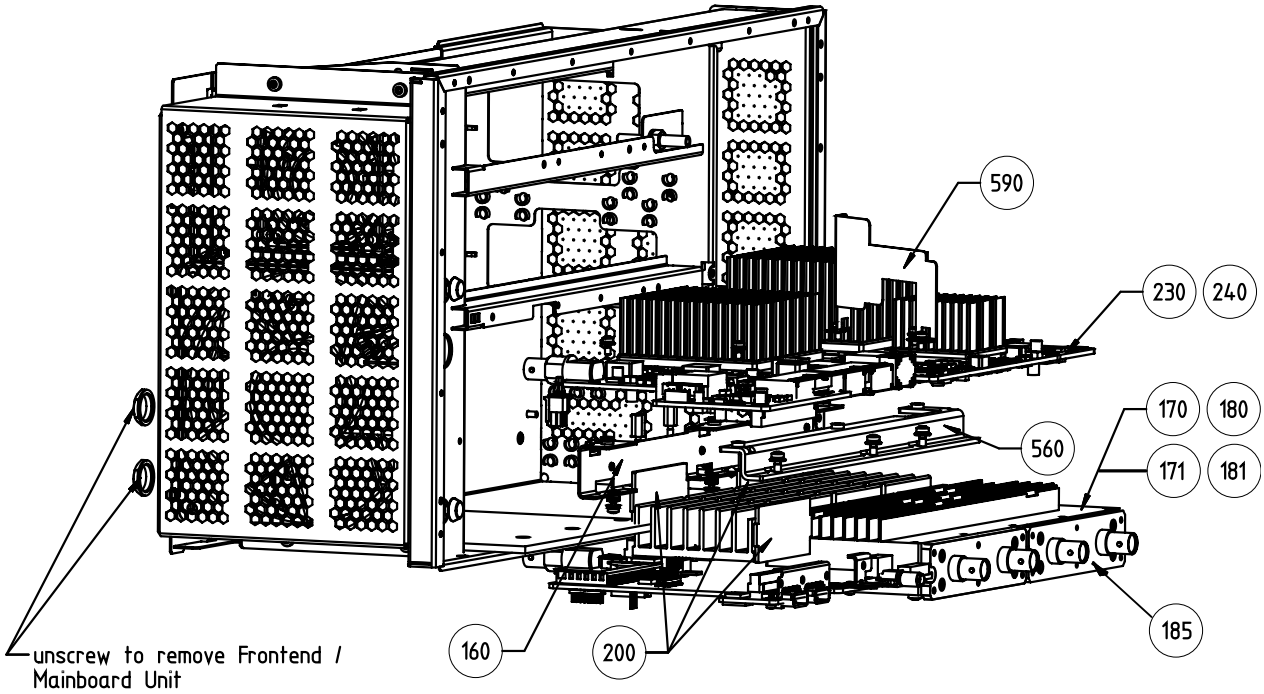
The SIM card holds the identity of the RTO and all option information. Make sure to keep the SIM card because you need it for the new connecting board to hand over all device and option data.

1. Switch off the instrument at the mains and disconnect the power plug.
2. Remove the front unit. See Chapter 4.2.2, "Removing the Front Unit", on page 74.
3. Remove the probe adaptation board. See Chapter 4.2.3, "Removing the Probe Adaptation Board", on page 74.
4. Remove the mounting trough. See Chapter 4.2.4, "Removing the Mounting Trough", on page 75.
5. Remove the connecting board.
6. Remove the fan cables. See Chapter 4.4.12, "Fans", on page 91.
7. Remove the 2 screws. See Figure 4-1.
8. Remove the SIM card.
   Store the SIM card together with the instrument

4.4.5.2 Installing the Connecting Board

1. Gently place the connecting board on the mainboard.
2. Reassemble the mounting trough. See Chapter 4.3.1, " Reassembling the Mounting Trough", on page 76.
3. Reassemble the probe adaptation board. See Chapter 4.3.2, "Reassembling the Probe Adaptation Board", on page 76.
4. Reassemble the front unit. See Chapter 4.3.3, "Reassembling the Front Unit", on page 77.
5. Fix screws.
6. Insert the original SIM Card.
7. Connect the fan cable as shown in Chapter 4.4.12, "Fans", on page 91.
   a) Connect the small fan cable to the upper connector (Fan 0) on the connecting board.
   b) Connect the large fan cable to the lower connector (Fan 1) on the connecting board.

4.4.6 Replacement of Frontend and Mainboard



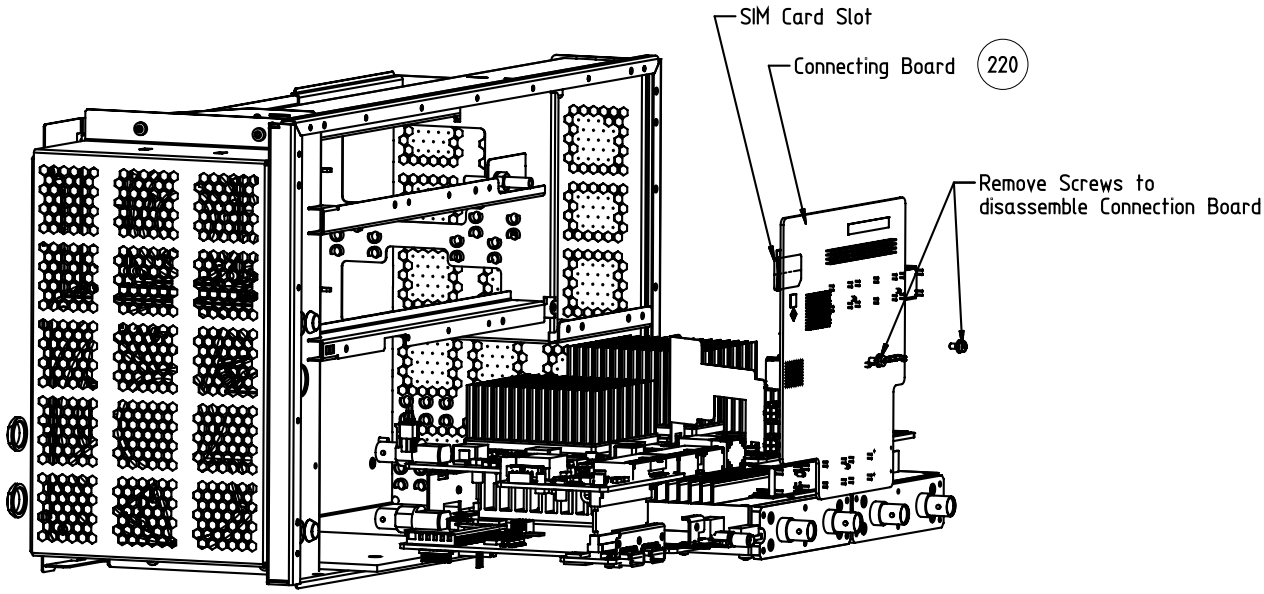
1. Switch off the instrument at the mains and disconnect the power plug.
2. Remove the front unit. See Chapter 4.2.2, "Removing the Front Unit", on page 74.
3. Remove the mounting trough. See Chapter 4.2.4, "Removing the Mounting Trough", on page 75.
4. Remove the connecting board.
5. Unplug the fan cables.
6. Remove the frontend / mainboard module combination.
   a) Remove the BNC trigger in and out nuts and washers.
   b) Remove the 3 M 2.5 screws on the instrument rear.
7. Slide off the frontend / mainboard (230, 240) module combination.

   Frontend:
   - Pos. 170 and 180 for serial numbers < 3xxxxx
   - Pos. 171 and 181 for serial numbers ≥ 3xxxxx
   - Pos. 185 for R&S RTO2064 instruments
8. Separate the mainboard from the frontend by removing the air flow sheet (590) and all 7 screws from the top side.
9. To exchange the frontend remove position numbers 160 and 560 and keep them.

   Note: They belong to the instrument and not to the frontend or mainboard.

4.4.7 SIM Card with Instrument Identity

4.4.7.1 Replacing the SIM Card



► Open the instrument. You need access to the connecting board, see Chapter 4.4.5.1, "Removing the Defective Connecting Board", on page 81.

4.4.7.2 Putting into Operation after the SIM Card was Replaced

1. Connect the power cable to the instrument and switch on the instrument using the rear switch. The instrument stays in standby mode.
2. Switch on the instrument and wait until the instrument is fully booted.
3. Check if all options are listed: [Setup] > "SW Options".

SIM Card handling

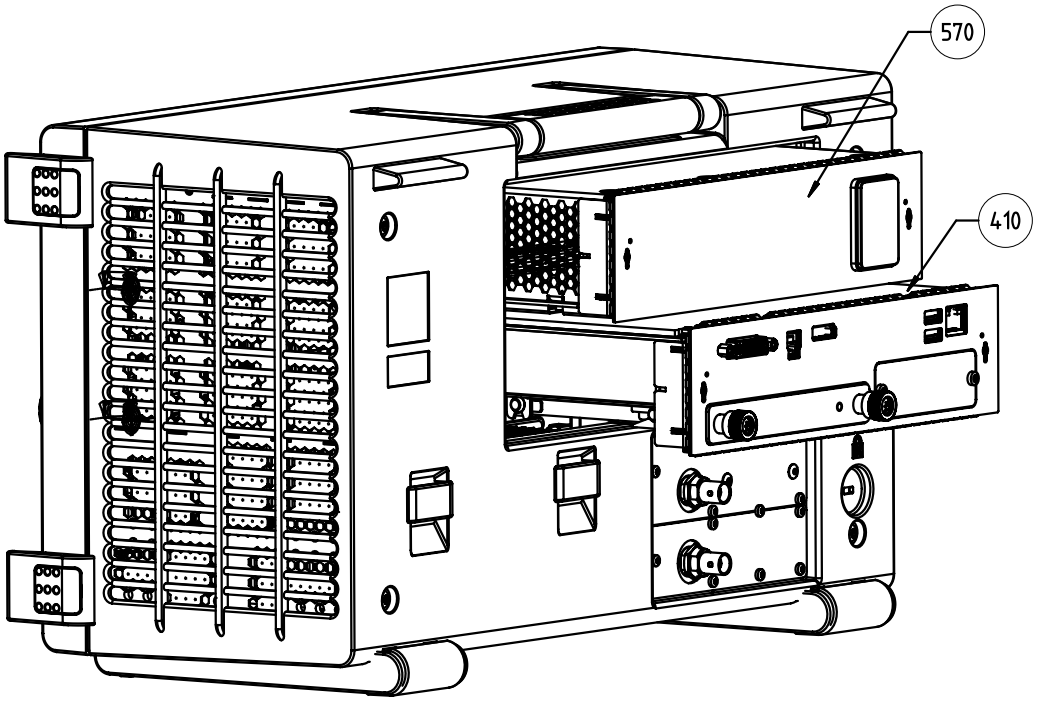
If you have a defective SIM card, contact the spare part department in advance for proper handling.

4.4.8 Controller Unit

The controller is placed on the rear side of the R&S RTO and consists of the CPU board with backup battery, mechanical mounting frame and the attached removable hard disk.

The CPU board is equipped with two 4 GB RAM modules at delivery.

If option RTO-B110 is installed, the 2 8 GB RAM modules of the option have to be changed in addition. Remove them from the old CPU and install them to the new CPU.

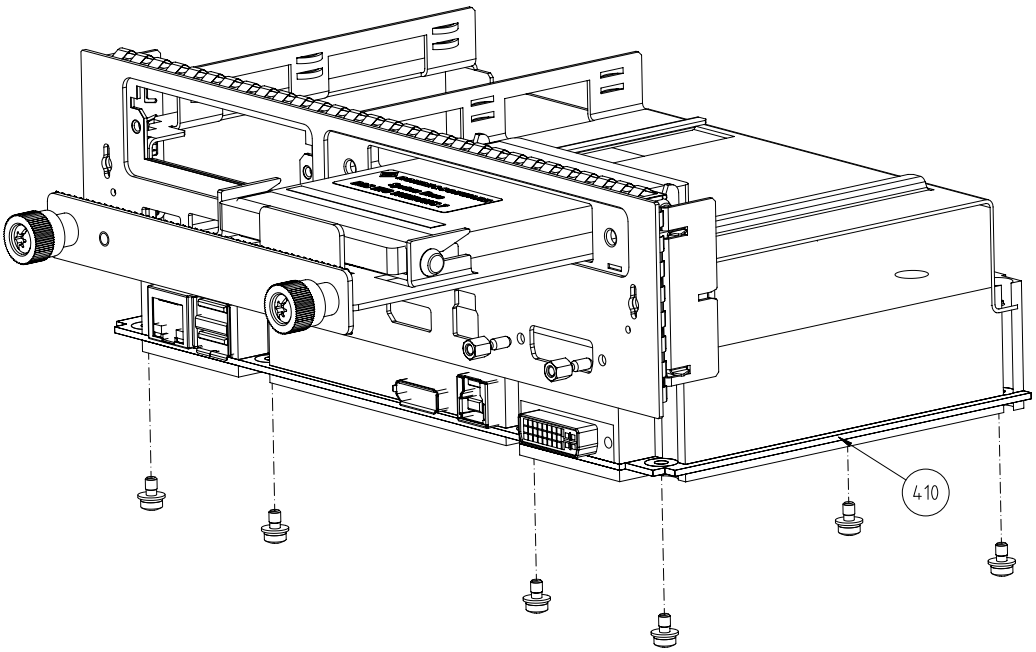


Pull out tool for controller and power supply

To remove the Controller Unit, a special pull-out service tool (PN: 1174.0301.00) is required.

4.4.8.1 Removing the Defective CPU Board

1. Switch off the instrument and disconnect the power plug.
2. Remove the controller using the pull-out tool.
3. Remove the DVI port screws.
4. Disassemble the frame from the CPU board by removing 7 screws.



4.4.8.2 Installing the New CPU Board

If option RTO-B110 is installed, the 2 8 GB RAM modules of the option have to be changed in addition. Remove them from the old CPU and install them to the new CPU.

1. Mount the CPU Board to the frame by fastening 7 screws.
2. Gently slide back the controller unit to the instrument.

   Note: Make sure that the controller unit is installed correctly and the locking springs are embodied on both sides.

4.4.8.3 Putting into Operation after the CPU Board was Replaced

1. Connect the power cable to the instrument and switch on the instrument using the rear switch. The instrument stays in standby mode.
2. Switch on the instrument and wait until the instrument is fully booted.
3. Perform a BIOS Update.

4.4.8.4 BIOS Update

1. Enter the second-level service password: "File" menu > "Board detection/Maintenance > Service".

2. Press the [Setup] key. Select the "System" tab.
3. Under "Select file for Bios update", tap "Open" and select the file.
4. Press "Select" to perform the update.

NOTICE

Risk of causing instrument unusability

During the BIOS update, do not switch off the instrument. If you terminate the update procedure before it is completed, the instrument will likely not boot again. In this case, contact your Rohde & Schwarz service center.

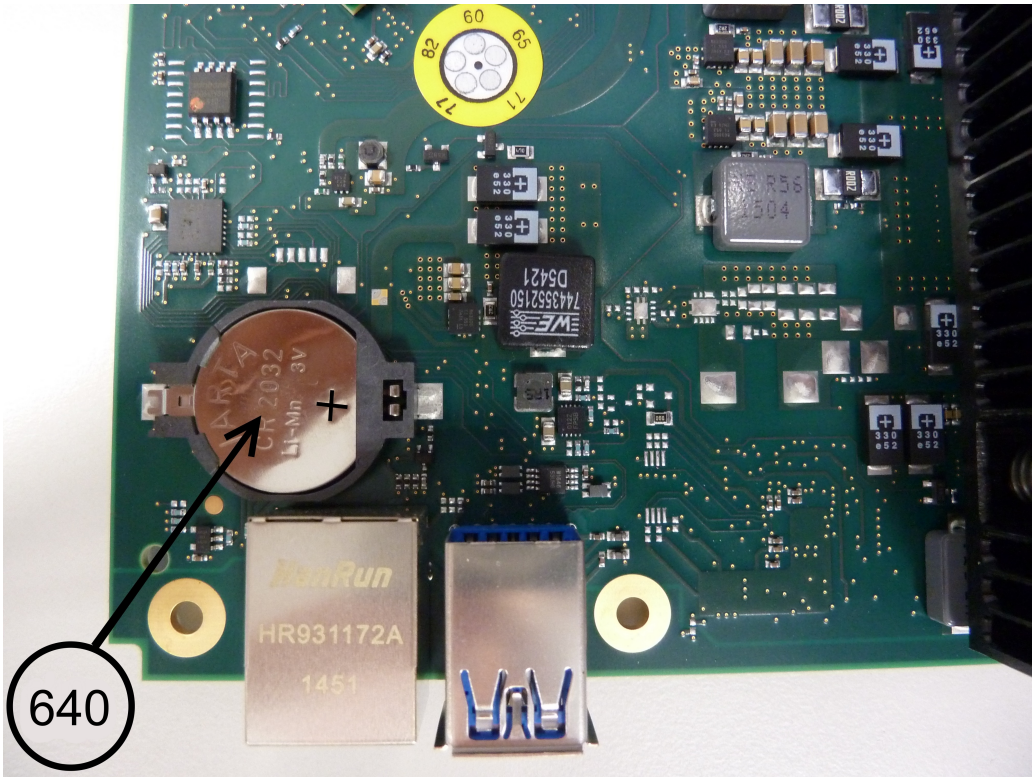
4.4.9 Backup Battery

See spare parts. The lithium battery (640) is located on the CPU Board.

4.4.9.1 Removing the Lithium Battery

1. Switch off the instrument and disconnect the power plug.
2. Remove the controller unit with the aid of the pull-out tool.
3. Disassemble frame from CPU Board by removing 7 screws.
4. Carefully push the contact springs of the battery holder up and remove the battery.

4.4.9.2 Installing the New Battery



NOTICE

Risk of damage to the instrument.

Do not short-circuit the battery.

1. Carefully push the contact springs of the battery holder up and insert battery into the holder beneath the springs.

   Note: The plus pole (+) of the battery points upwards.

2. Reassemble the CPU Boardas described in Chapter 4.4.8, "Controller Unit", on page 83.

4.4.9.3 Putting into Operation

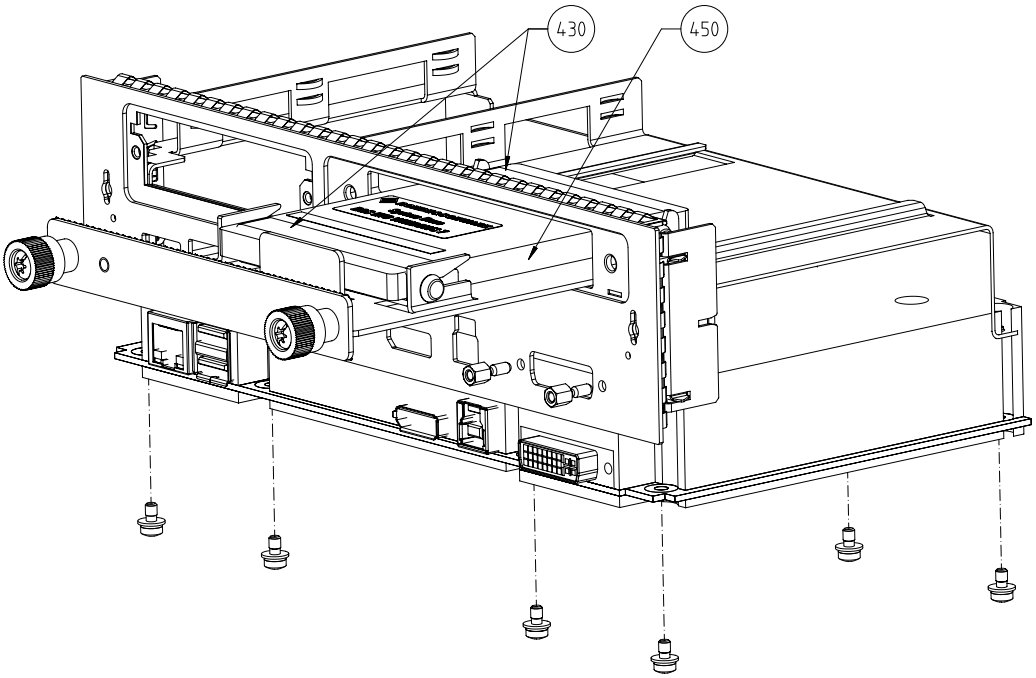
1. Connect the instrument to the mains and switch on its power switch.
2. After starting the instrument, set the time and date.

4.4.10 SATA Hard Disk

The spare part is already formatted for the R&S RTO and contains the complete software (operating system incl. R&S RTO instrument firmware).

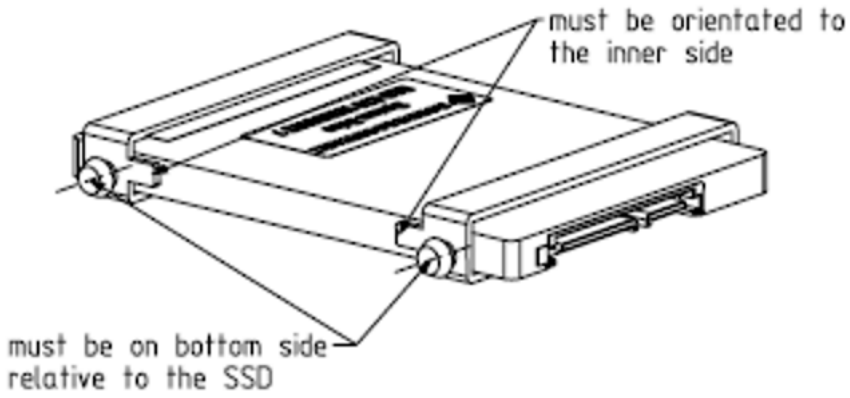
4.4.10.1 Removing the SATA Hard Disk

1. Switch off the instrument and disconnect the power plug.
2. Remove the controller unit with the aid of the pull-out tool.
3. Unscrew the two knurled screws and remove the hard disk to the rear.
4. Carefully remove the SSD 450 together with the two holders 430 from the sheet metal part.
5. Remove the two holders (430) from the hard disk (450).



4.4.10.2 Installing the New SATA Hard Disk

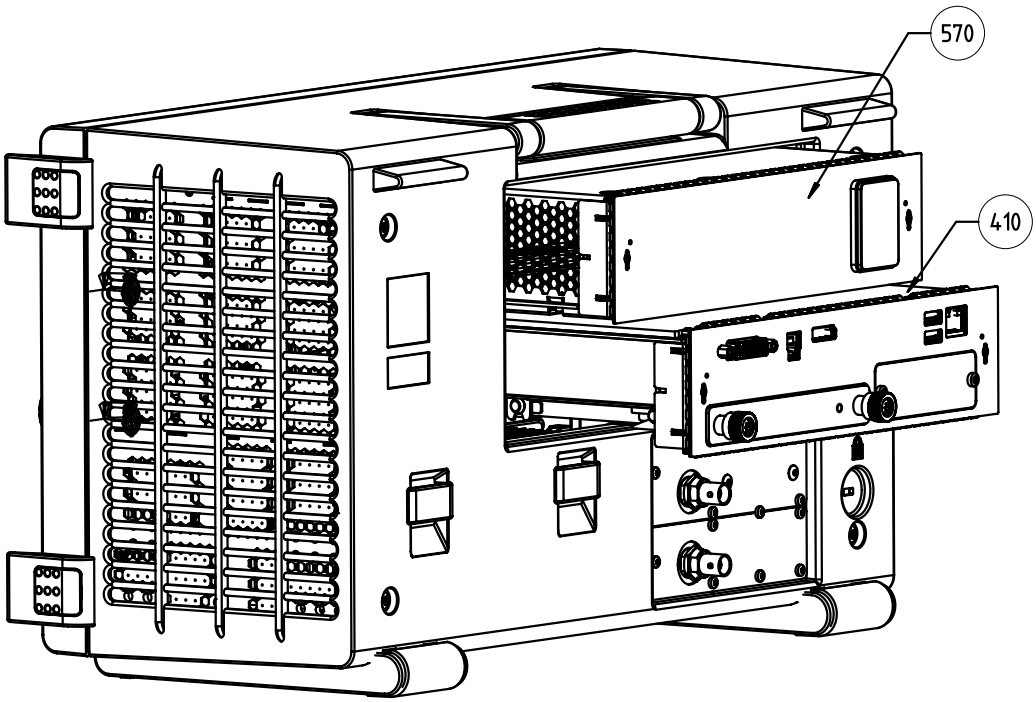
► Mount the holder. Pay attention to the exact positioning.



4.4.10.3 Putting into Operation

1. Connect the power cable to the instrument and switch on the instrument using the rear switch. The instrument stays in standby mode.
2. Switch on the instrument and wait until the instrument is fully booted.
3. Update to the latest R&S RTO Firmware if necessary.
4. Perform a self-alignment. See Chapter 3.1, "Self-alignment", on page 65.

4.4.11 Power Supply



4.4.11.1 Removing the Defective Power Supply

1. Switch off the instrument and disconnect the power plug.
2. Remove the power supply (570) unit with the aid of the pull-out tools.

4.4.11.2 Installing the New Power Supply

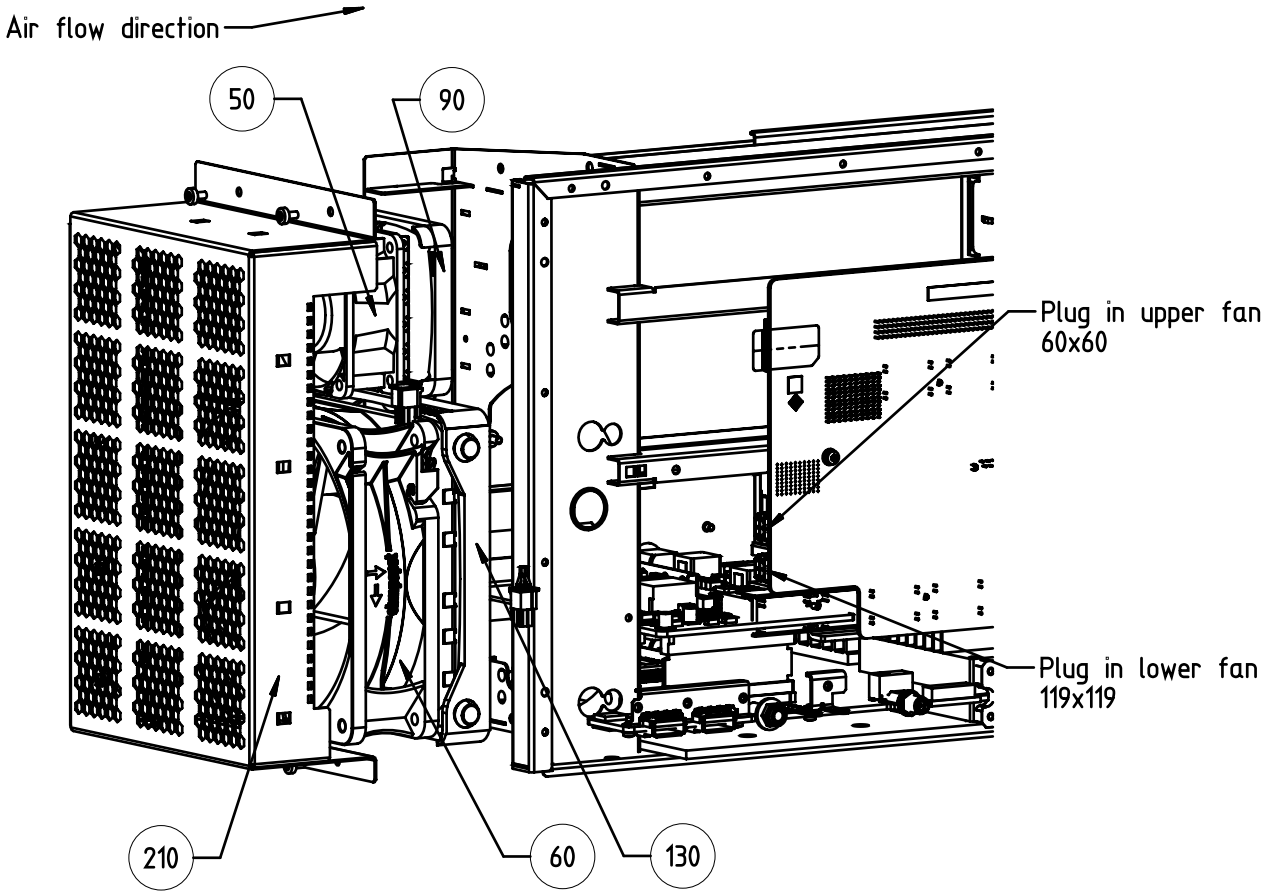
► Insert the power supply (570) gently into the instrument's frame.

Note: Make sure that the power supply is installed correctly and the locking springs are embodied on both sides.

4.4.11.3 Putting into Operation

1. Connect the instrument to the mains and switch on the instrument using the rear power switch.
2. Switch on the instrument with the ON/OFF key and wait until the instrument is booted completely.
3. Perform a selftest.
4. Perform an internal self-alignment.

4.4.12 Fans



4.4.12.1 Removing Fans

1. Open the instrument. See Chapter 4.2, "Opening the Instrument", on page 73.
2. Remove the front unit (see Chapter 4.2.2, "Removing the Front Unit", on page 74) and mounting trough (see Chapter 4.2.4, "Removing the Mounting Trough", on page 75) to get access to the click ferrite, fan cables and connectors.
3. Disconnect cables to remove the fans.
4. Remove the fan 0 including the fan collar by pulling the collar in the direction against the airflow as indicated.
5. Remove the fan 1 including the fan collar by shifting the collar to the rear of the instrument.

4.4.12.2 Installing New Fans

NOTICE

Consider airflow direction

Ensure that the fans are mounted in the correct airflow direction. Check the air flow markers on the fans point from outside into the instrument.

Installing the Small Fan

1. Flip the small fan (50) into the small fan collar (90).

   Note:
   - Make sure that the fan is engaged completely into the collar.
   - Make sure that the cables of the fan are positioned as indicated by the red circles.
   - Make sure that the fans are mounted in the airflow direction.

2. Feed the cable through the hole Fan 1 in the main frame.
3. Slip the fan collar into the mounting holes.
4. Move the fan collar with the fan to the left to lock the assembly.
5. Connect the cable from the small fan to FAN 1 on the connecting board .

Install large fan: Flip fan into the large collar

1. Flip the large fan (60) into the large fan collar (130).

   Note:
   - Make sure that the fan is engaged completely into the collar.
   - Make sure that the cables of the fan are positioned as indicated by the red circles.
   - Make sure that the fans are mounted in the airflow direction.

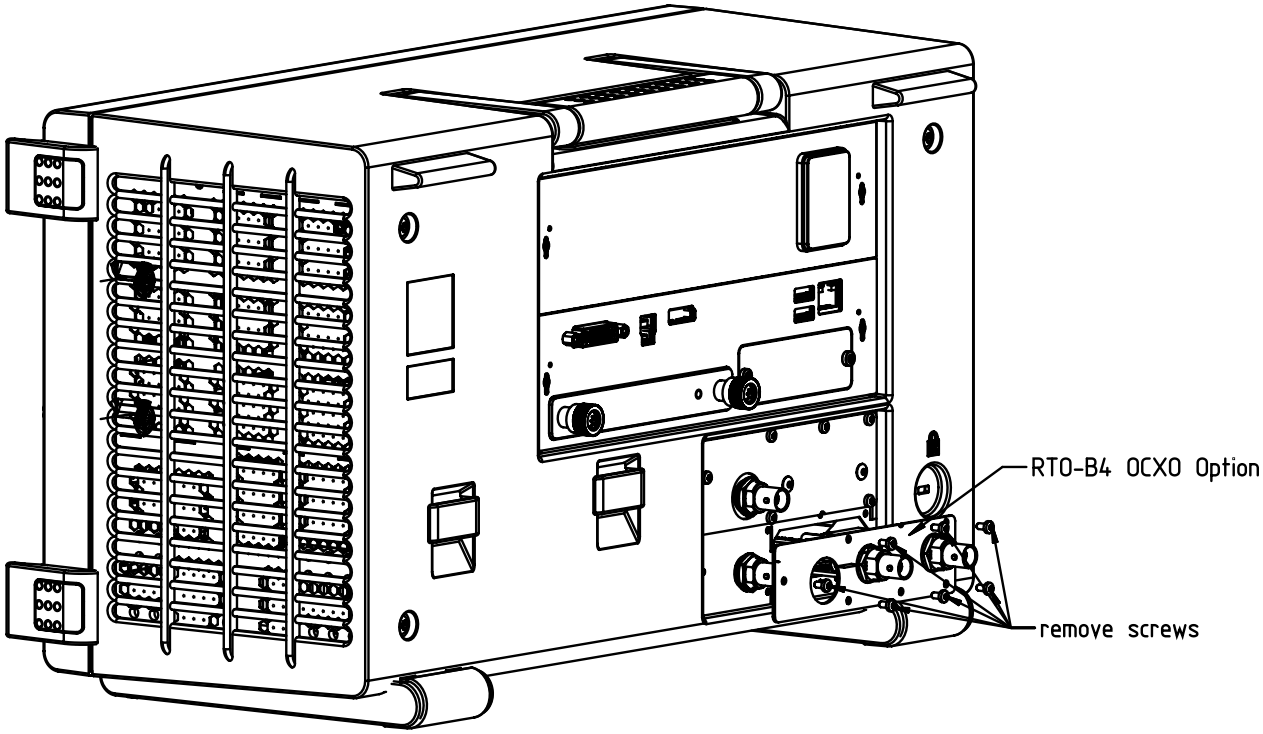
2. Implement the cable through the hole of FAN 1 into the main frame.
3. Slip the fan into the mounting holes on both sides.
4. Press the fan collar with the fan down until it locks.
5. Connect cable from small fan to FAN 0 on the connecting board .

4.4.12.3 Putting into Operation

1. Connect the instrument to the mains and switch on the instrument using the rear power switch.
2. Switch on the instrument with the ON/OFF key and wait until the instrument is booted completely.

3. Perform a selftest.
4. Perform an internal self-alignment.

4.4.13 Option R&S RTO-B4, OCXO



4.4.13.1 Removing a Defective OCXO

1. Switch off the instrument at the mains and disconnect the power plug.
2. Remove 7 screws.
3. Remove the OCXO option by pulling the option to the rear.

4.4.13.2 Installing the New OCXO and Putting into Operation

1. Slide in the new OCXO.
2. Fix screws (595).

4.4.13.3 Putting into Operation

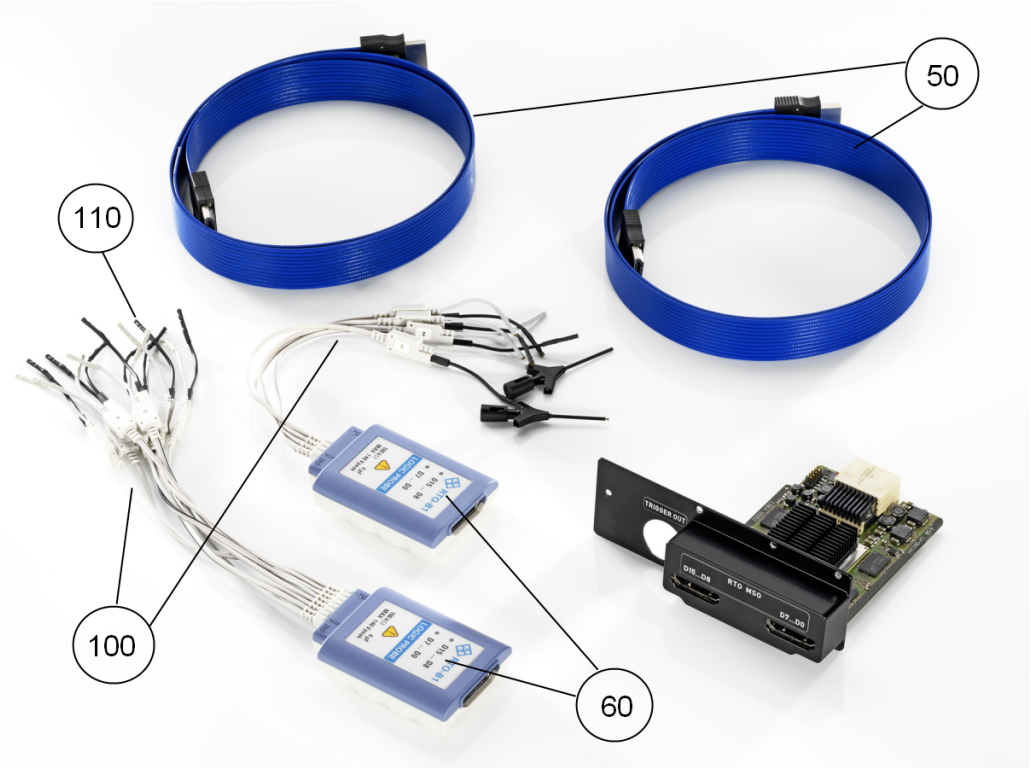
1. Connect the instrument to the mains and switch on the instrument using the rear power switch.
2. Switch on the instrument with the ON/OFF key and wait until the instrument is booted completely.
3. Check if OCXO is listed: [Setup] key > "HW Options" tab.
4. Perform a selftest.
5. Adjust the OCXO as described in Chapter 3.3, "Adjusting the Reference Oscillator", on page 66.
6. Perform an internal self-alignment.

4.4.14 Option R&S RTO-B1, MSO

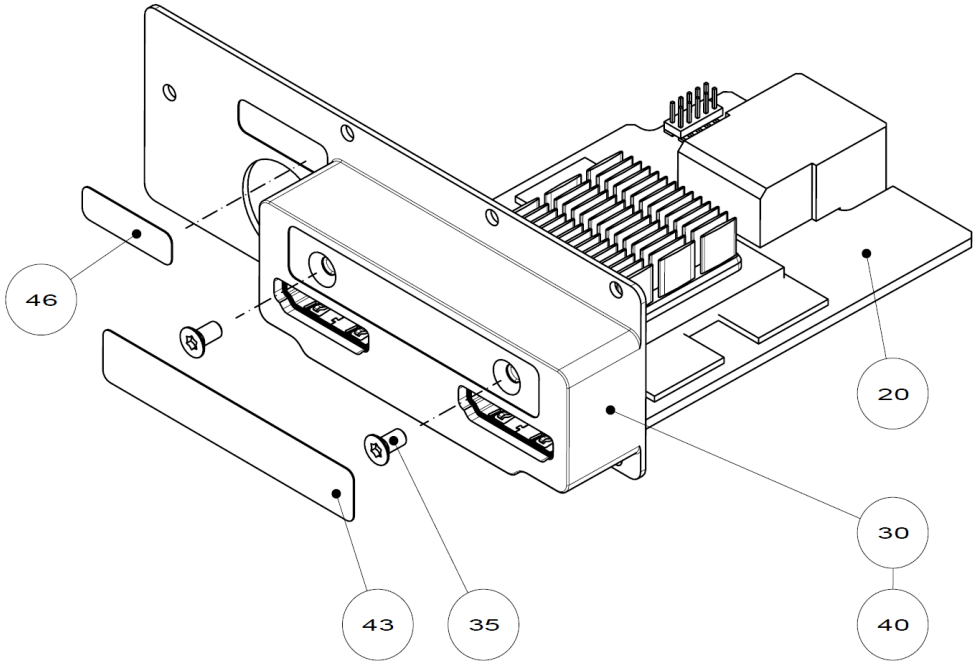
The option R&S RTO-B1 uses the same slot as the R&S RTO-B10 option. Therefore either option R&S RTO-B1 or option R&S RTO-B10 can be installed. The MSO option R&S RTO-B1 is available in two different variants depending on the part number of the instrument.

- Variant 02 is used in RTO 1304.6002Kxx
- Variant 03 is used in RTO 1316.1000Kxx and 1329.7002Kxx

The R&S RTO-B1 option consists of the MSO hardware module, the TWINNAX flat cables (50), the MSO logic probe boxes (60) , the MSO logic probe cables (100) and the MICRO HOOKs (110).



4.4.14.1 Removing Option



1. Switch off the instrument at the mains and disconnect the power plug.

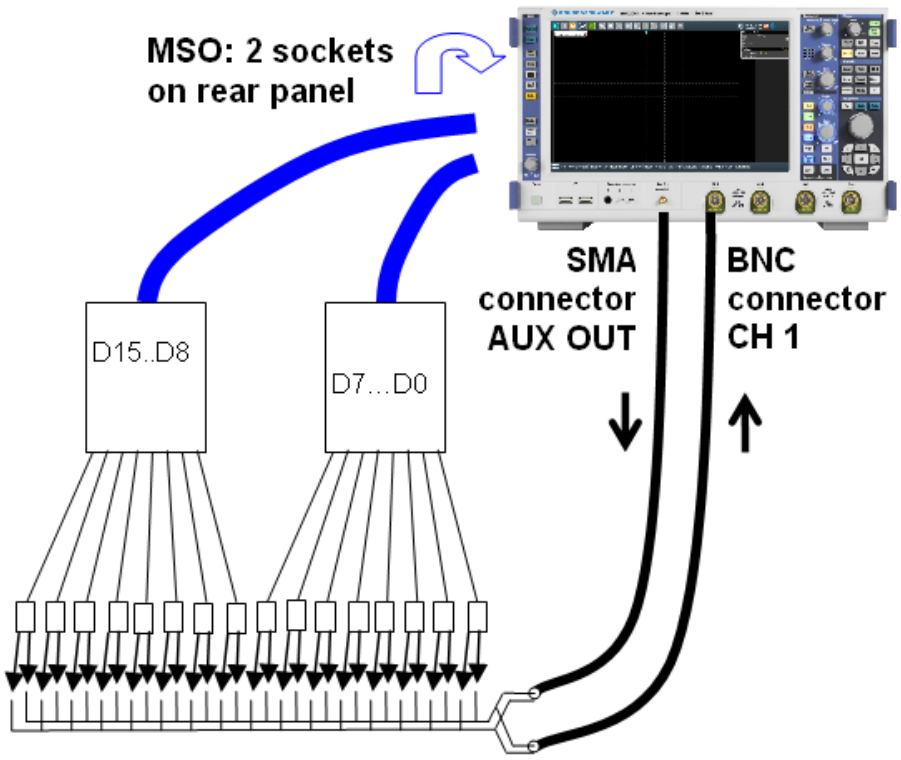
2. Disconnect TWINAX flat cables from the logic probe boxes.
3. Remove 7 screws (580).
4. Remove additional screws from auxiliary output (570) only valid for option.
5. Remove Trigger Out nut with washer (variant 03 only).
6. Remove MSO option by pulling the option to the rear.
7. Remove R&S RTO-MSO pin allocation label (43).
8. Remove the two screws that were hidden by the label (35).
9. Remove the rear option cover (30) or (40).

4.4.14.2 Installing New MSO Option

1. Mount the rear option cover (30) or (40) to the MSO option PCB (20) by the two screws (35).
2. Fix the R&S RTO MSO pin allocation label (43) which is part of the spare part set.
3. Fix the "Trigger Out" label (46) to the option cover (40) (variant 03 only).
4. Mount screws from auxiliary output (570) (Var.02 only).
5. Mount the Trigger Out nut with the washer (variant 03 only).
6. Slide in the MSO option to the R&S RTO and fasten all screws (580).

4.4.14.3 Putting into Operation

To check the functionality of the MSO R&S RTO-B1 option, the logic probes have to be connected via the service adapter to the instrument.



Starting the DC threshold selftest

1. Perform an instrument [Preset].
2. Enter service password: "File" menu > "Board detection/Maintenance > Service".
3. Select "MSO" tab.
4. Start the threshold DC test by pressing "Prepare" after the test setup is connected.
5. Start the test procedure with the "Selftest" button, which is visible now.

Reading the selftest results

Press the "Show Result Log" button to view the calibration results

The MSO calibration results are stored under `SelftestResult_MSOThreshold.log` at path `C:\Documents and Settings\All Users\Application Data\Rohde-Schwarz\RTO\Log`.

Starting DCR selftest

The DCR selftest procedure tests the data transfer and data quality of the MSO option fitted to the RTO.

1. Enter service password: "File" menu > "Board detection/Maintenance > Service".
2. Select "MSO" tab.

3. Start the DCR selftest by pressing "Prepare"
4. Start the test procedure with the "Selftest" button which is visible now.

Reading the selftest results

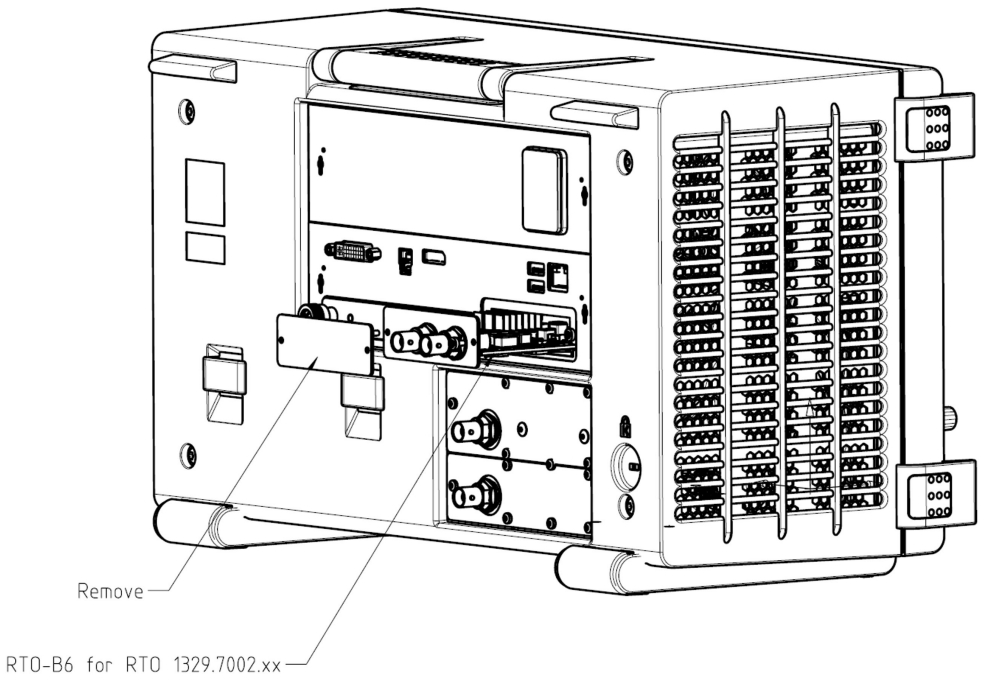
Press the "Show Result Log" button to view the selftest results

4.4.14.4 Service Adapter

To test or calibrate the MSO RTO-B1 option, a service adapter is required to adapt the logic probes to the required test signal.

The MSO Calibration Service adapter can be ordered via the R&S spare part department, PN: 5007.5380.02

4.4.15 R&S RTO-B6 Waveform Generator



4.4.15.1 Removing the R&S RTO-B6 Waveform Generator

1. Switch off the instrument at the mains and disconnect the power plug.
2. Remove the rear panel by removing 2 screws.
3. Remove the R&S RTO-B6 by pulling the option to the rear.

4.4.15.2 Installing the R&S RTO-B6

1. Slide the option R&S RTO-B6 into the main frame.
2. Fix it with 2 screws to a torque of 0.66 Nm.

4.5 Troubleshooting

Malfunctions may have simple causes but also may be caused by faulty components.

These troubleshooting instructions enable you to locate error causes down to board level and make the instrument ready for use again by means of board replacement.

We recommend that you ship the instrument to our experts in one of the service centers (see address list) for module replacement and further error elimination.

WARNING

Risk of electric shock

With the casing open, you can touch current-carrying components and suffer an electric shock. Before opening the casing, make sure that the instrument is switched off and disconnected from all power supplies. Read all safety instructions at the beginning of this manual carefully!

NOTICE

Risk of damage to the boards

Be careful not to cause short circuits when measuring voltages at pins placed close together!

Frequent cause of problems: connections

When problems occur, first check whether any cables, plug-in connections of boards, etc are damaged and whether they are connected properly.

4.5.1 Utilities Provided in the R&S RTO for Diagnostic Purposes

- Permanent monitoring of temperature
- Continuous test
- Selftest
- Internal alignment
- Service reporter

4.5.1.1 Permanent Monitoring of Temperature

The R&S RTO is equipped with a number of temperature sensors at every key position. If one of the temperature sensors detects a temperature alert, the instrument outputs a warning on the instrument screen.

If the warning is ignored and the temperature still rises, the instrument automatically shuts down.

To reset the instrument, switch it off using the main switch on the rear side of the instrument and then on again.

4.5.1.2 Continuous Test

In addition to the temperature monitoring, some additional parameters are monitored. If an event is recorded it is indicated in the event list on the right-hand top corner of the display.

4.5.1.3 Self Test

The selftest checks the functionality of the RTO. To test the frontend, a calibration signal is switched into the RF path directly after the input connector and is analyzed. The functionality of the mainboard is tested with a test pattern.

To start the self test:

- On the "File" menu, tap "Selftest".
- Tap the "Selftest" button.

4.5.1.4 Internal Alignment

The internal alignment is divided into a horizontal alignment for channel alignment, and the vertical alignment where offset and gain of all channels are aligned.

To start the alignment:

- On the "File" menu, select "Selfalignment".
- Tap "Start Alignment".

The results of the alignment can be viewed in the "Results" tab. If the alignment fails, the parameter "out of tolerance" is displayed there. In addition, the "UNCAL" flag appears on the display.

4.5.2 Maintenance Information

"File" menu > "Maintenance"

The "Maintenance" dialog box provides information on your R&S RTO configuration, which can be helpful in case you need support.

System Info
This tab provides general information on the hardware configuration, and indicates where system information can be found on the instrument. Here you can also show the content of the device footprint file.

Mainboard
This tab provides information on the mainboard configuration in your instrument.

Frontend
This tab provides information on the frontend configuration in your instrument.

Frontpanel
This tab provides information on the front panel module installed in your instrument.

MSO
This tab is only relevant if the MSO option R&S RTO-B1 is installed. The tab provides information on the MSO hardware module that is installed in your instrument.

AWG
This tab is only relevant if the waveform generator option R&S RTO-B6 is installed. The tab provides information on the generator hardware module that is installed in your instrument.

PSC
This tab is only relevant if the pulse source option R&S RTO-B7 is installed. The tab provides information on the pulse source hardware module that is installed in your instrument.

Service
In this tab, you enter the service password. If the correct password is entered, an additional menu entry "Service" on the "File" menu is activated.

Additional service functions include adjusting the VCXO or OCXO, and the MSO option if installed.

5 Software Update / Installing Options

This chapter contains information on updating software, restoring the operating-system installation and installing options to the R&S RTO. Additional manuals obtained together with a software/firmware update or with subsequently acquired options can be filed here.

5.1 Updating the Firmware

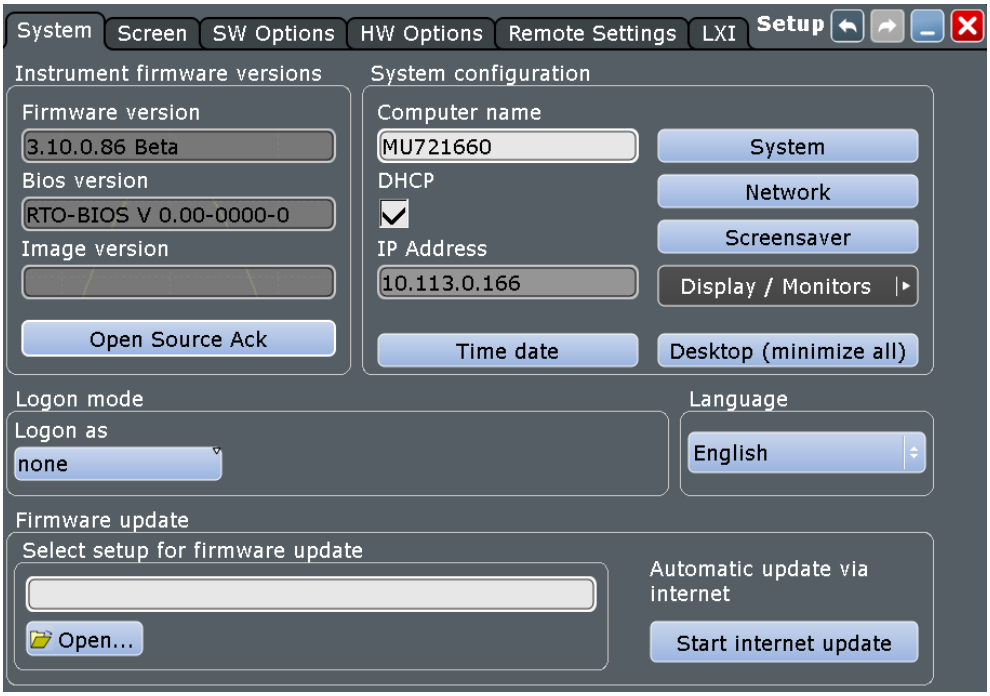
To enable new features and to improve the instrument, update the firmware regularly. Ask your sales representative or check the www.rohde-schwarz.com/product/rto.html R&S RTO website for availability of firmware updates. The "Firmware" page provides the firmware installation file and the Release Notes.

If the instrument has an internet connection, you can also update the firmware directly from the Internet.

Before updating the firmware on your instrument, read the Release Notes. The document informs about new and modified functions, known problems, and provides a detailed installation procedure that covers also specific installation scenarios.

1. Download the setup file `Setup_Rtx_Vxxxx_x64.exe` from the www.rohde-schwarz.com/product/rto.html website and store it on a USB flash device, on a server network drive that the instrument can access, or directly on the instrument using Remote Desktop and a LAN connection.
2. Switch on the instrument and wait until the firmware is running.
3. **NOTICE!** Stop acquisition. The firmware update must not be performed during running acquisition.

   If an acquisition is running, stop it by pressing [Run Stop] or [Single].
4. Insert the flash drive, or connect the instrument to the LAN.
5. Press the [SETUP] key, or tap "Setup" on the "File" menu.
6. Select the "System" tab.



7. Tap "Open" under "Firmware update" on the bottom of the dialog box.
8. Change the path to the drive and directory which you prepared (USB flash device, remote PC directory or directory on a server), select the `Setup*.exe` file, and tap "Select".
9. Tap "Next" in the installation dialog box.
10. Tap "Install" to start the update.
11. After the firmware update, the R&S RTO reboots automatically.
12. Depending on the previous firmware version, a reconfiguration of the hardware might be required during the first start of the firmware. The reconfiguration starts automatically, and a message box informs you about the process. Once the reconfiguration has finished, the instrument automatically reboots again.

    Note: Do not switch off the instrument during the reconfiguration process!
13. The firmware update is complete. It is recommended that you perform a self-alignment after the update ("File > Selfalignment"). The self-alignment procedure is described in the "Getting Started" manual, chapter "Setting Up the Instrument". It may take several minutes.

5.2 Hardware Options

A list of all available hardware and software options is provided on our product Internet site at www.rohde-schwarz.com.

For retrofitting, note the mounting instructions enclosed with the options.

WARNING

Risk of electric shock

With the casing open, you can touch current-carrying components and suffer an electric shock. Before opening the casing, make sure that the instrument is switched off and disconnected from all power supplies. Read all safety instructions at the beginning of this manual carefully!

NOTICE

Instrument damage caused by electrostatic discharge

Electrostatic discharge (ESD) can damage the electronic components of the instrument and the device under test (DUT). Electrostatic discharge is most likely to occur when you connect or disconnect a DUT or test fixture to the instrument's test ports. To prevent electrostatic discharge, use a wrist strap and cord and connect yourself to the ground, or use a conductive floor mat and heel strap combination.

When installing hardware options, note the following:

1. Switch off the instrument and disconnect the power supply cables.
2. Unscrew that part of the rear-panel where the option has to be inserted.
3. Plug in the option and fix it using the screws you previously removed.
4. Switch on the R&S RTO.
5. Install additional software, if supplied, according to the instructions enclosed with the option.
6. If an adjustment is required for this option, the appropriate notes can be found in the installation instructions for the option.

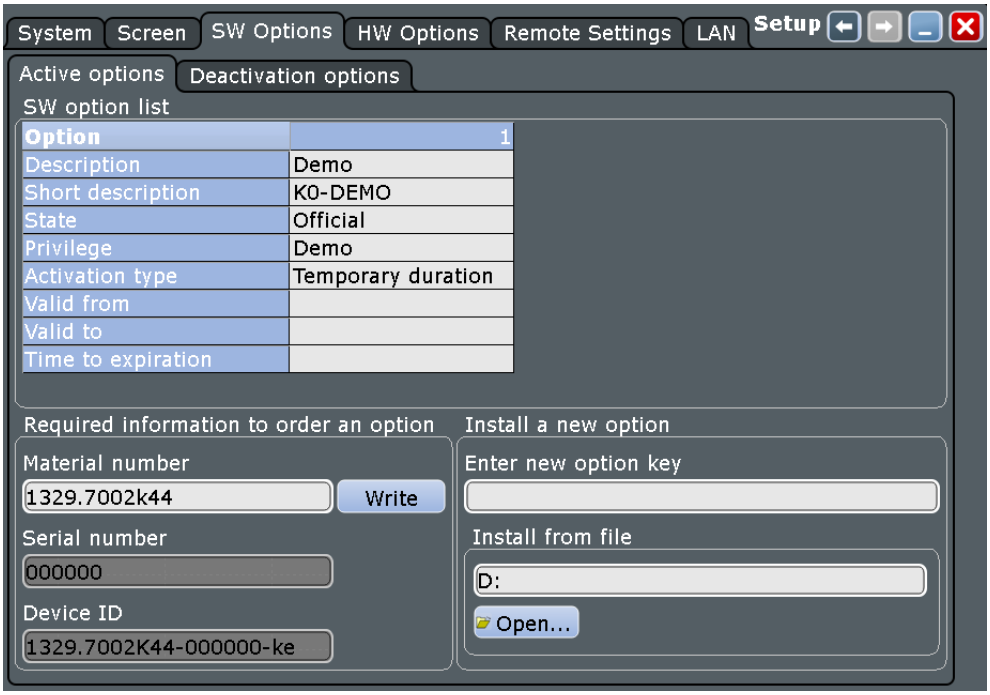
5.3 Activating Options

Options are activated by license keys. No additional installation is required. Consult your sales representative and provide the material number and serial number (or the device ID) of your instrument to get a license key. The license key is provided in written form or in a file. Unregistered licenses must be registered in the R&S License Manager before they can be activated on the instrument.

If the option has a portable license, keep the license file or option key at a save place. You need the license to move it to another instrument.

Only users with administrator rights can activate options.

1. Press the [SETUP] key and select the "SW options" tab.



2. If you received a key in written form, enter the key in the "Enter new option key" field.
   If you received a key in digital form as a file, tap "Open", navigate to the directory that contains the file, and select the option key file.
3. If you want to activate several options, repeat step 3 for each option.
4. Restart the instrument or the firmware.

The information provided in the "Option list" is for administration and troubleshooting purposes only. If you require support for the option, provide this information to the service representative.

6 Documents

This chapter provides information on the ordering of spare parts and contains the spare part list and the documents for the complete R&S RTO unit.

6.1 Spare Parts

The stock numbers necessary for ordering replacement parts and modules can be found in the spare part list further down.

NOTICE

Risk of damaging a module

When shipping a module, observe the instructions provided in the section titled "Procedure in Case of Service and Ordering of Spare Parts" at the beginning of this document.

Pos.-Nr. *ItemNo*	Menge *Quantity*	ME *Unit*	El.Kennz *Ref.Des.*	Benennung / Bezeichnung *Designation*	Z	Sachnummer *Stock No.*	Ersatzteil *Subst.part*	BA	VH
				ACHTUNG EGB/ATTENTION ESD *VARIANTENERKLAERUNG +EXPLANATION OF VARIANTS *VAR02=RTO 2002 +VAR02=RTO 2002 *VAR04=RTO 2004 +VAR04=RTO 2004 *VAR12=RTO 2012 +VAR12=RTO 2012 *VAR14=RTO 2014 +VAR14=RTO 2014 *VAR22=RTO 2022 +VAR22=RTO 2022 *VAR24=RTO 2024 +VAR24=RTO 2024 *VAR32=RTO 2032 +VAR32=RTO 2032 *VAR34=RTO 2034 +VAR34=RTO 2034 *VAR42=RTO 2042 +VAR42=RTO 2042 *VAR44=RTO 2044 +VAR44=RTO 2044 *VAR64=RTO 2064 +VAR64=RTO 2064					
1	0	S		PH BEMERKUNG NOTE Spare Part List for RTO2xxx 1329.7002.01		0999.9610.00		B	O
5	1	S		MM BW2010 SCHLUESSEL BW2010 KEY not used in the device tool to replace power supply unit and cpu unit 2 pieces necessary to remove Modules		1174.0301.00		B	O
10	1	S		MM WFA DECKEL FUER STUETZE WFA COVER FOR PILLAR ## Verwendet in: / Used in: ## 1329.7002.01		1304.7609.00		B	O
20	1	S		MM WFA FUSS KOMPL. WFA BASEBOARD COMPL. ## Verwendet in: / Used in: ## 1329.7002.01		1304.7615.00		B	O
30	1	S		MM GEHAUSE WFA CASE WFA ## Verwendet in: / Used in: ## 1329.7002.01		1304.6690.00		B	O
40	1	S		MM GRIFF WFA HANDLE WFA ## Verwendet in: / Used in: ## 1329.7002.01		1304.6760.00		B	O
50	1	S	E20	EV 60X60X25 12.8L/S 12V PWM L180 FAN 60X60X25 12.8L/S 12V PWM L180 ## Verwendet in: / Used in: ## 1329.7002.01		1304.7015.00		B	O
60	1	S	E10	EV 119X119X38 67L/S 12V PWM L100 FAN 119X119X38 67L/S 12V PWM L100 ## Verwendet in: / Used in: ## 1329.7002.01		1304.7021.00		B	O
70	0	S		OS KLEBESCHILD RW LABEL RW replaced by 1333.0321.00		1304.8863.00		M	P
71	1	S		OS RUECKWANDSCHILD LABEL REAR PANEL		1333.0321.00		M	

Pos.-Nr. *ItemNo*	Menge *Quantity*	ME *Unit*	El.Kennz *Ref.Des.*	Benennung / Bezeichnung *Designation*	Z	Sachnummer *Stock No.*	Ersatzteil *Subst.part*	BA	VH
80	1	S		KB RW BLECH FE BEDR. RW SHEET FE PRINTED ## Verwendet in: / Used in: ## 1329.7002.01		1304.9701.00		M	P
90	1	S		EV LUEFTERMANS. 60X60X3 T=0.7-1.25 F FAN COLLAR 60-30-10-F (T0.7) ## Verwendet in: / Used in: ## 1329.7002.01		1304.9930.00		B	O
100	1	S		VS SCHRAUBE M4 X 16 ISR PA SCREW M4 X 16 ISR PA ## Verwendet in: / Used in: ## 1329.7002.01		3586.3307.00		B	O
110	1	S		VS SCHRAUBE M4 X 10 ISR PA SCREW M4 X 10 ISR PA ## Verwendet in: / Used in: ## 1329.7002.01		3586.3313.00		B	O
120	1	S		VS SCHRAUBE M4 X 6 ISR PA SCREW M4 X 6 ISR PA ## Verwendet in: / Used in: ## 1329.7002.01		3586.3320.00		B	O
130	1	S		EV LUEFTERMANS. 119X119 SEITLICH FAN COLLAR 119 ## Verwendet in: / Used in: ## 1329.7002.01		1305.0350.00		B	O
140	1	S		MZ HF-ABSORBERMATTE RF-ABSORBER MAT ## Verwendet in: / Used in: ## 1329.7002.01		1305.0895.00		M	P
150	1	S		ZM RW BLECH MB MIT LUFTFÜHRUNG RW SHEET MB WITH AIRGUIDE ## Verwendet in: / Used in: ## 1329.7002.01	Z	1317.3607.00		M	P
160	1	S		ZN VERSTEIFUNG RÜCKWAND REINFORCEMENT RW ## Verwendet in: / Used in: ## 1329.7002.01	Z	1317.4649.00		M	P
170	1	S		ED RTO FRONTEND RTO FRONTEND VAR 02 12 22 32 für Seriennummer < 300000 for device serialnumber < 300000	Z	1317.4903.20		M	O
171	1	S	A100	ED RTO FRONTEND RTO FRONTEND VAR 02 12 22 32 ab Seriennummer >=3xxxxx for device serialnumber >= 300000	Z	1326.2680.42		M	
180	1	S		ED RTO FRONTEND RTO FRONTEND VAR 04 14 24 34 44 für Seriennummer < 3xxxxx for device serialnumber < 300000	Z	1317.4903.40		M	P
181	1	S	A100	ED RTO FRONTEND RTO FRONTEND VAR 04 14 24 34 44 ab Seriennummer >=3xxxxx for device serialnumber >= 300000	Z	1326.2680.44		M	
185	1	S	A100	ED RTO FRONTEND RTO FRONTEND VAR 64	Z	1326.2680.64		M	
190	1	S		ZM GRUNDRAHMEN LASERGESCHWEIßT	Z	1317.5068.00		M	B

Pos.-Nr. *ItemNo*	Menge *Quantity*	ME *Unit*	El.Kennz *Ref.Des.*	Benennung / Bezeichnung *Designation*	Z	Sachnummer *Stock No.*	Ersatzteil *Subst.part*	BA	VH
				MAIN FRAME ## Verwendet in: / Used in: ## 1329.7002.01					
200	1	S		DQ HSEC8 BOARD 2 HSEC8 BOARD 2 VAR 02 04 12 14 22 24 32 34 44 64 ## Verwendet in: / Used in: ## 1329.7002.01		1317.5722.00		M	P
210	1	S		KN LÜFTER HAUBE FAN COVER ## Verwendet in: / Used in: ## 1329.7002.01	Z	1326.0020.00		M	P
220	1	S	A300	ED CONNECTING BOARD RTO2000 CONNECTING BOARD RTO2000 ## Verwendet in: / Used in: ## 1329.7002.01	Z	1329.6106.02		M	
230	1	S	A200	ED MAINBOARD FL RTO MAINBOARD FL RTO VAR 04 14 24 34 44 64 ## Verwendet in: / Used in: ## 1329.7002.01	Z	1329.6206.40		M	
240	1	S	A200	ED MAINBOARD FL RTO MAINBOARD FL RTO VAR 02 12 22 32 ## Verwendet in: / Used in: ## 1329.7002.01	Z	1329.6206.20		M	
250	1	S		ZN MONTAGEWANNE RTO2000 MOUNTING THROUGH ## Verwendet in: / Used in: ## 1329.7002.01	Z	1329.6229.00		M	
260	1	S	W10	DF FLEX-STRIP 30P R=0.5 L=400 FLEX-STRIP 30P. R=0.5 L=400 ## Verwendet in: / Used in: ## 1329.6258.01		2112.6790.00		B	T
270	1	S		MM WFA STUETZE WFA PILLAR ## Verwendet in: / Used in: ## 1329.6258.01		1304.7596.00		B	O
280	1	S		VS SCHRAUBE F.KUST 2.5 X 8 DELTA PT SCREW 2.5 X 8 WN5451 ## Verwendet in: / Used in: ## 1329.6258.01		5705.4231.00		B	O
290	1	S		MZ LAUTSPRECHER RAHMEN SPEAKER FRAME ## Verwendet in: / Used in: ## 1329.6258.01		1317.7054.00		M	P
300	1	M		WT KANTENSCHUTZ 0.9-1.6 MM GROMMET EDGING 0.9-1.6 MM ## Verwendet in: / Used in: ## 1329.6258.01		5800.2919.00		B	O
310	1	S	A500	ED FRONTPANEL RTO FRONTPANEL RTO ## Verwendet in: / Used in: ## 1329.6258.01	Z	1329.6164.02		M	
320	1	S	A510	ND DISPLAYEINHEIT RTO2XXX DISPLAY UNIT RTO2XXX ## Verwendet in: / Used in: ## 1329.6258.01	Z	1329.6664.00		B	O
330	1	S		MZ FEDER FRONTPANEL RTO SPRING FRONTPANEL RTO ## Verwendet in: / Used in:		1329.6706.00		M	

Pos.-Nr. *ItemNo*	Menge *Quantity*	ME *Unit*	El.Kennz *Ref.Des.*	Benennung / Bezeichnung *Designation*	Z	Sachnummer *Stock No.*	Ersatzteil *Subst.part*	BA	VH
				## 1329.6258.01					
340	1	S		SF SCHALTMATTENSATZ RTO2000 2 KANAL RUBBER KEYPAD SET RTO2000 2CH ## Verwendet in: / Used in: ## 1329.6258.01		1329.6393.00		B	O
350	1	S		MM KNOPF 16 KNOB 16 ## Verwendet in: / Used in: ## 1329.6258.01		1329.6787.00		B	O
360	1	S		MM KNOPF 12 KNOB 12 ## Verwendet in: / Used in: ## 1329.6258.01		1329.6793.00		B	O
370	1	S		MM KNOPF 25 KNOB 25 ## Verwendet in: / Used in: ## 1329.6258.01		1329.6770.00		B	O
380	1	S	W20	DG DISPLAY KABEL 30 P GESCHIRMT DISPLAY CABLE 30 POLE SHIELDED ## Verwendet in: / Used in: ## 1329.6258.01		1329.6970.00		B	O
390	1	S	W40	DX USB KABEL EASY TOUCH USB KABEL EASY TOUCH ## Verwendet in: / Used in: ## 1329.6258.01	Z	1329.6964.00		M	
400	1	S		SF SCHALTMATTENSATZ RTO2000 4 KANAL RUBBER KEYPAD SET RTO2000 4CH ## Verwendet in: / Used in: ## 1329.6258.01		1329.6387.00		B	O
410	1	S	A700	NR LPW11 ALL-IN-ONE CPU BOARD LPW11 ALL-IN-ONE CPU BOARD ## Verwendet in: / Used in: ## 1329.6293.00	Z	1320.7000.00		B	O
420	1	S		ZM LPW11 HALTERUNG GESCHWEISST LPW11 FRAME WELDED ## Verwendet in: / Used in: ## 1329.6293.00	Z	1329.6287.00		M	
430	1	S		MP HARDDISKHALTER 2.5 ZOLL H=7MM HOLDER 2.5INCH H=7MM ## Verwendet in: / Used in: ## 1329.6729.01		3590.8897.00		B	O
440	1	S		ZM HARDDISKHALTERUNG HARDDISK BRACKET ## Verwendet in: / Used in: ## 1329.6729.01	Z	1329.6641.00		M	
450	1	S		HS SSD MIT SOFTWARE RTO2000 WIN7P SSD WITH SOFTWARE RTO2000 WIN7P ## Verwendet in: / Used in: ## 1329.6729.01	Z	1317.6870.07		M	
460	1	S		OS TYPENSCHILD RTO 2004 LABEL RTO 2004 VAR 04 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6535.00		B	O
470	1	S		OS TYPENSCHILD RTO 2002 LABEL RTO 2002 VAR 02 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6529.00		B	O

Pos.-Nr. *ItemNo*	Menge *Quantity*	ME *Unit*	El.Kennz *Ref.Des.*	Benennung / Bezeichnung *Designation*	Z	Sachnummer *Stock No.*	Ersatzteil *Subst.part*	BA	VH
480	1	S		OS TYPENSCHILD RTO 2012 LABEL RTO 2012 VAR 12 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6541.00		B	O
490	1	S		OS TYPENSCHILD RTO 2024 LABEL RTO 2024 VAR 24 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6570.00		B	O
500	1	S		OS TYPENSCHILD RTO 2034 LABEL RTO 2034 VAR 34 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6593.00		B	O
520	1	S		OS TYPENSCHILD RTO 2014 LABEL RTO 2014 VAR 14 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6558.00		B	O
530	1	S		OS TYPENSCHILD RTO 2032 LABEL RTO 2032 VAR 32 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6587.00		B	O
540	1	S		OS TYPENSCHILD RTO 2022 LABEL RTO 2022 VAR 22 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6564.00		B	O
550	1	S		OS TYPENSCHILD RTO 2044 LABEL RTO 2044 VAR 44 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6612.00		B	O
560	1	S		ZN WINKEL RTO-FL BRACKET ## Verwendet in: / Used in: ## 1329.7002.01	Z	1329.6735.00		M	
570	1	S	A600	NJ PSW450 PSU 1X 450W 12.2V 37.5A AC/DC POWER SUPPLY UNIT	Z	1316.0879.00		B	A
580	1	S	W4	DY DATENKABEL W4 DATA CABLE W4 ## Verwendet in: / Used in: ## 1329.7002.01	Z	1329.6835.00		M	
590	1	S		MZ LUFTFUEHRUNG RTO MB AIR GUIDE RTO MB ## Verwendet in: / Used in: ## 1329.7002.01		1329.6870.00		M	
600	1	S		OB ZUBEHÖR TASCHE FUER RTO ACCESSORY CASE FOR RTO ## Verwendet in: / Used in: ## 1332.9702.01		1304.7121.00		B	O
610	1	S		NV 500MHZ TASTK. PASSIV 10X (RT-ZP10) 500MHZ PROBE PASSIVE 10X (RT-ZP10) ## Verwendet in: / Used in: ## 1332.9702.01	Z	1409.7520.00		B	T
620	1	S		MZ DUMMY BLECH ARB OPTION DUMMY REAR PANEL ARB OPTION ## Verwendet in: / Used in: ## 1329.7002.01		1329.6670.00		M	

Pos.-Nr. *ItemNo*	Menge *Quantity*	ME *Unit*	El.Kennz *Ref.Des.*	Benennung / Bezeichnung *Designation*	Z	Sachnummer *Stock No.*	Ersatzteil *Subst.part*	BA	VH
630	1	S		ZM CHIPCARD SERVICE KIT CHIPCARD SERVICE KIT	Z	1201.5610.03		M	B
640	1	S		EB CR2032 BATT(P) LI-MNO2 3.0/0.23 BATTERIES NON-RECHARGEABLE (PRIMARY)		0858.2049.00		B	O
650	1	S		KB FRONTHAUBE 2CH BEKLEBT FRONT PANEL 2CH LAMINATED VAR 02 12 22 32	Z	1332.9854.00		M	
660	1	S		KB FRONTHAUBE 4CH BEKLEBT FRONT PANEL 4CH LAMINATED VAR 04 14 24 34 44	Z	1332.9860.00		M	
710	1	S		OS TYPENSCHILD RTO 2064 LABEL RTO 2064 VAR 64 ## Verwendet in: / Used in: ## 1329.7002.01		1329.6635.00		B	O

Pos.-Nr. *ItemNo*	Menge *Quantity*	ME *Unit*	El.Kennz *Ref.Des.*	Benennung / Bezeichnung *Designation*	Z	Sachnummer *Stock No.*	Ersatzteil *Subst.part*	BA	VH
				ACHTUNG EGB/ATTENTION ESD *VARIANTENERKLAERUNG +EXPLANATION OF VARIANTS *VAR02=ERSATZTEILSTÜCKLISTE RTO-B7 PULSE S +VAR02=SPARE PARTS RTO-B7 PULSE SOURCE					
10	0	S		PH BEMERKUNG NOTE Ersatzeilstückliste für RTO-B7 Pulsquelle Spare Part List for RTO-B7 Pulse Source 1333.2030.01		0999.9610.00		B	O
20	1	S		ED PULSE SOURCE RTO PULSE SOURCE RTO	Z	1326.3970.02		M	
30	0	S		FJ SMA KURZSCHLUSSKAPPE SMA SHORTING CAP JACK		3629.7237.00		B	O
40	0	S		FJ ABSCHLUSSW. 50OHM SMA 1W TERMINATION 50OHMS		5201.1262.00		B	O
50	0	S		FJ ADAPTER BU/BU SMA ADAPTER, SMA JACK TO SMA JACK		3630.0578.00		B	O
60	0	S		DH HIGH FLEXIBLE SMA CABLE 1.05M 18GHZ HIGH FLEXIBLE SMA CABLE 1.05M 18GHZ		1337.9081.00		B	O
70	0	S		FJ ADAPTER SMA-BNC BU-ST ADAPTOR SMA JACK BNC PLUG		1316.0762.00		B	O