R&S®RTB
Digital Oscilloscope
Service Manual

1333163402

Service Manual

Version 02

ROHDE&SCHWARZ

This manual describes the following R&S®RTB models:

- R&S®RTB2002 (1333.1005K02)
- R&S®RTB2004 (1333.1005K04)

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1333.1634.02 | Version 02 | R&S®RTB

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol, e.g. R&S®RTB is abbreviated as R&S RTB.

Contents

1 Documentation Overview

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

1.1 Manuals and Instrument Help

You find the manuals on the product page at:

www.rohde-schwarz.com/manual/rtb2000

Getting started manual

Introduces the R&S RTB and describes how to set up the product. A printed English version is included in the delivery.

User manual

Contains the description of all instrument modes and functions. 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.

Instrument help

The help offers quick, context-sensitive access to the functional description directly on the instrument.

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 RTB in secure areas.

Service manual

Describes the performance test for checking the rated specifications, module replacement and repair, 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 RTB. 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/rtb2000

1.3 Calibration Certificate

The document is available on https://gloris.rohde-schwarz.com/calcert. You need the device ID of your instrument, which you can find on a label on the rear panel.

1.4 Release Notes and 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.

See www.rohde-schwarz.com/firmware/rtb2000. The open source acknowledgment documant can also be read directly on the instrument.

2 Performance Tests

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.

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 20 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.

2.1 Test Equipment

Table 2-1: Test equipment

Item	Type of equipment	Recommended characteristics or features	Recommended model	R&S Order No.	Application
1.	DC calibrator	Output voltages: • DC up to ±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 System SourceMeter Model 2601A		DC gain accuracy Offset accuracy
2.	Digital multimeter		Agilent 34401A		DC gain accuracy
3.	Signal generator	RF output: • Frequency range 10 MHz to 1 GHz • Power level up to +16 dBm	R&S SMB100A with option SMB-B101 or higher	1406.6000.02 1407.2509.02	Analog bandwidth Crosstalk Internal trigger External trigger
4.	Power sensor	1 MHz to 1 GHz < 0.15 dB	R&S NRP-Z91	1168.8004.02	Analog bandwidth Crosstalk Internal trigger External trigger
5a.	Power meter		R&S NRP		Analog bandwidth Crosstalk Internal trigger External trigger

Item	Type of equipment	Recommended characteristics or features	Recommended model	R&S Order No.	Application
5b.	USB adapter for NRP sensors	Alternative	R&S NRP-Z4	1146.8001.02	Analog bandwidth Crosstalk Internal trigger External trigger
6.	Power splitter	DC to 1 GHz	Agilent 11667A		Analog bandwidth
7.	Frequency counter	1 GHz < $2*10^{-9}$	Advantest R5361B		Reference frequency accuracy
8.	BNC Feed-through termination	Impedance 50 Ω			Analog bandwidth Crosstalk Internal trigger External trigger
9.	Adapter N (m) to BNC (f)				Analog bandwidth Crosstalk Internal trigger External trigger
10.	N cable				Analog bandwidth Crosstalk Internal trigger External trigger
11.	BNC cable				DC gain accuracy Reference frequency accuracy
12.	Adapter BNC (m) to dual banana (f)				DC gain accuracy
13.	Banana cable				DC gain accuracy
14.	BNC TEE adapter				DC gain accuracy

2.2 Oscilloscope Tests on R&S RTB

2.2.1 DC Gain Accuracy

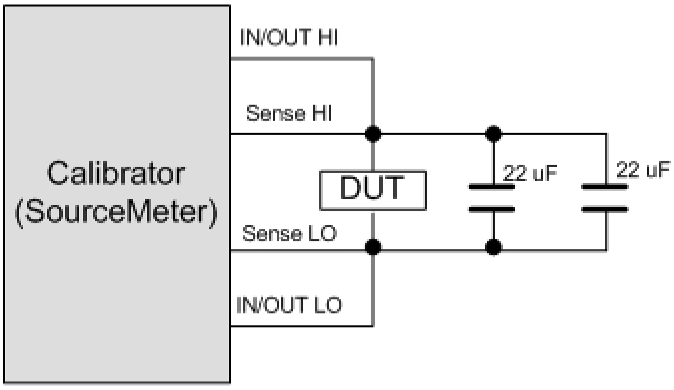
Test equipment:

- DC calibrator (see Table 2-1, Test equipment, item 1)
- Digital multimeter N (m) to BNC (f) (see Table 2-1, Test equipment, item 2)
- BNC cable (see Table 2-1, Test equipment, item 11)
- BNC TEE adapter (see Table 2-1, Test equipment, item 14)

Test setup:

Switch the output voltage of DC calibrator OFF.

Connect the DC calibrator output to CH1 input of the R&S RTB.



Note: Consider the voltage drop on the test cables.

For best results, use 4-wire connection. Connect the sense lines as close as possible to the RTB input.

If the DC calibrator does not support sensing, use a digital multimeter to control the voltage at the RTB input.

To reduce the noise of DC calibrator, add a capacity directly at the input of RTB. Recommended: 2 * 22 µF (parallel), min. voltage 40 V.

If Keithley SourceMeter 2601A is used as DC calibrator, use the following setting: [CONFIG → SRC → HIGHC-MODE → SRC-ENABLE].

Important note: Due to the voltage measurement accuracy of the Keithley SourceMeter 2601A, for DC voltages below 180 mV the digital multimeter must be used to control the calibrator voltage at the RTB input.

R&S RTB settings: [PRESET]

[CH1 : Termination 1 MΩ : Bandwidth 20 MHz : Offset see table below : Y-Scale see table below]

[VERTICAL OFFSET 0.0 V] (After a preset, the offset of channel 2, 3 and 4 are not set to 0.0 V)

[HORIZONTAL SCALE 1 ms/div]

[VERTICAL OFFSET 0.0 V] (After a preset, the offset of channel 2, 3 and 4 are not set to 0.0 V!)

[MEAS: `DVM<n>:TYPE DC`]

Measurement: Set the calibration voltage to the positive value (see table below)

Measure the calibration voltage at the RTB input ($V_{calibrator\_pos}$)

Read the mean value from the RTB ($V_{DUT\_mean\_reading\_pos}$)

Set the calibration voltage to the negative value (see table below)

Measure the calibration voltage at the RTB input ($V_{calibrator\_neg}$)

Read the mean value from the RTB ($V_{DUT\_mean\_reading\_neg}$)

Y-Scale	Offset calibration voltage
5 V/div	±22.5 V
2 V/div	±9 V
1 V/div	±4.5 V
500m V/div	±2.25 V
200 mV/div	±900 mV
100 mV/div	±450 mV
50 mV/div	±225 mV

20 mV/div	±90 mV
10 mV/div	±45 mV
5 mV/div	±22.5 mV
2 mV/div	±9 mV

Evaluation: Calculate the DC gain accuracy for each measurement. Use the following equation:

$$DC_{gain\_accuracy} = \left(\frac{V_{DUT\_mean\_reading\_pos} - V_{DUT\_mean\_reading\_neg}}{V_{calibrator\_pos} - V_{calibrator\_neg}} \right) \times 100\ [\%]$$

Measurement: Repeat the measurement with all vertical scale settings simultaneously.

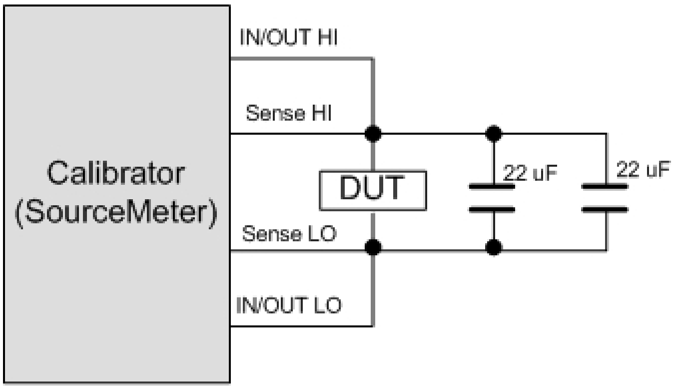
2.2.2 Offset Accuracy

Test equipment:

- DC calibrator (see Table 2-1, Test equipment, item 1)
- Digital multimeter N (m) to BNC (f) (see Table 2-1, Test equipment, item 2)
- BNC cable (see Table 2-1, Test equipment, item 11)
- BNC TEE adapter (see Table 2-1, Test equipment, item 14)

Test setup: Switch OFF the output voltage of DC calibrator.

Connect the DC calibrator output to CH1 input of the R&S RTB.



Note: For best results, use 4-wire connection. Connect the sense lines as close as possible to the RTB input.

If the DC calibrator does not support sensing, use a digital multimeter to control the voltage at the RTB input.

To reduce the noise of the DC calibrator, add a capacity direct at the input of RTB. Recommended: 2 * 22 µF (parallel), min. voltage 40 V.

If Keithley SourceMeter 2601A is used as DC calibrator use the following setting: [CONFIG → SRC → HIGHC-MODE → SRC-ENABLE].

Important note: Due to the voltage measurement accuracy of the Keithley SourceMeter 2601A, for DC voltages below 180 mV the digital multimeter must be used to control the calibrator voltage at the RTB input.

Test Offset accuracy with input resistance 1 MΩ

R&S RTB settings: [PRESET]
[CH1 : Termination 1 MΩ : Bandwidth 20 MHz : Offset see table below : Y-Scale see table below]
[VERTICAL OFFSET 0.0 V] (After a preset the offset of channel 2, 3 and 4 are not set to 0.0 V)
[HORIZONTAL SCALE 1 ms/div]
[MEAS: `DVM<n>:TYPE DC`]

Measurement: Set the calibration voltage (refer to below table)
Measure the calibration voltage at the RTB input ($V_{calibrator}$)
Read the mean value from RTB display ($V_{DUT\_mean\_reading}$)

R&S RTB			
Y-Scale	Offset and calibration voltage		
500 mV/div	-40 V	0 V	+40 V
5 mV/div	-1.2 V	0 V	+1.2 V

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

$$V_{offset\_\_deviation} = V_{calibrator} - V_{DUT\_\_mean\_\_reading}$$

Measurement: Repeat the measurement with all vertical scale settings simultaneously.

2.2.3 Reference Frequency Accuracy

Test equipment:
- Frequency counter (refer to Table 2-1, Test equipment, item 7)

Test setup: Connect the RF input of the frequency counter directly to the R&S RTB trigger output

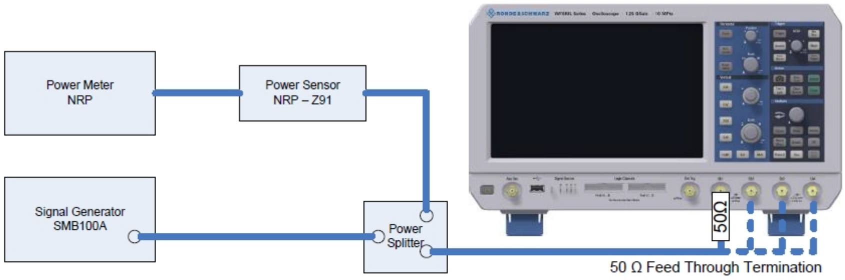
R&S RTB settings: [PRESET]
Set the reference frequency to the TRIGGER OUT: Menu: [SETUP : Aux Out: 10 MHz
`:TRIGger:OUT:MODE REFerence`

Measurement: Read frequency counter display.

2.2.4 Analog Bandwidth

Test equipment:
- Signal generator (refer to Table 2-1, Test equipment, item 3)
- Power meter (refer to Table 2-1, Test equipment, item 5a or 5b)
- Power sensor (refer to Table 2-1, Test equipment, item 4)
- Power splitter (refer to Table 2-1, Test equipment, item 6)
- 50 Ω Feed Through Terminator (refer to Table 2-1, Test equipment, item 8)
- N Cable (refer toTable 2-1, Test equipment, item 10)

Test setup: Connect the signal generator to the power splitter input.
Connect the power sensor to the power splitter output 1.
Connect the RTB to the power splitter output 2.



Note: Before using any BNC adapters, please check the rated specification, because not all BNC connecters are suitable for higher RF frequencies.

Test: **Analog bandwidth**

R&S RTB settings: [PRESET]

[CH1 : Termination extern 50 Ω : Coupling AC : Y-Scale see table below]

[HORIZONTAL SCALE 2µs/div]

[TRIGGER SOURCE : Channel x] (depending channel to be measured)

[VERTICAL OFFSET 0.0 V] (After a preset the offset of channel 2, 3 and 4 are not set to 0!)

[MEAS : Meas. Type “σ-Std. Dev. Wave (STDD)” : Measure 1 “On”] Single Channel Mode

Signal generator setting: [Frequency:]

Option	Reference frequency	Signal generator frequency
Basic Instrument 2CH/4CH	1.0 MHz	70 MHz
B221/B241	1.0 MHz	100 MHz
B222/B242	1.0 MHz	200 MHz
B223/B243	1.0 MHz	300 MHz

[Level:]

Y-scale	Generator level	Signal height
500 mV/DIV	10 dBm	2.0 Vpp
50 mV/DIV	-4 dBm	400 mVpp
5 mV/DIV	-24 dBm	40 mVpp
1 mV/DIV	-38 dBm	8 mVpp

Reference measurement: Read the standard deviation value from R&S RTB at input frequency of 10 MHz ($V_{DUT\_reference}$)

Read the power sensor level ($P_{sensor\_reference}$)

Bandwidth measurement: Read the standard deviation value from R&S RTB at input frequency (V_{DUT})

Read the power sensor level (P_{sensor})

Evaluation: Calculate the signal level gain (L_{DUT}) with the following equation

$$L_{DUT} = 20 \times \log \frac{V_{DUT}}{V_{DUT\_reference}} - \left(P_{sensor} - P_{sensor\_reference}\right) [dB]$$

Measurement: Repeat the measurement with all vertical scale settings.

Repeat the measurement with all frequency options.

Repeat all measurements with the remaining channels.

Test **Bandwidth limitation**

R&S RTB settings: [PRESET]

[CH1 : Termination extern 50 Ω : Bandwidth 20MHz : Y-Scale 5 mV/div]

[HORIZONTAL SCALE : 2 µs/div] (reference frequency)

[TRIGGER SOURCE : Channel 1]

[VERTICAL OFFSET 0 div] (After a preset the offset of channel 2, 3 and 4 are not set to 0 div!)

[Waveform Rate Max. OFF]

[MEAS : Meas. Type “σ-Std. Dev. Wave (STDD)” : Measure 1 “On”] Single Channel Mode

Signal generator [Reference frequency: 1 MHz]

[Frequency: 20 MHz]

[Level : 40 mVpp (-24 dBm) (Signal level at RTB input. Due to power splitter, level of signal generator must be 6 dB higher)]

Evalution

$$L_{DUT} = 20 \times \log \frac{V_{DUT}}{V_{DUT\_reference}} - \left(P_{sensor} - P_{sensor\_reference}\right) [dB]$$

Measurement: Repeat the measurement with all settings from table above.

Repeat all measurements with the remaining channels.

2.2.5 Channel to Channel Isolation

Test equipment:

- Signal generator (see Table 2-1, Test equipment, item 2)
- BNC cable (see Table 2-1, Test equipment, item 11)
- Adapter N (m) to BNC (m) (see Table 2-1, Test equipment, item 11)
- Feedthrough termination (see Table 2-1, Test equipment, item 7)

Test: Channel to channel isolation CH1 to CH2

Test setup: Connect the RF output of the signal generator via the 50 Ohm feedthrough termination to the RS RTB input channel 1.

Signal gen. settings:

Option	Signal generator frequency
Instrument	70 MHz
B221/B241	100 MHz
B222/B242	200 MHz

B223/B243	300 MHz

R&S RTB settings:
[PRESET]
[HORIZONTAL SCALE 5 µs/div]
[CH1 : ON : Y-Scale 200 mV/div]
[CH2 : ON : Y-Scale 200 mV/div]
[FFT : Wfm. Arithmetic “Average” : No. of Averages 4]
Basic Instrument:
[FFT : FFT Setup : Span 50 MHz : Center 70 MHz]
B221/B241:
[FFT : FFT Setup : Span 50 MHz : Center 100 MHz]
B222/B242:
[FFT : FFT Setup : Span 50 MHz : Center 200 MHz]
B223/B243 :
[FFT : FFT Setup : Span 50 MHz : Center 300 MHz]
[FFT : Y(t) Setup : Show Channels]
[CURSOR : Set cursor 1 with NAVIGATION knob to FFT center frequency]

Measurement:
[FFT-Source: CH2], [Cursor-Source FFT-Average]
Nx-Single Read curser level L1 ($L1_{CH2}$) [dBm]
[FFT-Source: CH1]
[Cursor-Source FFT-Average]
Nx-Single Read curser level L1 ($L1_{CH1}$)
$L1_{CH1}$ [dBm] (approximated 8 dBm – RTB attenuation of ≈ 2.5 dB)

Evaluation
Channel-to-channel isolation CH1 to CH2 ($a_{CH1-CH2}$)

$$a_{CH1-CH2} = L1_{CH1} - L1_{CH2}[dB]$$

Test
Channel-to-channel isolation CH4 to CH3 (only for RTB with 4 channels)

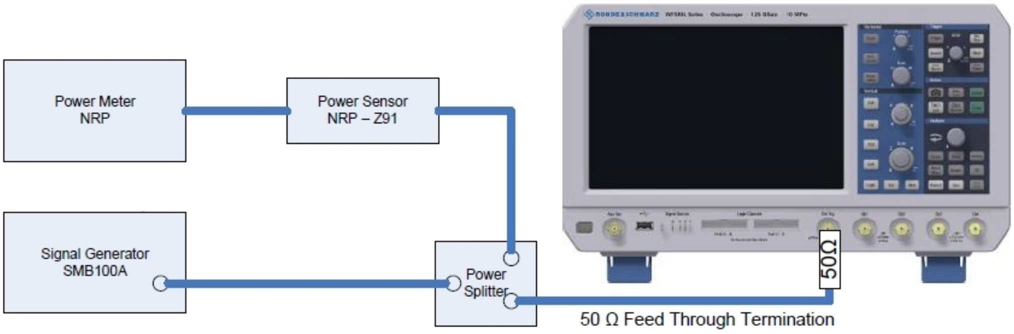
Test setup
Connect the RF output of the signal generator directly to the R&S RTB input channel 4. Repeat the measurement above with CH3 and CH4 instead CH1 and CH2.

2.2.6 External Trigger

Test equipment:

- Signal generator (refer to Table 2-1, Test equipment, item 3)
- Power meter (refer to Table 2-1, Test equipment, item 5a or 5b)
- Power sensor (refer to Table 2-1, Test equipment, item 4)
- Power splitter (refer to Table 2-1, Test equipment, item 6)
- N cable (see Table 2-1, Test equipment, item 12)
- 50 Ω Feed Through Terminator (refer to Table 2-1, Test equipment, item 8)

Test setup:
Connect the equipment as shown below.
Connect the signal generator to the power splitter input.
Connect the power splitter output 1 to power sensor.
Connect the power splitter output 2 via 50 Ω feed trough terminator to the external trigger input of the RTB.



Test equipment:

- Signal generator (refer to Table 2-1, Test equipment, item 3)
- Power meter (refer to Table 2-1, Test equipment, item 5a or 5b)
- Power sensor (refer to Table 2-1, Test equipment, item 4)
- Power splitter (refer to Table 2-1, Test equipment, item 6)
- N cable (see Table 2-1, Test equipment, item 12)
- 50 Ω Feed Through Terminator (refer to Table 2-1, Test equipment, item 8)

Test setup: Connect the equipment as shown below.

Connect the signal generator to the power splitter input.

Connect the power splitter output 1 to power sensor.

Connect the power splitter output 2 via 50 Ω feed trough terminator to the external trigger input of the RTB.

Note: Make sure that the cables from the splitter to the power sensor and to the external trigger input are of equal length and are as short as possible!

Test: Ext. trigger sensitivity

R&S RTB settings: [PRESET]

[TRIGGER SOURCE : Extern: DC]

[TRIGGER LEVEL : 0 V]

[TRIGGER SETUP : Setup : Slope “Both”]

[Measure: Trigger Frequency Counter]

Signal generator setting:

Signal generator frequency	Voltage at external trigger input	Power meter display
10 kHz	300 mVpp	-6.48 dBm
300 MHz	300 mVpp	-6.48 dBm

Note the 6 dB attenuation of the power splitter for setup signal generators level.

Measurement: Read indicated trigger frequency on RTB within 2 % of generator frequency. Repeat all measurements with the remaining channels

2.3 Waveform Generator Tests on R&S RTB

2.3.1 DC Output Voltage

Test equipment:
- Voltmeter(see Table 2-1, Test equipment, item 1)
- 2 banana cables (see Table 2-1, Test equipment, item 13)

Test setup: Connect the voltmeter to the generator output of the R&S RTB.

R&S RTB settings [PRESET]

[Set generator output type DC]

Measurement: Set the R&S RTB generator DC voltage according to the table below. Measure the voltage with the voltmeter.

DC output voltage						
2.5 V	500 mV	50 mV	0 mV	-50 mV	-500 mV	-2.5 V

Evaluation: Measure VDC ±3% or VDC ± 5mV, whatever is greater

2.3.2 LF Output Voltage

Test equipment:
- Voltmeter(see Table 2-1, Test equipment, item 1)
- 2 banana cables (see Table 2-1, Test equipment, item 13)

Test setup: Connect the voltmeter to the generator output of the R&S RTB.

R&S RTB settings [PRESET]

[Set generator output type SINE]

Measurement: Set the R&S RTB generator frequency and amplitude according to the table below. Measure the voltage with the voltmeter.

Sine wave output voltage				
Frequency	100 Hz	1 kHz	10 kHz	100 kHz
Amplitude 1	5 Vpp	5 Vpp	5 Vpp	5 Vpp
Amplitude 2	100 mVpp	100 mVpp	100 mVpp	100 mVpp

Evaluation: Measure VAC ±3%

2.4 Performance Test Report R&S RTB

ROHDE & SCHWARZ	**Digital oscilloscope** **R&S RTB2002** **R&S RTB2004**	 **1333.1005.02** **1333.1005.04**
Model:		
Serial number:		
Date:		
Person responsible:		
Signature:		

For nominal data and limit values refer to the data sheet.

2.4.1 Oscilloscope Test Report on R&S RTB2002/RTB2004

2.4.1.1 DC Gain Accuracy

Channel 1

Vertical Scale	Calibrator Voltage	DL	Actual	MU
5 V/div	± 22.5 V	± 1.5 %	%	
2 V/div	± 9.00 V	± 1.5 %	%	
1 V/div	± 4.50 V	± 1.5 %	%	
500 mV/div	± 2.25 V	± 1.5 %	%	
200 mV/div	± 900 mV	± 1.5 %	%	
100 mV/div	± 450 mV	± 1.5 %	%	
50 mV/div	± 225 mV	± 1.5 %	%	
20 mV/div	± 90.0 mV	± 1.5 %	%	
10 mV/div	± 45.0 mV	± 1.5 %	%	
5 mV/div	± 22.5 mV	± 2.0 %	%	
2 mV/div	± 9.00 mV	± 2.0 %	%	

Channel 2

Vertical Scale	Calibrator Voltage	DL	Actual	MU
5 V/div	± 22.5 V	± 1.5 %	%	
2 V/div	± 9.00 V	± 1.5 %	%	
1 V/div	± 4.50 V	± 1.5 %	%	
500 mV/div	± 2.25 V	± 1.5 %	%	
200 mV/div	± 900 mV	± 1.5 %	%	
100 mV/div	± 450 mV	± 1.5 %	%	
50 mV/div	± 225 mV	± 1.5 %	%	
20 mV/div	± 90.0 mV	± 1.5 %	%	
10 mV/div	± 45.0 mV	± 1.5 %	%	
5 mV/div	± 22.5 mV	± 2.0 %	%	
2 mV/div	± 9.00 mV	± 2.0 %	%	

Channel 3 (R&S RTB2004 only)

Vertical Scale	Calibrator Voltage	DL	Actual	MU
5 V/div	± 22.5 V	± 1.5 %	%	
2 V/div	± 9.00 V	± 1.5 %	%	
1 V/div	± 4.50 V	± 1.5 %	%	
500 mV/div	± 2.25 V	± 1.5 %	%	
200 mV/div	± 900 mV	± 1.5 %	%	
100 mV/div	± 450 mV	± 1.5 %	%	
50 mV/div	± 225 mV	± 1.5 %	%	
20 mV/div	± 90.0 mV	± 1.5 %	%	
10 mV/div	± 45.0 mV	± 1.5 %	%	
5 mV/div	± 22.5 mV	± 2.0 %	%	
2 mV/div	± 9.00 mV	± 2.0 %	%	

Channel 4 (R&S RTB2004 only)

Vertical Scale	Calibrator Voltage	DL	Actual	MU
5 V/div	± 22.5 V	± 1.5 %	%	
2 V/div	± 9.00 V	± 1.5 %	%	
1 V/div	± 4.50 V	± 1.5 %	%	
500 mV/div	± 2.25 V	± 1.5 %	%	

Vertical Scale	Calibrator Voltage	DL	Actual	MU
200 mV/div	± 900 mV	± 1.5 %	%	
100 mV/div	± 450 mV	± 1.5 %	%	
50 mV/div	± 225 mV	± 1.5 %	%	
20 mV/div	± 90.0 mV	± 1.5 %	%	
10 mV/div	± 45.0 mV	± 1.5 %	%	
5 mV/div	± 22.5 mV	± 2.0 %	%	
2 mV/div	± 9.00 mV	± 2.0 %	%	

2.4.1.2 Offset Accuracy

Channel 1

Vertical Scale	Calibrator Voltage	DL	Actual	MU
500 mV/div	0.0 V	±51.0 mV	V	
500 mV/div	+40.0 V	±251.0 mV	V	
500 mV/div	−40.0 V	±251.0 mV	V	
5 mV/div	0.0 V	±1.5 mV	V	
5 mV/div	+1.2 V	±7.5 mV	V	
5 mV/div	−1.2 V	±7.5 mV	V	

Channel 2

Vertical Scale	Calibrator Voltage	DL	Actual	MU
500 mV/div	0.0 V	±51.0 mV	V	
500 mV/div	+40.0 V	±251.0 mV	V	
500 mV/div	−40.0 V	±251.0 mV	V	
5 mV/div	0.0 V	±1.5 mV	V	
5 mV/div	+1.2 V	±7.5 mV	V	
5 mV/div	−1.2 V	±7.5 mV	V	

Channel 3 (R&S RTB2004 only)

Vertical Scale	Calibrator Voltage	DL	Actual	MU
500 mV/div	0.0 V	±51.0 mV	V	
500 mV/div	+40.0 V	±251.0 mV	V	
500 mV/div	−40.0 V	±251.0 mV	V	
5 mV/div	0.0 V	±1.5 mV	V	

Vertical Scale	Calibrator Voltage	DL	Actual	MU
5 mV/div	+1.2 V	±7.5 mV	V	
5 mV/div	−1.2 V	±7.5 mV	V	

Channel 4 (R&S RTB2004 only)

Vertical Scale	Calibrator Voltage	DL	Actual	MU
500 mV/div	0.0 V	±51.0 mV	V	
500 mV/div	+40.0 V	±251.0 mV	V	
500 mV/div	−40.0 V	±251.0 mV	V	
5 mV/div	0.0 V	±1.5 mV	V	
5 mV/div	+1.2 V	±7.5 mV	V	
5 mV/div	−1.2 V	±7.5 mV	V	

2.4.1.3 Frequency Accuracy

AC Voltage range	Calibrator voltage V_{cal}	Calibrator frequency	DL	Actual	MU
10 V	0.5 V	10 MHz	25 Hz	Hz	

2.4.1.4 Analog Bandwidth

Channel 1

Vertical Scale	Reference frequency	Basic instrument	DLL	Actual		MU	
500 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B221/B241	DLL	Actual		MU	
500 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B222/B242	DLL	Actual		MU	
500 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B223/B243	DLL	Actual		MU	
500 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB

Channel 2

Vertical Scale	Reference frequency	Basic instrument	DLL	Actual		MU	
500 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B221/B241	DLL	Actual		MU	
500 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B222/B242	DLL	Actual		MU	
500 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B223/B243	DLL	Actual		MU	
500 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB

Channel 3 (R&S RTB2004 only)

Vertical Scale	Reference frequency	Basic instrument	DLL	Actual		MU	
500 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B221/B241	DLL	Actual		MU	
500 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B222/B242	DLL	Actual		MU	
500 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B223/B243	DLL	Actual		MU	
500 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB

Channel 4 (R&S RTB2004 only)

Vertical Scale	Reference frequency	Basic instrument	DLL	Actual		MU	
500 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	70 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B221/B241	DLL	Actual		MU	
500 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	100 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B222/B242	DLL	Actual		MU	
500 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	200 MHz	−3.0 dB		dB		dB

Vertical Scale	Reference frequency	Option B223/B243	DLL	Actual		MU	
500 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
50 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
5 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB
1 mV/div	1 MHz	300 MHz	−3.0 dB		dB		dB

2.4.1.5 Channel to Channel Isolation

Channel 1 to channel 2

Options	FFT center frequency	FFT frequency span	FFT points	Generator frequency	DLL	Actual	MU
Basic Instrument	70 MHz	50 MHz	65536	70 MHz	50.0 dB		
B221/B241	100 Mhz	50 MHz	65536	100 Mhz	50.0 dB		
B222/B242	200 MHz	50 MHz	65536	200 MHz	50.0 dB		
B223/B243	300 MHz	50 MHz	65536	300 MHz	50.0 dB		

Channel 4 to channel 3

Options	FFT center frequency	FFT frequency span	FFT points	Generator frequency	DLL	Actual	MU
Basic Instrument	70 MHz	50 MHz	65536	70 MHz	50.0 dB		
B221/B241	100 Mhz	50 MHz	65536	100 Mhz	50.0 dB		
B222/B242	200 MHz	50 MHz	65536	200 MHz	50.0 dB		
B223/B243	300 MHz	50 MHz	65536	300 MHz	50.0 dB		

2.4.2 Waveform Generator Test Report on R&S RTB2002/RTB2004

2.4.2.1 DC Output Voltage

DC Output voltage	DMM	DL	Actual	MU
2.5 V	V	±3.0 %	%	%
0.5 V	V	±3.0 %	%	%
50 mV	mV	±5.0 mV	mV	mV
0 V	mV	±5.0 mV	mV	mV
-50 mV	mV	±5.0 mV	mV	mV
0.5 V	V	±3.0 %	%	%
2.5 V	V	±3.0 %	%	%

2.4.2.2 LF Output Voltage

DUT Frequency	Amplitude	DMM	DL	Actual	MU
0.1 kHz	5.0 Vpp	V	±3.0 %	%	%
0.1 kHz	0.1 Vpp	V	±3.0 %	%	%
1 kHz	5.0 Vpp	V	±3.0 %	%	%
1 kHz	0.1 Vpp	V	±3.0 %	%	%
10 kHz	5.0 Vpp	V	±3.0 %	%	%
10 kHz	0.1 Vpp	V	±3.0 %	%	%
100 kHz	5.0 Vpp	V	±3.0 %	%	%
100 kHz	0.1 Vpp	V	±3.0 %	%	%

3 Adjustment

3.1 Self-alignment

The instrument is equipped with a self-alignment feature; no extra manual adjustments are necessary after module replacement.

Parameters that cannot be adjusted using the self-alignment feature and which require additional measuring equipment to be adjusted or corrected are pre-adjusted in the factory, or the level deviations are determined as correction values.

The alignment values are stored in the serial flash memory of the complexboard. Thus, after exchanging the board, it is only necessary to perform a self-alignment.

3.2 Performing self-alignment

Prerequisites:

- Instrument has to be switched on for at least 20 minutes prior to performing the self-alignment.
- Remove all cables connected to the oscilloscope inputs.

Performing self-alignment:

- Activate the self-alignment by selecting [SETUP : Self Alignment : Start]. During the self-alignment the status information is displayed on the screen.
- After self-alignment has been successfully completed, a message is displayed.
- If a non-correctable level deviation or limit violation is detected during the self-alignment, the process is aborted and an error message window is shown on the display.
- The self-alignment result log file can be exported to a USB storage for detailed investigation by selecting [SETUP : Self Alignment : Save Alignment Log file]

4 Repair

4.1 Functional Description

Two models of the R&S RTB oscilloscope are available:

- RTB2002 with two analog channels
- RTB2004 with four analog channels

Both models use the same front controller board, which is fastened at the mainframe.

The complexboard for both models is generally the same. Oscilloscope channels 3 and 4 are not mounted on 2CH complexboard.

4.1.1 Front Controller Board

Front controller board supports complexboard providing following functions:

- Keypad: mechanical underlay for the keypad and processing of the key events.
- Keypad backlight: LED under every transparent key (white). These LEDs are controlled by LED drivers.
- Rotary encoder.
- Power on/off sequencing and standby control.

A Cortex-M3 CPU controls all the front controller board functions.

4.1.2 Complexboard

4.1.2.1 Oscilloscope Analog Frontend

The signal from BNC compatible input connectors is divided into two paths with different attenuation. Every path is AC-coupled to a JFET with a separate DC control. Followed by a DVGA, the signal is split to the trigger system and the SAD ADC.

4.1.2.2 ADC, FPGA and CPU

ASIC SAD converts the analog signal to digital domain. It can convert two channels at 2.5 GSa/s or up to four channels at 1.25 GSa/s simultaneously. The sampled data is transferred via LVDS lines to the acquisition FPGA for further signal processing.

Oscilloscope control application runs on the ARM-based processing system of the Cyclone V.

Device can boot from serial flash memory (as default).

Factory alignment and option management data are stored in the flash memory.

4.1.2.3 Waveform Generator

The waveform generator consists of the high-speed DAC, gain DAC, offset DAC and analog backend including a safety circuit. It opens a relay when the voltage at the output connector is outside -6 V ... +6 V. The output data and settings of the generator are controlled by the Cyclone V FPGA

Waveform generator is switched off by booting the oscilloscope.

4.1.2.4 Interfaces

- LAN for remote control of the instrument
- USB type A (host USB) to connect a USB flash device for file transfer
- USB mini type B (device USB) to be used for remote control of the instrument
- 2 MSO PODs
- Probe calibration and pattern generator

4.2 Opening the Instrument

WARNING

Shock hazard

Before opening the housing, 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!

Risk of electrostatic discharge

Protect the work area against electrostatic discharge to avoid damage to electronic components in the modules. For details, refer to the safety instructions at the beginning of this manual.

4.2.1 Removing the Housing

1. Switch off the instrument and disconnect the power plug.
2. Place the instrument face down on the workbench.
3. Turn down the instrument feet (250).
4. Unscrew the 7 screws at the rear of the instrument casing using a TORX Plus 10 IP screwdriver. See Figure 4-1.
5. Gently slide off the housing (240) from the instrument in a vertical direction.

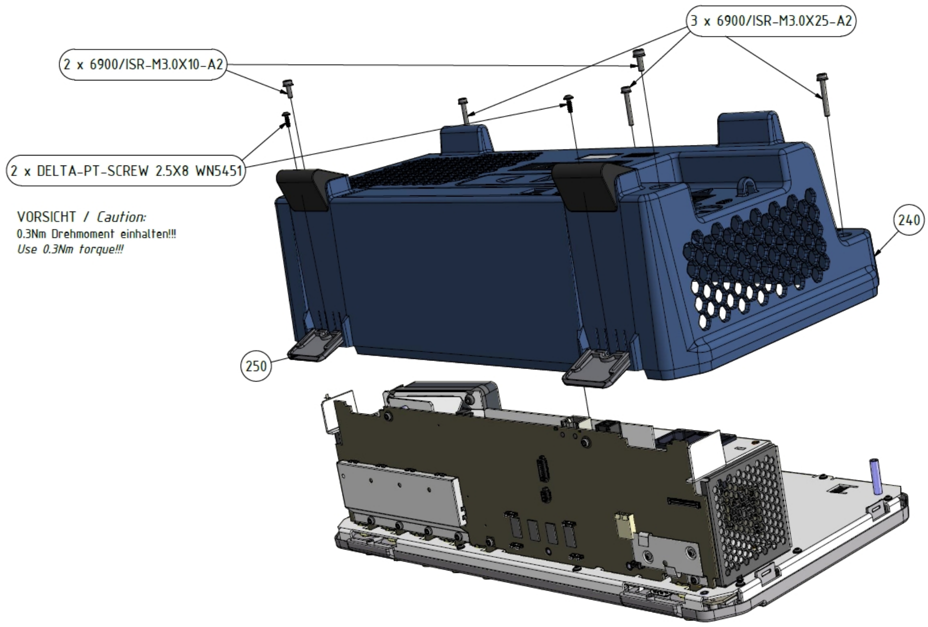


Figure 4-1: Exploded assembly drawing of housing mounting

4.2.2 Removing the Complexboard

1. Remove the housing as described in Chapter 4.2, "Opening the Instrument", on page 28
2. Disconnect all cable connectors from complexboard including power supply connector, fan connector, display connector, touch connector and front board connector. See Figure 4-2.
3. Turn the device bottom to the top.
4. Unscrew the 10 screws holding complexboard assembly using a TORX Plus 10 IP screwdriver. See Figure 4-3.
5. Now the complexboard is free to remove from the mainframe. Just push the complexboard slightly backwards and then remove it to the top.

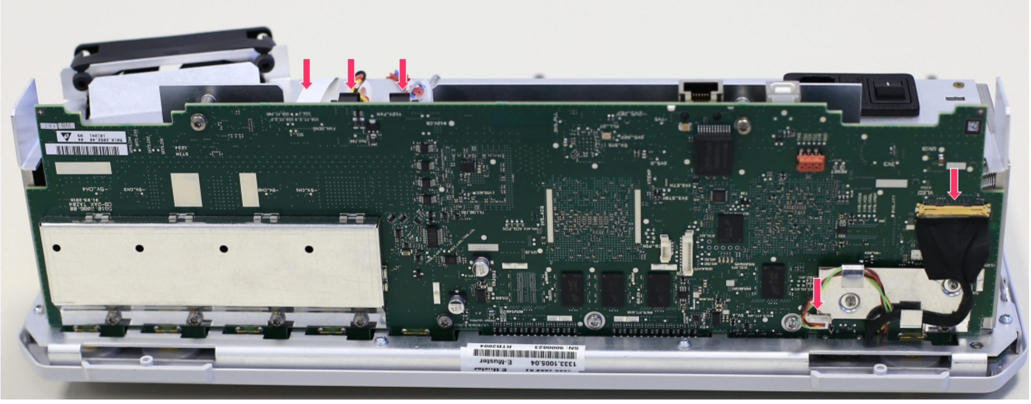


Figure 4-2: Unplugging cables

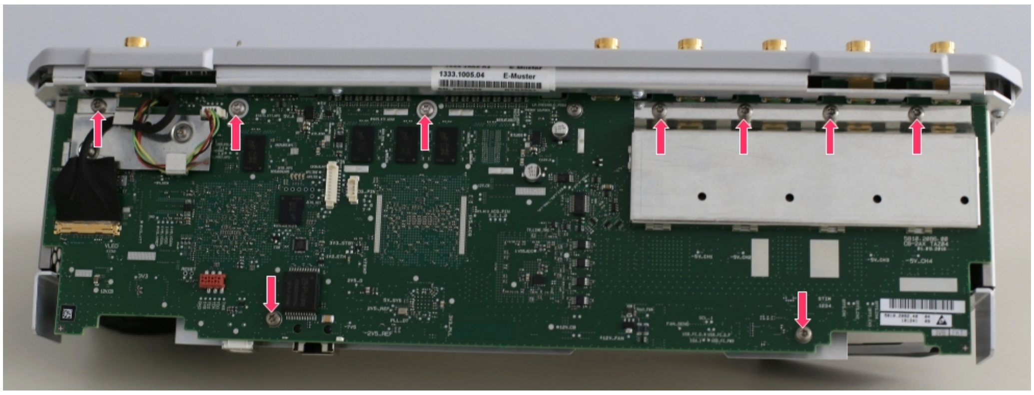


Figure 4-3: Removing the screws of complexboard

4.3 Completing the Instrument

4.3.1 Reassembling the Complexboard

1. Turn the device bottom to the top.
2. Place the complexboard into the device openings from an upper rear position and push the board forward until the holes in the assembly match the mounting holes in the mainframe.
3. Fasten all screws. See Figure 4-4
4. Connect the fan cable, the power supply connector, the display connector, the touch connector and the frontboard connector.

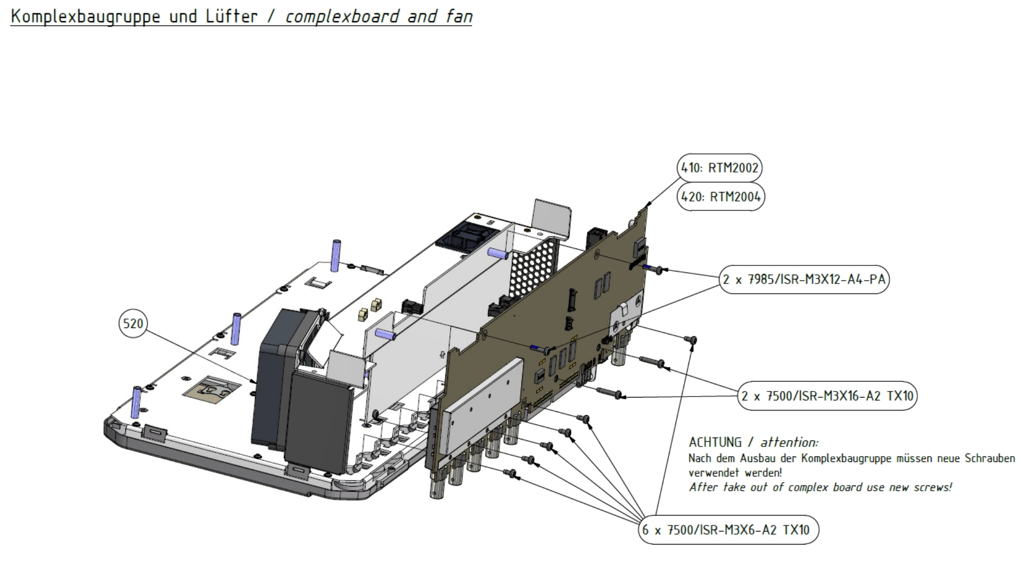


Figure 4-4: Exploded assembly drawing: installation of the complexboard

4.3.2 Reassembling the Housing

1. Place the mainframe with assembled complexboard face down on the workbench.
2. Put on the housing with care. Ensure proper alignment of both parts.
3. Fix the housing with 7 screws using a TORX Plus 10 IP screwdriver.
   See Figure 4-1.

4.4 Module Replacement

4.4.1 Replacement of the Complexboard

Device recovery

Programming of the device data has to be carried out after replacement of the complexboard.

1. Remove the housing as described in Chapter 4.2.1, "Removing the Housing", on page 28.
2. Remove the complexboard as described in Chapter 4.2.2, "Removing the Complexboard", on page 29.

3. Replace the six M3 x 6 (3588.3240.00) and the two M3 x 12 (1148.2881.00) screws. See Figure 4-4.
4. Use the CB-2A20 for 2 channel and the CB-2A40 for 4 channel devices. Reassemble the complexboard according to Chapter 4.3.1, "Reassembling the Complexboard", on page 30.
5. Reassemble the housing according to Chapter 4.3.2, "Reassembling the Housing", on page 31.

4.4.2 Replacing the Power Supply Unit

1. Remove the housing as described in Chapter 4.2.1, "Removing the Housing", on page 28.
2. Remove the complexboard as described in Chapter 4.2.2, "Removing the Complexboard", on page 29.
3. Turn the instrument bottom up.
4. Unscrew the 4 screws of the PS-Cover using a TORX Plus 10 IP screwdriver. See Figure 4-5.
5. Remove the cable from the power inlet (W2) and the power supply cable (W3) from the power supply unit. See Figure 4-6.
6. Remove the 4 screws from the power supply unit.
7. Now the power supply unit (310) is free to remove from the mainframe.
8. Reverse this procedure to reinstall a new power supply unit.

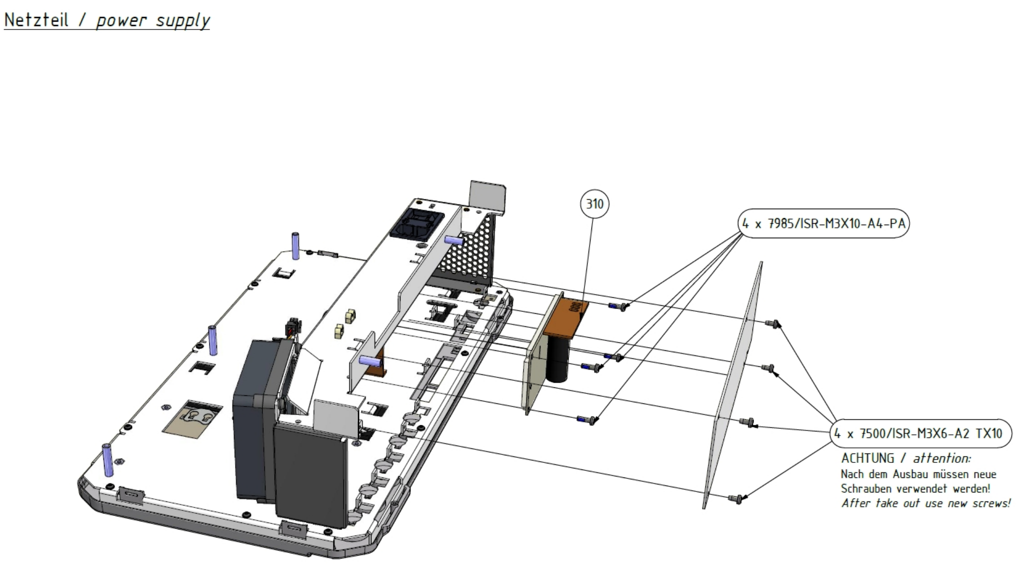


Figure 4-5: Exploded assembly drawing: Power supply installation

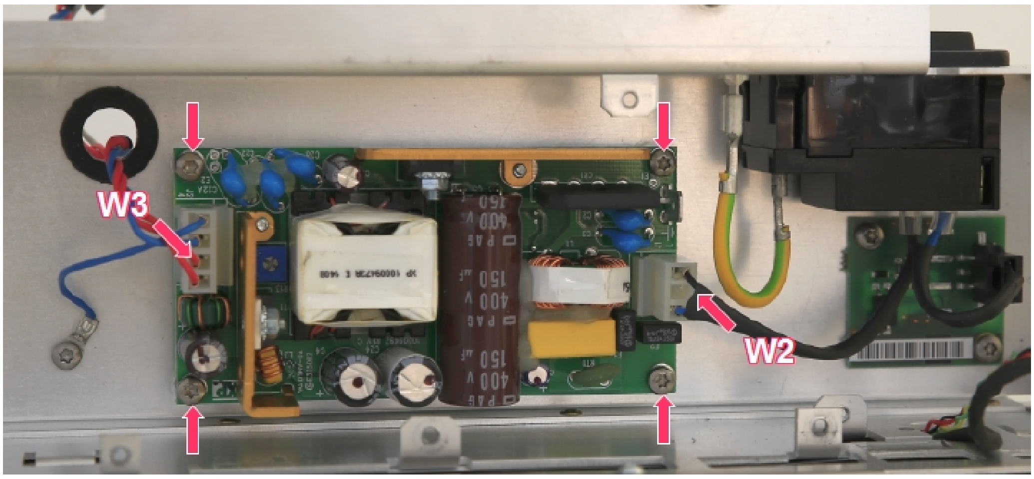


Figure 4-6: Remove the power supply unit

4.4.3 Replacing the Fan

1. Remove the housing as described in Chapter 4.2.1, "Removing the Housing", on page 28.
2. Unplug the fan cable from the complexboard (1).
3. Release the fan supply cable from the cable clip on mainframe (2).
4. Take off the fan (520, 3).
5. Install a new fan into the mainframe.
6. Mount the fan cable into the cable clip.
7. Plug the fan cable into the fan connector of the complexboard.
8. Reassemble the housing according to Chapter 4.3.2, "Reassembling the Housing", on page 31.

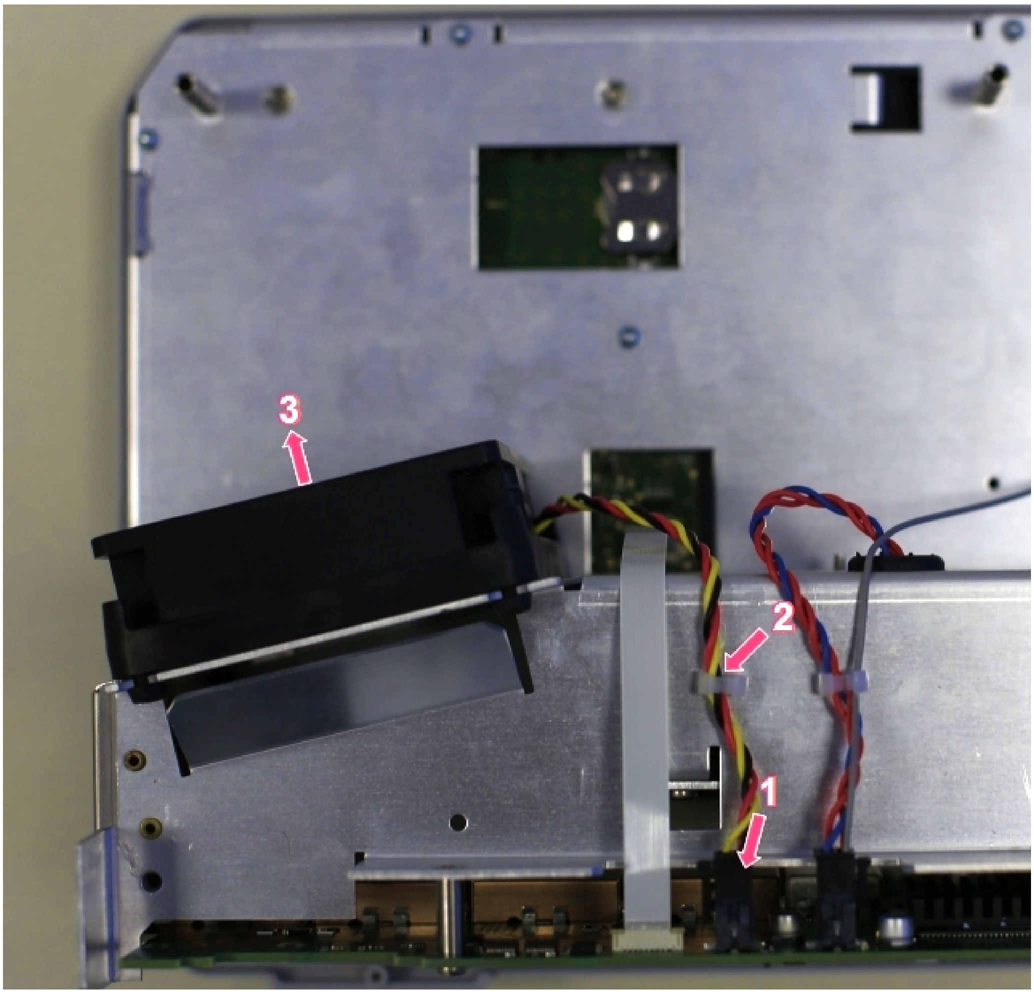


Figure 4-7: Removing the fan

4.4.4 Replacement of the Lithium Battery

⚠ WARNING

Risk of short-circuit

Use isolated tools to remove the battery.

Do not connect the housing of the battery with the mainframe when the battery is mounted in the battery holder.

The lithium battery is located on the backside of front controller board. There is an opening in the mainframe allowing to replace the battery.

1. Remove the housing as described in Chapter 4.2.1, "Removing the Housing", on page 28.

2. Use an isolated tool in the right 45° corners of the battery holder and push the battery to the left. See Figure 4-8.
3. Remove the old battery.
4. Carefully put a new battery into the battery holder.
5. Reassemble the housing according to Chapter 4.3.2, "Reassembling the Housing", on page 31.

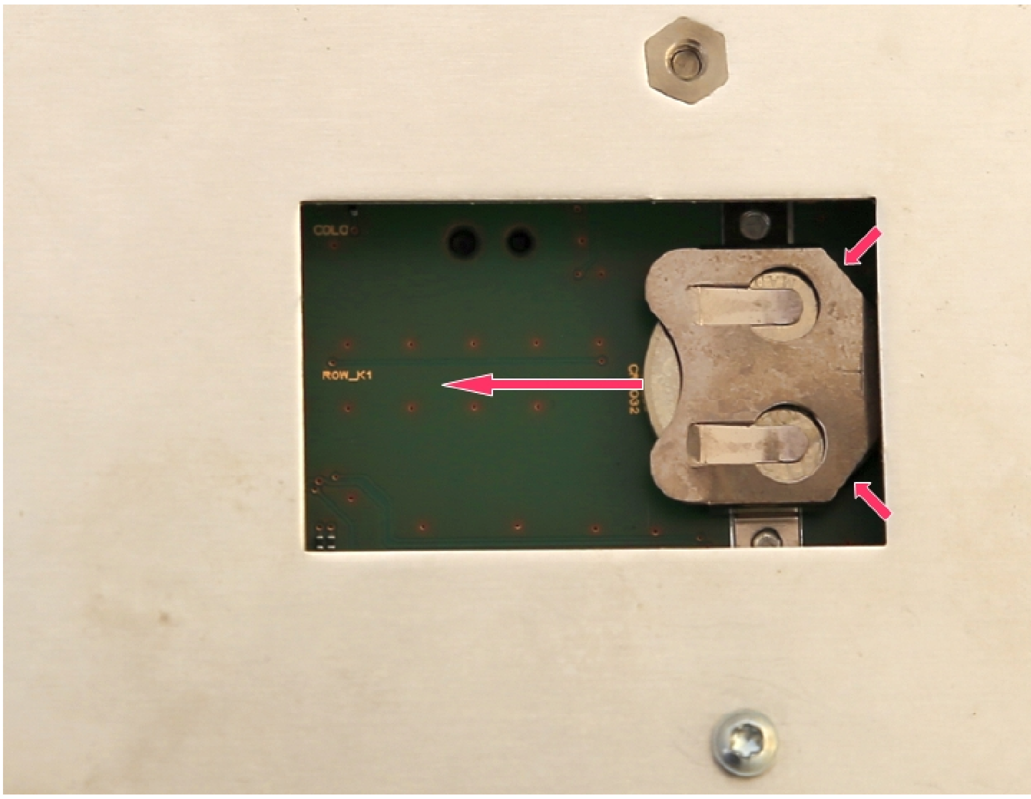


Figure 4-8: Battery replacement

4.4.5 Replacing the Line Fuse

WARNING

Risk of electric shock

The fuse is part of the main power supply. Therefore, handling the fuse while power is on can lead to electric shock. Before opening the fuse holder, make sure that the instrument is switched off and disconnected from all power supplies.

Always use fuses supplied by Rohde & Schwarz as spare parts, or fuses of the same type and rating.

Type of fuses to use: Size 5x20mm, 250V~, T2.5H IEC60127-2/V

1. Pull the fuse holder out of its slot on the power entry module.
2. Replace the defective fuse.
3. Insert the fuse holder carefully back in its slot until it latches.

Figure 4-9: Replacing the fuse

4.4.6 Replacing the Instrument Foot

Always replace both instrument feet.

1. Turn down the foot (1).
2. Pinch the plastic component (2) as shown in Figure 4-10 to remove the foot.
3. Snap in a new foot.

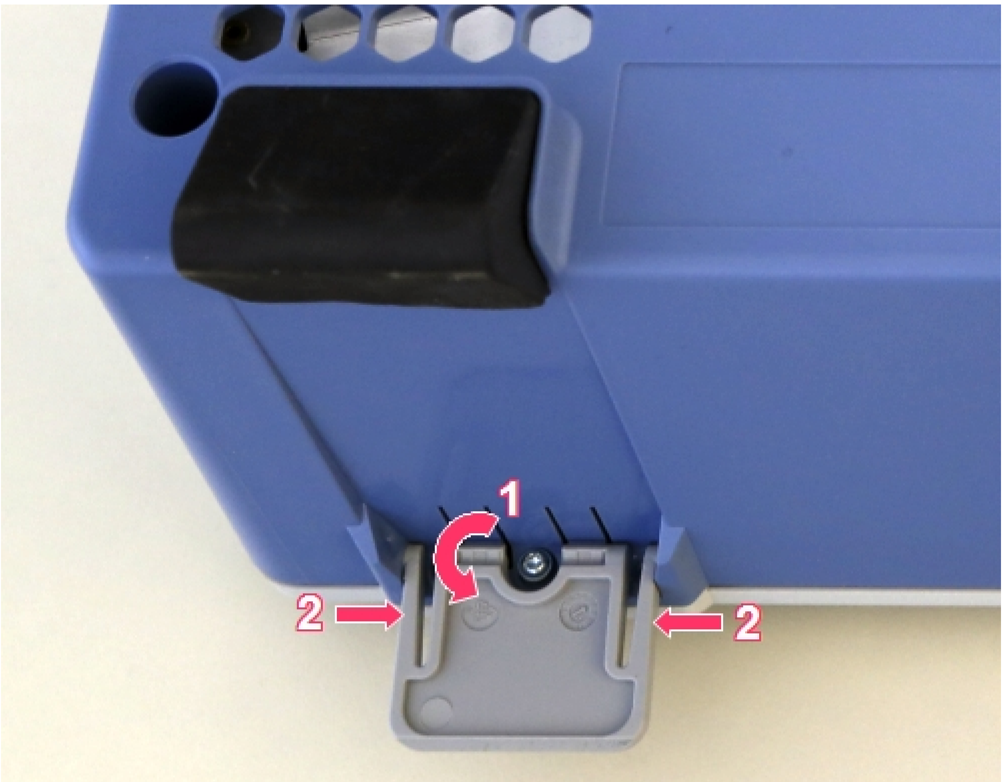


Figure 4-10: Instrument foot replacement

4.4.7 Replace a Knob at the Front Side

1. Pull off the knob from the rotary sensor. See Figure 4-11.
2. Press a new knob on the axis of the rotary sensor.

Figure 4-11: Replacing the knobs

5 Software Update / Installing Options

5.1 Updating the Firmware

Your instrument is delivered with the latest firmware version. Firmware updates are provided on the Internet at

Along with the firmware file, you find the Release Notes describing the improvements and modifications.

Make sure to update the firmware if a new version is available.

1. Download the firmware installation file `*.fwu` to a USB flash drive.
2. Connect the USB flash drive to the USB connector at the front of the instrument.
3. Tap the "Menu" icon in the lower right corner of the screen.
4. Scroll down the menu. Tap "Setup".
5. Select "Firmware Update"
   Now you can see an info window with information about the installed and new firmware and front controller firmware. If you have no newer firmware than the installed one, a message appears.
6. Tap "Execute" to start the firmware update.

   Wait until the update has finished. After installation, the instrument restarts automatically.

5.2 Options

All options are activated by license keys. No additional installation or hardware change is required.

Unregistered licenses

Unregistered licenses are not assigned to a particular instrument. The instrument accepts only registered licenses. If your license is delivered unregistered, use the online tool R&S License Manager to register the license for your instrument. The registration of a permanent license is irreversible, so ensure that you register it for the correct instrument. The address of the tool is https://extranet.rohde-schwarz.com/service.

The "Active Options" tab provides information on installed software options. Here you can install new options or deactivate existing options using license keys.

The "Inactive Options" tab lists all deactivated and expired options.

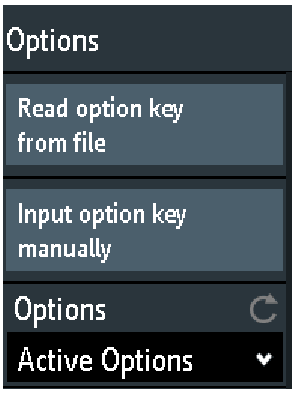
The "Deactivated Options" tab shows all deactivated options with their deactivation information and provides a function to export the deactivation response. The response is required by the R&S License Manager.

5.2.1 Activating Options

Consult your sales representative and provide the material number, serial number, and the device ID of your instrument to get a license key. You find this information in "Setup" menu > "Device Information".

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.

1. If you received the option key in a file, save the file to a USB flash drive.
2. Connect the drive to the R&S RTB.
3. Tap the "Menu" icon in the lower right corner of the screen.
4. Scroll down the menu. Tap "Setup".
5. Select "Options".
6. If you received a key in written form, tap "Input option key manually". Enter the key. If you received a key in digital form as a file, tap "Read option key from file". Select path /USB_FRONT and the option key file.



7. If you want to activate several options, repeat step 5 for each option.
8. Restart the instrument.

6 Documents

6.1 Spare Parts

The stock numbers necessary for ordering replacement parts and modules are listed in the following spare part lists for R&S RTB and R&S RTB-B1.

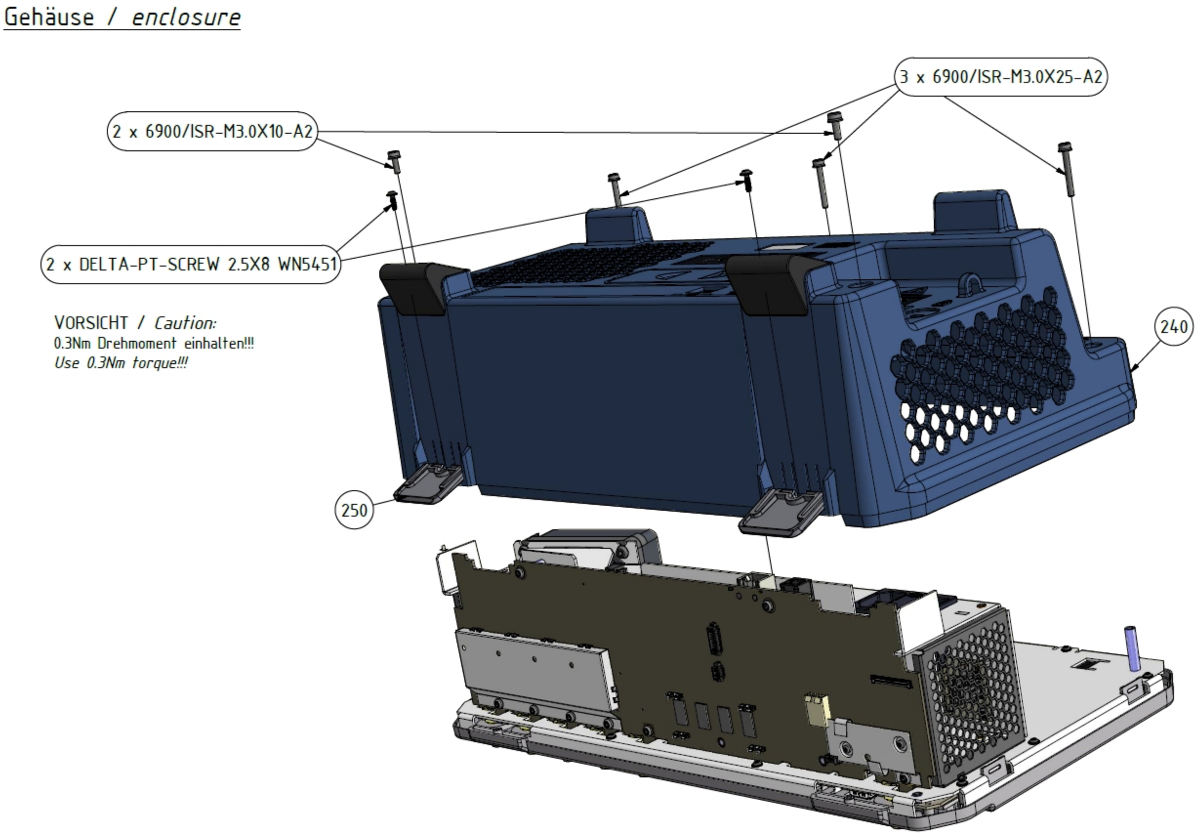
Risk of damaging a module

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

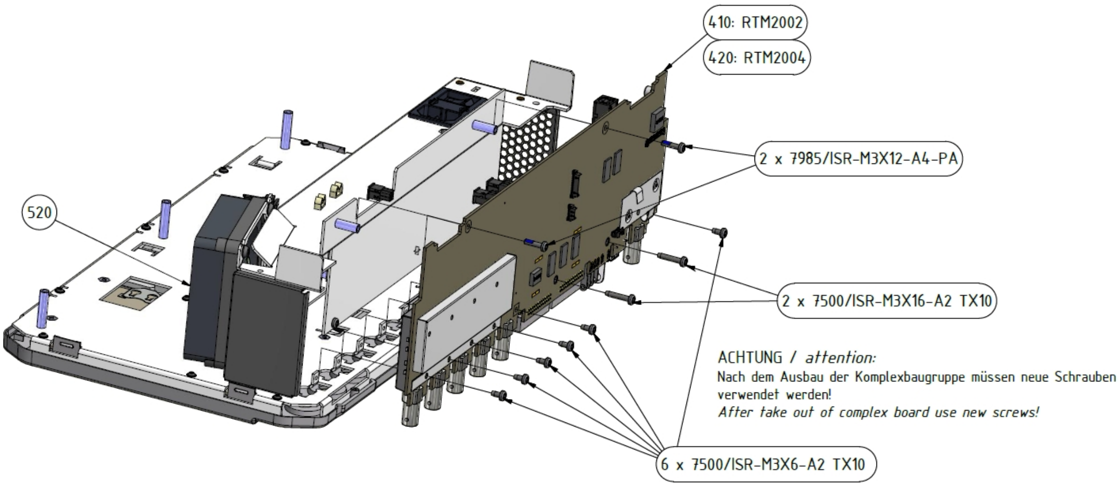
Item No	Quantity	Ref.Des.	Designation	Stock No.	Subst.part
210	1		KNOB 12 WFL	1329.6487.00	
220	1		KNOB 16 WFL	1329.6493.00	
240	1		ENCLOSURE FOR RTB2000	5810.2734.00	
250	1		INSTRUMENT FOOT RTS/WFLX always order two pieces	5810.1380.00	
310	1		NJ XP ECS65US12 65W 12V 4X2ZOLL 2FI AC/DC POWER SUPPLY UNIT	3590.4691.00	
380	1		FUSE 2.5A T IEC60127-2/V	0020.7575.00	
410	1		COMPLEXBOARD CB-2A20 VAR 02 addtitionally required: 2 pcs. Screw 3588.7280.00 (ItemNo 610) 6 pcs. Screw 3588.3240.00 (ItemNo 600)	5810.2092.20	
420	1		COMPLEXBOARD CB-2A40 VAR 04 addtitionally required: 2 pcs. Screw 3588.7280.00 (ItemNo 610) 6 pcs. Screw 3588.3240.00 (ItemNo 600)	5810.2092.40	
520	1		DC-FAN 80X80X25 12V ASSEMBLED	5810.2192.00	
530	0		RTB2002 OSCILLOSCOPE 70 MHz 2CH To be customized at Rohde & Schwarz	1333.1005P02	
540	0		RTB2004 OSCILLOSCOPE 70 MHz 4CH To be customized at Rohde & Schwarz	1333.1005P04	

600	1		VS 7500/ISR M3 X 6 A2 FORM C T X 10 3588.3240.00 B O SCREW 7500/ISR M3 X 6 A2 FORM C T X 10	3588.3240.00	
610	1		VS 7500/ISR M3 X 16 A2 FORM C T X 10	3588.7280.00	

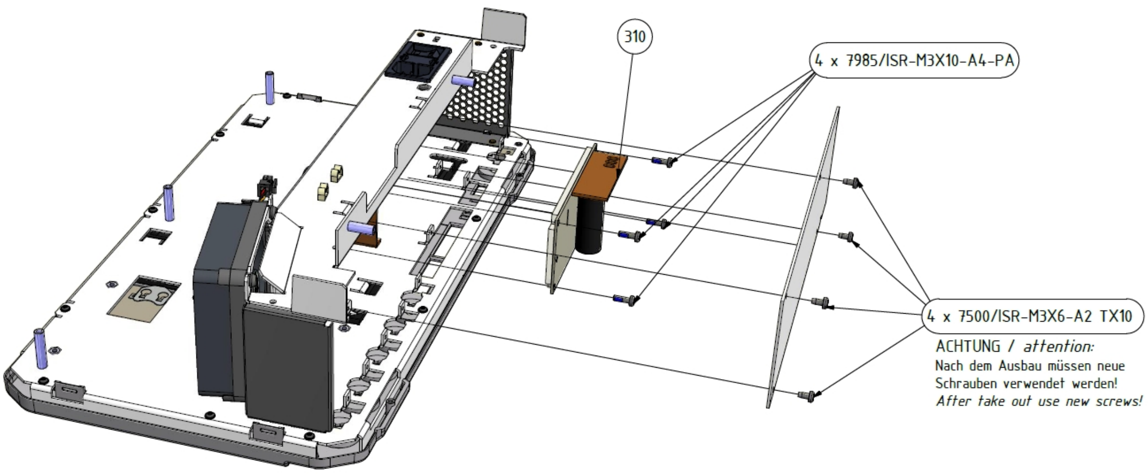
6.2 Mechanical Drawings



Komplexbaugruppe und Lüfter / *complexboard and fan*



Netzteil / *power supply*



6.3 Block Diagram

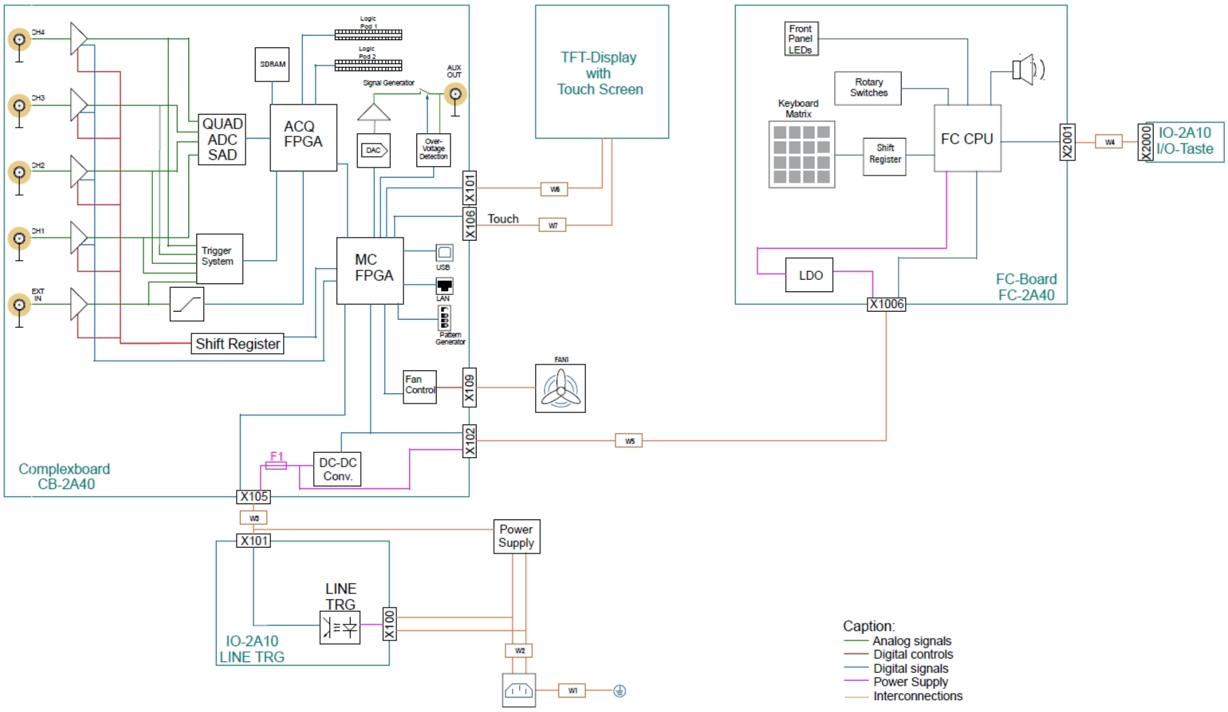


Figure 6-1: Block diagram RTB2004

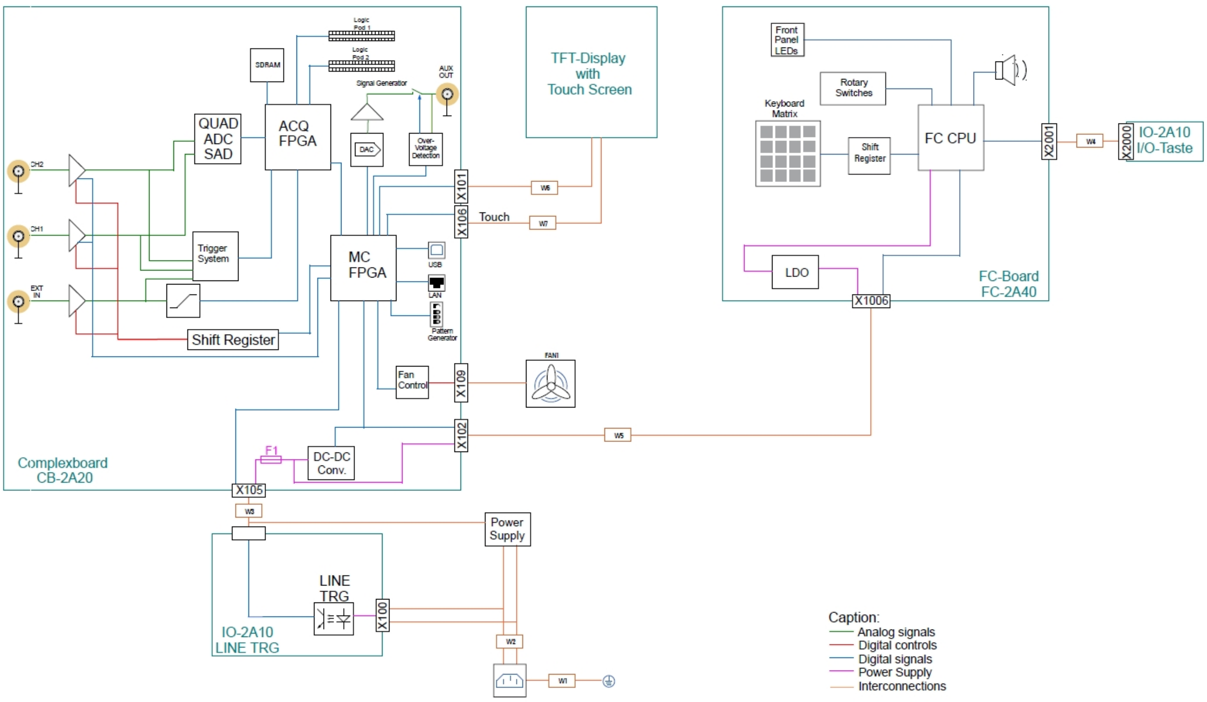


Figure 6-2: Block diagram RTB2002