ROHDE&SCHWARZ

Test and Measurement
Division

Service Manual

Handheld Spectrum Analyzer

R&S® FSH

1145.5850.03
1145.5850.06
1145.5850.13
1145.5850.23
1145.5850.26

Dear Customer,

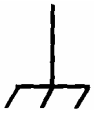
Contents

Safety Instructions

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

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

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

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

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

   IP degree of protection 2X, pollution severity 2 overvoltage category 2, only for indoor use, altitude max. 2000 m.

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

   Unless specified otherwise in the data sheet, a tolerance of ±10% shall apply to the nominal voltage and of ±5% to the nominal frequency.

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

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

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

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

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

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

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

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

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

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

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

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

7. Ensure that the connections with information technology equipment comply with IEC950 / EN60950.

8. NiMH batteries must not be exposed to high temperatures or fire.

   Keep batteries away from children.

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

   NiMH batteries are suitable for environmentally-friendly disposal or specialized recycling. Dispose them into appropriate containers, only.

   Do not short-circuit the battery.

9. Equipment returned or sent in for repair must be packed in the original packing or in packing with electrostatic and mechanical protection.

10. Electrostatics via the connectors may damage the equipment. For the safe handling and operation of the equipment, appropriate measures against electrostatics should be implemented.

11. The outside of the instrument is suitably cleaned using a soft, lint-free dustcloth. Never use solvents such as thinners, acetone and similar things, as they may damage the front panel labeling or plastic parts.
12. Any additional safety instructions given in this manual are also to be observed.

Qualitätszertifikat

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist u.a. nach ISO 9001 und ISO 14001 zertifiziert.

Certificate of quality

Dear Customer,

You have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards. The Rohde & Schwarz quality management system is certified according to standards such as ISO 9001 and ISO 14001.

Certificat de qualité

Cher client,

Vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité. Le système de gestion qualité de Rohde & Schwarz a été homologué, entre autres, conformément aux normes ISO 9001 et ISO 14001.

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Spare Parts Express Service

Phone: **+49 89 4129 - 12465**

Fax: **+49 89 4129 - 13306**

E-mail:werner.breidling@rsd.rohde-schwarz.com

In case of urgent spare parts requirements for this Rohde & Schwarz unit, please contact our spare parts express service.

Outside business hours, please leave us a message or send a fax or e-mail. We shall contact you promptly.

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Contents of Manual for Spectrum Analyzer R&S FSH

Service Manual - Instrument

The Service Manual - Instrument describes how to check compliance with rated specifications, as well as instrument function, repair, troubleshooting and fault elimination. It contains all information required when repairing the R&S FSH by replacing modules.

This Service Manual consists of four chapters and an annex (chapter 5) that describes how to ship the instrument and to order spare parts.

Chapter 1 provides all the information necessary to check for compliance with rated specifications. The required test equipment is also specified.

Chapter 2 describes the manual adjustment of the calibration source and of the frequency accuracy as well as the automatic adjustment of individual module data following module replacement.

Chapter 3 describes the design as well as simple measures for repair and fault diagnosis, including in particular the replacement of modules.

Chapter 4 contains information about extensions and modifications by installing instrument software and retrofitting options.

Chapter 5 describes how to ship the instrument and order spare parts, and contains spare parts lists.

Operating Manual

The Operating Manual provides information about the technical specifications, the controls and connectors on the front and rear panel, required steps for placing the instrument into operation, the basic operating concept, as well as manual and remote control.

Typical measurement tasks are explained in detail using the functions of the user interface and program examples.

The Operating Manual also provides useful information on preventive maintenance and fault diagnosis by means of warnings and error messages output by the unit.

Quick Start Manual

The Quick Start Manual provides information about typical measurement tasks, the basic operation concept, as well as manual and remote control. Each of these items is explained in detail using the functions of the user interface and program examples.

Service and Repair

If your equipment requires service or repair or if you want to order spare parts and modules, please contact your Rohde & Schwarz support center or our spare parts express service.

Rohde & Schwarz representatives and the address of our spare parts express service are listed in the front section of this service manual.

You will need to provide the following information in order for us to respond to your inquiries quickly and accurately and to determine whether the warranty for your instrument is still valid:

- Instrument model
- Serial number
- Firmware version
- Detailed error description in case of repair
- Contact partner for checkbacks

Rohde & Schwarz offers the following calibrations:

- Calibration on R&S-type test systems. The calibration documentation meets the requirements of the quality management system ISO 9000.
- Calibration at an R&S calibration center approved by the German Calibration Service (DKD). The calibration documentation consists of the DKD calibration certificate.

Refer to Chapter 5 for a detailed description of how to ship the instrument and to order spare parts.

1 Performance Test

Test Instructions

- The rated specifications of the analyzer are tested after a warm-up time of at least 15 minutes. Only by adhering to this requirement can compliance with the guaranteed data be ensured.
- Values specified in the following sections are not guaranteed. Only the technical specifications provided on the data sheet are binding.
- The values specified in the data sheet are the guaranteed limits.
- Inputs for settings during measurements are shown as following:

  [**<KEY>**] Press a key on the front panel, eg **[SPAN]**

  [<SOFTKEY>] Press a softkey, e.g. [MARKER -> PEAK].

  [<**nn unit**>] Enter a value and terminate by entering the unit, e.g. [**12 kHz**].

  Successive entries are separated by [:], e.g. [**BW** : MANUAL RES BW : **3 kHz**].

Measuring Equipment and Accessories

Item	Type of equipment	Specifications recommended	Equipment recommended	R&S order no.	Use
1	Signal generator	Frequency: R&S°FSH3 10 MHz to 3 GHz R&S°FSH6 10 MHz to 6 GHz Uncertainty of frequency: 0.1 ppm Phase noise at 500 MHz: < -100 dBc (1Hz) @ 10 kHz < -110 dBc (1Hz) @ 100 kHz < -130 dBc (1Hz) @ 1 MHz	R&S SML03 R&S SMT06	1090.3000.13 1039.2000.06	Frequency response Frequency accuracy of reference oscillator
2	6-dB divider (power splitter)		Weinschel 1506A		Frequency response
3	Power meter		R&S NRVD	0857.8008.02	Frequency response
4	Power sensor	1 MHz to 6 GHz RSS ≤ 0.8% Meter noise ≤ 20 pW	R&S NRV-Z4	0828.3618.02	Frequency response
5	N cable	Attenuation < 1 dB to 6 GHz			Tracking generator output level
6	50-Ω termination	1 MHz to 6 GHz Return loss ≤ -10 dB			Noise display

Performance Test

Checking the frequency accuracy

Test equipment: Signal generator (refer to section "Measurement Equipment and Accessories", item 1)

Test setup: ➢ Connect the signal generator to the RF input of the R&S FSH.

Signal generator settings:
- Frequency 1 GHz
- Level -30 dBm

R&S FSH settings:
- [**PRESET**]
- [**FREQ** : **1 GHz**]
- [**SPAN** : **100 kHz**]
- [**BW** : MANUAL RES BW : **10 kHz**]
- [**MARKER** : MARKER MODE : FREQ COUNT]

Measurement: ➢ Read out the frequency value (Count:) of the marker.

Nominal frequency: ..... 1.0 GHz ± 1 kHz

Note: *The frequency of the reference oscillator can be adjusted by means of a service function (refer to Chapter 2 "Adjustment").*

Checking the level accuracy and the frequency response

Test equipment:

- Signal generator (refer to section "Measurement Equipment and Accessories", item 1)
- Power meter (refer to section "Measurement Equipment and Accessories", item 3)
- Power sensor (refer to s ection "Measurement Equipment and Accessories", item 4)
- 6-dB p ower splitter (refer to section "Measurement Equipment and Accessories", item 2)

Determining the level accuracy at 100 MHz

Test setup:

- Connect the power sensor (item 4) to the power meter and execute function ´ZERO´ when there is no signal applied to the power sensor.
- Connect the RF output of the signal generator to the input of the divider.
- Connect output 1 of the divider to the power sensor / power meter.
- Connect output 2 of the divider to the RF input of the R&S FSH.

Signal generator settings:

- Frequency 100 MHz
- Level 6 dBm

- Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows 0 dBm.

R&S FSH settings:

- [**PRESET**]
- [**FREQ** : **100 MHz**]
- [**AMPT**: **0 dBm**]
- [**SPAN** : **100 kHz**]
- [**BW** : MANUAL RES BW : **10 kHz**]
- [**TRACE** : DETECTOR : RMS]

- Set the marker to the peak of the signal.

- [**MARKER:** SET MARKER: PEAK]

Evaluation:

The difference between the signal levels measured with the power meter and the level reading of the marker reflects the absolute level error of the R&S FSH. It can be calculated as:

$$\text{Level error}_{100\ \text{MHz}} = L - L_{\text{powermeter}}$$

Checking the frequency response

For the measurement of the frequency response, the value at 100 MHz for each reference level setting is used as the reference. The reference level influences the RF attenuation (RF attenuation = +10 dBm + reference level).

Test setup:
- ➢ Connect the RF output of the signal generator to the input of the divider.
- ➢ Connect output 1 of the divider to the power sensor / power meter.
- ➢ Connect output 2 of the divider to the RF input of the SA..

Signal generator settings:
- Frequency {f_{in}} *
- Level -4 dBm

Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows -10 dBm.

R&S FSH settings:
- [**PRESET**]
- [**AMPT** : Ref_Lev*)]
- [**SPAN** : **100 kHz**]
- [**BW** : MANUAL RES BW : **10 kHz**]
- [**TRACE** : DETECTOR : RMS]
- [**FREQ** : CENTER : {f_{in}} *]
- [**SETUP** : Hardware Setup: Low Noise]

*) Refer to table under “Performance Test Report” for values of Ref_Lev and f_{in}.

If the a RF preamplifier is installed, its frequency response has to be checked also. To switch it on please enter:

- [**SETUP** : Hardware Setup: Preamp: ON]

Reference measurement:
- ➢ Determine signal level $L_{powermeter}$.
- ➢ Set the marker to the peak of the signal.
- [**MARKER:** SET MARKER: PEAK]

The signal level L is displayed by the level reading of the marker.

$$Ref_{100MHz} = L - L_{powermeter}$$

Measurement

Signal generator settings:
- Frequency {f_{in}}

Refer to table under “Performance Test Report” for values of {f_{in}}.

Power meter settings:
Determine the signal level $L_{powermeter}$. To achieve higher accuracy, compensating the frequency response of the power sensor is recommended.

R&S FSH settings:
- [**FREQ** : {f_{in}}]

Refer to table under “Performance Test Report” for values of {f_{in}}.

- ➢ Set the marker to the peak of the signal.
- [**MARKER:** SET MARKER: PEAK]

The signal level L is displayed by the level reading of the marker.

Evaluation:
The frequency response can be calculated as:

$$\text{Frequency response} = L - L_{powermeter} - Ref_{100\ MHz}$$

Checking the accuracy of the RF attenuator

Test principle: The RF attenuator of the R&S FSH can be switched from 0 to 30 dB in 10-dB increments by changing the reference level (RF attenuation = +10 dBm + reference level).

Test equipment:
- Signal generator (refer to section "Measurement Equipment and Accessories", item 3)
  Frequency 100 MHz
  Maximum level ≥ 6 dBm

Test setup:
- ➢ Connect the RF output of the signal generator to the input of the divider.
- ➢ Connect output 1 of the divider to the power sensor / power meter.
- ➢ Connect output 2 of the divider to the RF input of the R&S FSH.

Signal generator settings:
- Frequency 100 MHz
- Level -14 dBm
- ➢ Determine the output power of the signal generator with the power meter. Adjust the output power of the signal generator until the power meter shows -20 dBm ± 0.2 dB.

R&S FSH settings:
- [**PRESET**]
- [**FREQ** : **100 MHz**]
- [**SPAN** : **10 kHz**]
- [**BW** : MANUAL RES BW : **1 kHz**]
- [**BW** : MANUAL VIDEO BW : **100 Hz**]
- [**TRACE** : DETECTOR : RMS]
- [**AMPT: 0 dBm**]
- [**SETUP** : Hardware Setup: Low Noise]

Reference measurement:
- ➢ Set the marker to the peak of the signal.
  [**MARKER:** SET MARKER: PEAK]

The signal level L is displayed by the level reading of the marker.

$$Ref_{0dBm} = L - L_{powermeter}$$

Measurement

Signal generator settings:
- Frequency 100 MHz
- Level Ref_Lev *) – 14 dB

*) Refer to table under “Performance Test Report” for values of {Ref_Lev}.

- ➢ Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows the value Ref_Lev – 10 dB.

R&S FSH settings:
- [**AMPT** : {Ref_Lev}]
- [**MARKER:** SET MARKER: PEAK]

Evaluation: The signal level L is displayed by the level reading of the marker.

The difference between the level inaccuracy of the R&S FSH and Ref_{0dBm} (at 10 dB RF-Att) is the uncertainty of the RF attenuation:

$$IF\text{-}Gain_{accuracy} = (L - L_{powermeter}) - Ref_{0dBm}$$

Checking the accuracy of the IF gain setting

Test principle: The IF gain of the R&S FSH can be switched from 0 to 15 dB by changing the reference level.

Test equipment:
- Signal generator (refer to section "Measurement Equipment and Accessories", item 3)
  Frequency 100 MHz
  Maximum level ≥ -10 dBm

Test setup:
- ➢ Connect the RF output of the signal generator to the input of the divider.
- ➢ Connect output 1 of the divider to the power sensor / power meter.
- ➢ Connect output 2 of the divider to the RF input of the SA.

Signal generator settings:
- Frequency 100 MHz
- Level -4 dBm

- ➢ Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows -10 dBm ± 0.2 dB.

R&S FSH settings:
- [**PRESET**]
- [**FREQ**: **100 MHz**]
- [**SPAN** : **10 kHz**]
- [**BW** : MANUAL RES BW: **1 kHz**]
- [**BW** : MANUAL VIDEO BW : **100 Hz**]
- [**TRACE** : DETECTOR : RMS]
- [**AMPT** : **Ref_Lev *)**]

*) Refer to table under “Performance Test Report” for values of {Ref_Lev}.

Reference measurement:
- ➢ Set the marker to the peak of the signal.
  - [**MARKER:** SET MARKER: PEAK]

The signal level L is displayed by the level reading of the marker.

$Ref_{-10dBm} = L - L_{powermeter}$

Measurement

Signal generator settings:
- Frequency 100 MHz
- Level Ref_Lev + 6 dB

- ➢ Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows the value Ref_Lev ± 0.2 dB.

R&S FSH settings:
- [**AMPT** : {Ref_Lev}]

*) Refer to table under “Performance Test Report” for values of Ref_Lev.

- [**MARKER**: SET MARKER: PEAK]

Evaluation: The signal level L is displayed by the level reading of the marker.
The difference between the level inaccuracy of the R&S FSH and Ref_{-10dBm} (at 0 dB IF gain) is the uncertainty of the IF gain:

$IF\text{-}Gain_{accuracy} = (L - L_{powermeter}) - Ref_{-10dBm}$

Checking the displayed average noise floor

Test equipment: 50-Ω termination (refer to section "Measurement Equipment and Accessories", item 6)

Test setup:
- ➢ Terminate the RF input of the R&S FSH with 50 Ω.

R&S FSH settings:
- [**PRESET**]
- [**SPAN** : ZERO SPAN]
- [**Manual Res BW** : **1 kHz**]
- [**Manual Video BW** : **10 Hz**]
- [**TRACE** : TRACE MODE: AVERAGE]
- [**AMPT** : -30 dBm]
- [**FREQ** : {f_n}]

Refer to table under “Performance Test Report” for values of f_n.

Measurement:
- ➢ Read out the marker level.

Evaluation: The displayed average noise floor is displayed by the level reading of the marker.

Checking the phase noise

Test equipment: Signal generator (refer to section "Measurement Equipment and Accessories", item 3)

Frequency	500 MHz
Level	≥ 0 dBm
Phase noise at 500 MHz:	< -100 dBc (1Hz) @ 10 kHz
	< -110 dBc (1Hz) @ 100 kHz
	< -120 dBc (1Hz) @ 1 MHz

Test setup:

- Connect the RF output of the signal generator to the RF input of the R&S FSH.

Signal generator settings:

- Frequency 500 MHz
- Level 8 dBm *)

*) The overrange of the AD converter is used for higher dynamic range.

R&S FSH settings:

- [**PRESET**]
- [**FREQ** : **500 MHz**]
- [**AMPT** : **0 dBm**]
- [**SPAN** : {span}]
- [**BW** : RBW MANUAL : {RBW}]

  Depending on the offset, refer to the table below for values of RBW and span.

- [**TRACE** : TRACE MODE: AVERAGE]
- Marker to peak
  [**MARKER**: SET MARKER: PEAK]
- Delta marker to {offset}
  [**MARKER**: DELTA: {offset}: **kHz**]
- Set marker mode to noise measurement
  [**MARKER**: MARKER MODE: NOISE]

Evaluation: The phase noise is displayed in the marker field by the reading Delta [dBc/Hz]´.

Phase noise measurement settings		
Offset	**Span**	**RBW**
30 kHz	100 kHz	1 kHz
100 kHz	220 kHz	10 kHz
1 MHz	2.2 MHz	100 kHz

Checking the display linearity

Test equipment:
- Signal generator (refer to section "Measurement Equipment and Accessories", item 1)
- Power meter (refer to section "Measurement Equipment and Accessories", item 3)
- Power sensor (refer to section "Measurement Equipment and Accessories", item 4)
- 6-dB power splitter (refer to section "Measurement Equipment and Accessories", item 2)

Test setup:
- ➢ Connect the power sensor (item 4) to the power meter and execute function ´ZERO´ when there is no signal applied to the power sensor.
- ➢ Connect the RF output of the signal generator to the input of the divider.
- ➢ Connect output 1 of the divider to the power sensor / power meter.
- ➢ Connect output 2 of the divider to the RF input of the R&S FSH.

1st Measurement
0 to 30 dB below reference level

Signal generator settings:
- Frequency 100 MHz
- Level + 6 dBm

- ➢ Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows
  0 dBm.

R&S FSH settings:
- [**PRESET**]
- [**AMPT: 0 dBm**]
- [**FREQ**: **100 MHz**]
- [**SPAN** : **10 kHz**]
- [**Manual Res BW** : **1 kHz**]
- [**Manual SWPTime** : **1 s**]
- [**TRACE** : DETECTOR : RMS]

Reference measurement:
- ➢ Set the marker to the peak of the signal.
- [**MARKER**: SET MARKER: PEAK]

The signal level L is displayed by the level reading of the marker.

$$Ref_{0dBm} = L - L_{powermeter}$$

Signal generator settings:
- Frequency 100 MHz
- Level Sig_Lev + 6 dB

Refer to table under “Performance Test Report” for values of {Sig_Lev}.

- ➢ Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows the value of {Sig_Lev}.

Evaluation:

The signal level L is displayed by the level reading of the marker.

The difference between the level inaccuracy of the R&S FSH and Ref_{0dBm} is the uncertainty of the display linearity:

$$Linearity_{uncertainty} = (L - L_{powermeter}) - Ref_{0dBm}$$

2nd Measurement
30 to 50 dB below reference level

Because the sensitivity of the power meter is limited, the internal RF attenuator of the Galaxy is used to increase the dynamic range of the input signal.

R&S FSH settings:

- [**AMPT: 20 dBm**]

Signal generator settings:

- Frequency 100 MHz
- Level - 4 dBm

➢ Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows
-10 dBm.

Reference measurement:

➢ Set the marker to the peak of the signal.
- [**MARKER**: SET MARKER: PEAK]

The signal level L is displayed by the level reading of the marker.

With the result of the 1st linearity measurement, a new correction factor is to be calculated. "$Linearity_{uncertainty}$ (-30dB)" is the measured uncertainty of the R&S FSH linearity at 30 dB below reference level.

$$Ref_{20dBm} = (L - L_{powermeter}) - Linearity_{uncertainty}\ (-30dB)$$

Signal generator settings:

- Frequency 100 MHz
- Level Sig_Lev + 6 dB

Refer to table under "Performance Test Report" for values of {Sig_Lev}.

➢ Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows the value Sig_Lev ± 0.2 dB.

Evaluation:

The signal level L is displayed by the level reading of the marker.

The difference between the level inaccuracy of the R&S FSH and Ref_{20dBm} is the uncertainty of the display linearity:

$$Linearity_{uncertainty} = (L - L_{powermeter}) - Ref_{20dBm}$$

Performance Test Tracking Generator

(Model 1145.5973.13, 1145.5973.23 or 1145.5973.26 only)

Checking output level / frequency response

Test equipment:

- N cable (refer to section "Measurement Equipment and Accessories", item 5)

Frequency	up to 3 GHz
Maximum attenuation	< 0.2 dB

Test setup:

➢ Connect the tracking generator output to the RF input of the R&S FSH.

R&S FSH settings:

- [**PRESET**]
- [**MEAS:** TRACKING GENERATOR]
- [**AMPT** : REF: **10 dB**]
- [**FREQ** : START FREQ **10 MHz**]

In the model 1145.5973.23 the output level of the tracking generator can be set to 0 dBm. Check the output level also with this setting:

- [**PRESET**]
- [**MEAS:** TRACKING GENERATOR]
- [**Output Level** : **0 dBm**]
- [**AMPT** : REF: **10 dB**]

In the FSH6 the output level of the tracking generator is measured with two different frequency settings :

1)
- [**FREQ** : START FREQ **10 MHz**]
- [**FREQ** : STOP FREQ **3 GHz**]

2)
- [**FREQ** : START FREQ **3 GHz**]
- [**FREQ** : STOP FREQ **6 GHz**]

Measurement:

Tune the marker to the maximum level of the trace.

- [**MARKER**: <tune the marker>]

Read out the marker level.

Tune the marker to the minimum value of the trace.

Read out the marker level.

Performance Test Report

Table 1-1 Performance Test Report

ROHDE & SCHWARZ	Performance Test Report	Spectrum Analyzer	Version 2 April 2004
Model ( ):			
Order number:			
Serial number:			
Test person:			
Date:			
Sign:			

Characteristic	**Included in**	**Min. value**	**Actual value**	**Max. value**	**Unit**	**Measurement uncertainty**
Frequency accuracy Reference oscillator	Page 1.2	0.999999	_____	1.000001	GHz	
Level accuracy at 100 MHz with Ref_Lev = 0 dBm	Page 1.3	-0.5	_____	+0.5	dB	

Characteristic	Included in	Min. value	Actual value	Max. value	Unit	Measurement uncertainty
Frequency response with Ref_Lev = 20 dBm	Page 1.3					
f_{fresp}						
10 MHz		-1	_____	+1	dB	
100 MHz			Reference		dB	
500 MHz		-1	_____	+1	dB	
1000 MHz		-1	_____	+1	dB	
1500 MHz		-1	_____	+1	dB	
2000 MHz		-1	_____	+1	dB	
2500 MHz		-1	_____	+1	dB	
2990 MHz		-1	_____	+1	dB	
R&S°FSH6 only :						
3500 MHz		-1	_____	+1	dB	
4000 MHz		-1	_____	+1	dB	
4500 MHz		-1	_____	+1	dB	
5000 MHz		-1	_____	+1	dB	
5500 MHz		-1	_____	+1	dB	
5990 MHz		-1	_____	+1	dB	
Frequency response with Ref_Lev = 10 dBm	Page 1.3					
f_{fresp}						
10 MHz		-1	_____	+1	dB	
100 MHz			Reference		dB	
500 MHz		-1	_____	+1	dB	
1000 MHz		-1	_____	+1	dB	
1500 MHz		-1	_____	+1	dB	
2000 MHz		-1	_____	+1	dB	
2500 MHz		-1	_____	+1	dB	
2990 MHz		-1	_____	+1	dB	
R&S°FSH6 only :						
3500 MHz		-1	_____	+1	dB	
4000 MHz		-1	_____	+1	dB	
4500 MHz		-1	_____	+1	dB	
5000 MHz		-1	_____	+1	dB	
5500 MHz		-1	_____	+1	dB	
5990 MHz		-1	_____	+1	dB	

Characteristic	Included in	Min. value	Actual value	Max. value	Unit	Measurement uncertainty
Frequency response with Ref_Lev = 0 dBm	Page 1.3					
f_{fresp}						
10 MHz		-1	_____	+1	dB	
100 MHz			Reference		dB	
500 MHz		-1	_____	+1	dB	
1000 MHz		-1	_____	+1	dB	
1500 MHz		-1	_____	+1	dB	
2000 MHz		-1	_____	+1	dB	
2500 MHz		-1	_____	+1	dB	
2990 MHz		-1	_____	+1	dB	
R&S°FSH6 only :						
3500 MHz		-1	_____	+1	dB	
4000 MHz		-1	_____	+1	dB	
4500 MHz		-1	_____	+1	dB	
5000 MHz		-1	_____	+1	dB	
5500 MHz		-1	_____	+1	dB	
5990 MHz		-1	_____	+1	dB	
Frequency response with Ref_Lev = -10 dBm	Page 1.3					
f_{fresp}						
10 MHz		-1	_____	+1	dB	
100 MHz			Reference		dB	
500 MHz		-1	_____	+1	dB	
1000 MHz		-1	_____	+1	dB	
1500 MHz		-1	_____	+1	dB	
2000 MHz		-1	_____	+1	dB	
2500 MHz		-1	_____	+1	dB	
2990 MHz		-1	_____	+1	dB	
R&S°FSH6 only :						
3500 MHz		-1	_____	+1	dB	
4000 MHz		-1	_____	+1	dB	
4500 MHz		-1	_____	+1	dB	
5000 MHz		-1	_____	+1	dB	
5500 MHz		-1	_____	+1	dB	
5990 MHz		-1	_____	+1	dB	

Characteristic	Included in	Min. value	Actual value	Max. value	Unit	Measurement uncertainty
Frequency response with PreAmp = ON (only if PreAmp is implemented) Ref_Lev = -15 dBm	Page 1.3					
f_{fresp}						
10 MHz		-1	_____	+1	dB	
100 MHz			Reference		dB	
500 MHz		-1	_____	+1	dB	
1000 MHz		-1	_____	+1	dB	
1500 MHz		-1	_____	+1	dB	
2000 MHz		-1	_____	+1	dB	
2500 MHz		-1	_____	+1	dB	
2990 MHz		-1	_____	+1	dB	
R&S°FSH6 only :						
3500 MHz		-1	_____	+1	dB	
4000 MHz		-1	_____	+1	dB	
4500 MHz		-1	_____	+1	dB	
5000 MHz		-1	_____	+1	dB	
5500 MHz		-1	_____	+1	dB	
5990 MHz		-1	_____	+1	dB	
Frequency response with PreAmp = ON (only if PreAmp is implemented) Ref_Lev = -25 dBm	Page 1.3					
f_{fresp}						
10 MHz		-1	_____	+1	dB	
100 MHz			Reference		dB	
500 MHz		-1	_____	+1	dB	
1000 MHz		-1	_____	+1	dB	
1500 MHz		-1	_____	+1	dB	
2000 MHz		-1	_____	+1	dB	
2500 MHz		-1	_____	+1	dB	
2990 MHz		-1	_____	+1	dB	
R&S°FSH6 only :						
3500 MHz		-1	_____	+1	dB	
4000 MHz		-1	_____	+1	dB	
4500 MHz		-1	_____	+1	dB	
5000 MHz		-1	_____	+1	dB	
5500 MHz		-1	_____	+1	dB	
5990 MHz		-1	_____	+1	dB	

Characteristic	Included in	Min. value	Actual value	Max. value	Unit	Measurement uncertainty
Attenuator accuracy	Page 1.5					
RF_Att / Ref_Lev :						
0 dB / -10 dBm		-0.5	_____	+0.5	dB	
10 dB / 0 dBm		-	Reference	-	-	
20 dB / 10 dBm		-0.5	_____	+0.5	dB	
30 dB / 20 dBm		-0.5	_____	+0.5	dB	
PreAmp = ON (only if PreAmp is implemented)						
0 dB / -15 dBm		-0.5	_____	+0.5	dB	
IF gain Switching accuracy	Page 1.5					
Reference level						
-10 dBm		-	Reference	-	-	
-15 dBm		-0.5	_____	+0.5	dB	
-20 dBm		-0.5	_____	+0.5	dB	
-25 dBm		-0.5	_____	+0.5	dB	
Displayed average Noise floor	Page 1.7					
f_{noise}:						
9.9 MHz		-	_____	-105	dBm	
101 MHz		-	_____	-105	dBm	
501 MHz		-	_____	-105	dBm	
1001 MHz		-	_____	-105	dBm	
1501 MHz		-	_____	-105	dBm	
2001 MHz		-	_____	-105	dBm	
2501 MHz		-	_____	-105	dBm	
2999 MHz		-	_____	-105	dBm	
R&S°FSH6 only :						
3501 MHz		-	_____	-103	dBm	
4001 MHz		-	_____	-103	dBm	
4501 MHz		-	_____	-103	dBm	
4999 MHz		-	_____	-103	dBm	
5501 MHz		-	_____	-96	dBm	
5999 MHz		-	_____	-96	dBm	

Characteristic	Included in	Min. value	Actual value	Max. value	Unit	Measurement uncertainty
Displayed average Noise floor with PreAmp = ON (only if PreAmp is implemented)	Page 1.7					
f_{noise}:						
9.9 MHz		-	_____	-120	dBm	
101 MHz		-	_____	-120	dBm	
501 MHz		-	_____	-120	dBm	
1001 MHz		-	_____	-120	dBm	
1501 MHz		-	_____	-120	dBm	
2001 MHz		-	_____	-120	dBm	
2499 MHz		-	_____	-120	dBm	
2999 MHz		-	_____	-115	dBm	
R&S°FSH6 only :						
3501 MHz		-	_____	-115	dBm	
4001 MHz		-	_____	-115	dBm	
4501 MHz		-	_____	-115	dBm	
4999 MHz		-	_____	-115	dBm	
5501 MHz		-	_____	-105	dBm	
5999 MHz		-	_____	-105	dBm	
Phase noise at 500 MHz	Page 1.8					
Offset frequency:						
30 kHz		-	_____	-85	dBc (1Hz)	
100 kHz		-	_____	-100	dBc (1Hz)	
1 MHz		-	_____	-120	dBc (1Hz)	

Characteristic	Included in	Min. value	Actual value	Max. value	Unit	Measurement uncertainty
Display linearity 0 to -30 dB Reference level: 0 dBm Sig_Lev : 0 dBm -5 dBm -10 dBm -15 dBm -20 dBm - 25 dBm - 30 dBm	Page 1.9	 - -0.2 -0.2 -0.2 -0.2 -0.2 -0.2	 Reference _____ _____ _____ _____ _____ _____	 - +0.2 +0.2 +0.2 +0.2 +0.2 +0.2	 - dB dB dB dB dB dB	
Display linearity -30 to -50 dB Reference level: 20 dBm Sig_Lev : -10 dBm -15 dBm -20 dBm - 25 dBm - 30 dBm	Page 1.9	 - -0.3 -0.3 -0.3 -0.3	 Reference _____ _____ _____ _____	 - +0.3 +0.3 +0.3 +0.3	 - dB dB dB dB	

Performance Test Report Tracking Generator

(model 1145.5850.13, 1145.5850.23 or 1145.5850.26 only)

Table 1-2 Performance Test Report

ROHDE & SCHWARZ	Performance Test Report	Option -B9	Version 2 April 2004
Serial number:			
Test person:			
Date:			
Sign:			

Characteristic	**Included in**	**Min. value**	**Actual value**	**Max. value**	**Unit**	**Measurement uncertainty**
R&S°FSH3: Level accuracy output level: -20 dBm	Page 1.11					
Maximum value		-3	_____	+5	dB	
Minimum value		-7	_____	-1	dB	
R&S°FSH3: Level accuracy output level: 0 dBm (model 1145.5850.23 only)	Page 1.11					
Maximum value		-3	_____	+5	dB	
Minimum value		-7	_____	-1	dB	
R&S°FSH6: Level accuracy	Page 1.11					
10 MHz to: 3 GHz						
Maximum value		-2	_____	+6	dB	
Minimum value		-5	_____	+4	dB	
3 GHz to 6 GHz						
Maximum value		2	_____	11	dB	
Minimum value		-11	_____	6	dB	

2 Adjustment

This chapter describes the adjustment of the software-controlled module data following the replacement of modules.

Adjustments can be performed only by using the adjustment program that is available from the R&S Service Board on the R&S Internet site. Using this program prevents mistakes in the calibration data.

The R&S FSH permits the following manual adjustments:

- Adjustment of the 10-MHz reference oscillator that determines the frequency accuracy of the R&S FSH.
- Adjustment of the level accuracy of the R&S FSH for different attenuator settings.

Adjustment enables you to maintain and restore the data integrity of the instrument.

Manual adjustments must be performed at an ambient temperature between +20°C and +30°C after the instrument has warmed up.

After the adjustments have been performed, the R&S FSH is ready for use and offers full data integrity. This can be verified by performing the Performance Test as described in Chapter 1.

Verifying the functionality of the R&S FSH is recommended before you start performing adjustments or the performance test. The verification procedure is described in the following section, ”Quick Verification”.

Quick Verification

The quick verification procedure verifies hardware functionality before full testing can start. Testing of the following is recommended:

- On/off functionality
- Connections of the power adapter and the AF output
- Display
- Level and noise

Measurement Equipment and Accessories for Quick Verification

The quick verification procedure requires a very limited amount of equipment.

Item	Type of equipment	Specifications recommended	Equipment recommended	R&S order no.	Use
1	Signal generator	Frequency: 10 MHz to 3 GHz	R&S SML		Level
2	N-cable	Attenuation: < 0.2 dB to 3 GHz			Tracking generator output level

Verifying on/off functionality

Test equipment	None
R&S FSH settings	Switch instrument ON.
Measurement	➢ Verify that the instrument switches ON.

Verifying power and AF connections

Test equipment	None
Accessories	AC power adapter Headphone
R&S FSH settings	Switch instrument ON. Connect the AC power supply.
Reference measurement	➢ Verify in the display that the battery symbol changes to a power plug.
R&S FSH settings	Connect the headphone. - [**Marker** : MARKER DEMOD : **AM**]
Reference measurement	➢ Verify that a noise signal is heard on the headphone.

Verifying the display

Test equipment	None
R&S FSH settings	Switch instrument ON.
Reference measurement	➢ Check the display for disturbance.

Verifying the level and noise

Test principle	The RF attenuator of the R&S FSH can be switched from 0 to 30 dB by changing the reference level in the instrument.
Test equipment	- Signal generator (refer to section "Measurement Equipment and Accessories for Quick Verification", item 1). Frequency 100 MHz Maximum level ≥ 6 dBm
Test setup	➢ Connect the RF output of the signal generator to the input of the R&S FSH.
Signal generator settings	- Frequency 100 MHz - Level - 20 dBm
R&S FSH settings	- [**PRESET**] - [**FREQ** : **100 MHz**] - [**SPAN** : **10 kHz**] - [**BW** : RES BW MANUAL : **1 kHz**] - [**BW** : VIDEO BW MANUAL : **100 Hz**] - [**TRACE** : DETECTOR : RMS] - [**AMPT**: **0 dBm**]
Verification	➢ Read the level and verify that it shows -20 dBm +/- 2 dB. ➢ Verify that the noise level in the display is < - 60 dBm.

Check 30 dB attenuation

Change signal generator setting	- Level -30 dBm
Change R&S FSH setting	- [**AMPT** : **-10 dBm**]
Verification	➢ Read the level and verify that it shows -30 dBm +/- 2 dB.

Check 10 dB attenuation

Change signal generator setting	- Level -10 dBm
Change R&S FSH setting	- [**AMPT** : **10 dBm**]
Verification	➢ Read the level and verify that it shows -10 dBm +/- 2 dB.

Check 0 dB attenuation

Change signal generator setting	- Level 0 dBm
Change R&S FSH setting	- [**AMPT** : **20 dBm**]
Verification	➢ Read the level and verify that it shows 0 dBm +/- 2 dB.

Verify the tracking generator output level

Test principle	The generator output must be connected to the RF input and verified.
Test equipment	None
Test setup	➢ Connect the generator output of the R&S FSH to the RF input.
R&S FSH settings	- [**PRESET**] - [**MEAS** : TRACKING GEN :]
Verification	➢ Verify that the level of the sweep shows 0 dB +5 /-7 dB. ➢ *Following internal calibration, verify that the level shows 0 +/-1 dB.*

Adjustment functions

Caution:

Only qualified personnel should carry out the re-alignment since any change substantially influences the measurement accuracy of the instrument. For this reason, the calibration program is available only on the R&S Service Board.

Adjustment

This section describes the measurement equipment and accessories required for the manual adjustment of the R&S FSH, the appropriate preparations of the equipment, and the individual adjustments.

An adjustment program provides the instructions for the input settings.

Adjustment Instructions

- The adjustment of the analyzer must be performed after a warm-up time of at least 30 minutes. Only by adhering to this requirement can compliance with the guaranteed data be ensured.
- Inputs for setting the R&S FSH during adjustment will be programmed automatically.

Measurement Equipment and Accessories

Item	Type of equipment	Specifications recommended	Equipment recommended	R&S order no.	Use
1	Signal generator	Frequency: 10 MHz to 3 GHz Uncertainty of frequency: 0.1 ppm Phase noise at 500 MHz: < -100 dBc (1Hz) @ 10 kHz < -110 dBc (1Hz) @ 100 kHz < -130 dBc (1Hz) @ 1 MHz	R&S SML		Frequency accuracy of reference oscillator
2	6-dB divider (power splitter)				Frequency response
3	Power meter		R&S NRVD	0857.8008.02	Frequency response
4	Power sensor	1 MHz to 3 GHz RSS ≤ 0.8% Meter noise ≤ 20 pW	R&S NRV-Z4	0828.3618.02	Frequency response

Adjusting the reference frequency accuracy

Test equipment — Signal generator (refer to section "Measurement Equipment and Accessories", item 2)

Test setup — ➢ Connect the generator to the RF input.

Generator settings
- Frequency 1 GHz
- Level -30 dBm

R&S FSH settings
- [**PRESET**]
- [**FREQ** : **1 GHz**]
- [**SPAN** : **100 kHz**]
- [**BW** : MANUAL RES BW : **10 kHz**]
- [**MARKER** : MARKER MODE : FREQ COUNT]

Adjustment — The program will adjust the reference oscillator to 10 MHz ± 1 ppm.

Adjusting the level accuracy

Test equipment

- Signal generator (refer to section "Measurement Equipment and Accessories ", item 1)
- Power meter (refer to section "Measurement Equipment and Accessories ", item 3)
- Power sensor (refer to section "Measurement Equipment and Accessories ", item 4)
- 6-dB power splitter (refer to section "Measurement Equipment and Accessories ", item 2)

Determining the level accuracy at 100 MHz

Test setup

- Connect the power sensor (item 4) to the power meter and execute function ´ZERO´ when there is no signal applied to the power sensor.
- Connect the RF output of the signal generator to the input of the divider.
- Connect output 1 of the divider to the power sensor / power meter.
- Connect output 2 of the divider to the RF input of the R&S FSH.

Signal generator settings

- Frequency 100 MHz
- Level 6 dBm

- Determine the output power of the signal generator with the power meter. Adjust the output power of the generator until the power meter shows the expected level “Ampt”. This level is displayed on the PC display during adjustment.

R&S FSH settings

- Performed automatically via the adjustment program.

Adjustment

The program will guide you through the required adjustments for different levels.

Save calibration data

If the measured values are within the programmed limits, the new constants will be automatically stored in the R&S FSH and will be used for future measurements.

Frequency Response Correction

Frequency response correction is part of the RF/IF module and is delivered with the module in an EEPROM. Any change requires the use of a special test program and test setup. If necessary, the module must be sent to R&S Service.

3 Repair

This chapter describes the design of the R&S FSH, simple measures for repair and troubleshooting, and, in particular, the replacement of modules.

Firmware updates and the installation of the DTF option are described in Chapter 4.

Instrument Design and Functional Description

The following figure shows a block diagram of the R&S FSH.

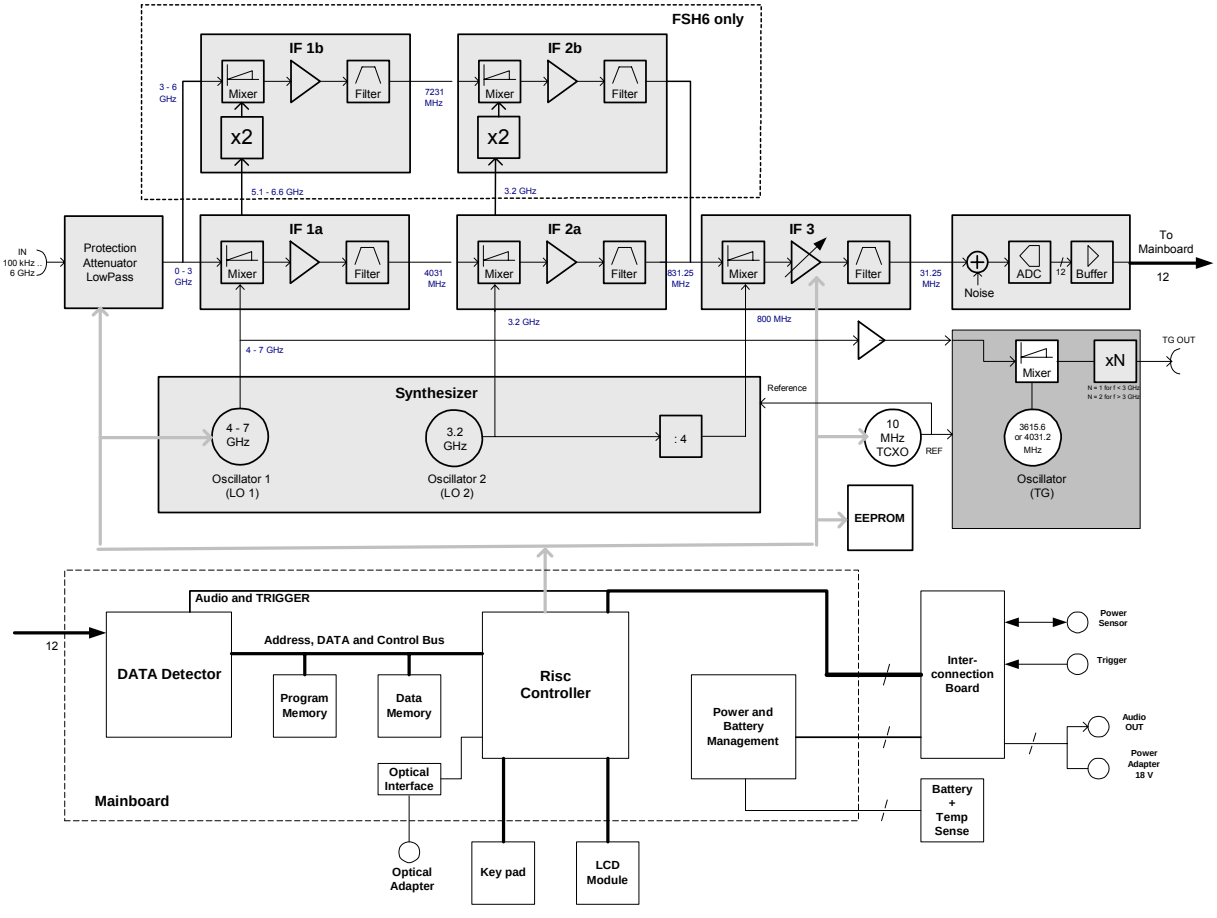


Fig. 3-1 Block Diagram R&S FSH

Description of the block diagram

The R&S FSH is a triple-conversion super-heterodyne receiver for the frequency range 100 kHz to 3 GHz. After signals are received, they are processed by the RF/IF board and the mainboard.

The RF/IF board contains the functions as described below.

Attenuator

The RF signal passes from the input connector RF INPUT to the programmable input attenuator, which can be switched from 0 dB to 30 dB in increments of 10 dB. The circuitry is protected from overvoltage.

RF to IF conversion

The RF/IF board converts the received frequencies in the range 100 kHz to 3 GHz to the low 31.25 MHz IF, which is digitized with 25 MHz before it is sent to the mainboard for digital processing. The RF/IF board also includes the required local oscillators and associated frequency processing circuits. The unit is housed in silver-plated aluminum packaging.

The input signal passes via the input attenuator and the lowpass filter to the first mixer. The lowpass filter provides suppression of the image frequency (image = LO+ IF) to keep the conversion unambiguous. In the 1st mixer the input signal is up-converted to an IF of 4031.25 MHz by means of the first LO (4031.25 MHz to 7031.25 MHz). The mixer is followed by a low noise IF amplifier, which compensates for the loss due to mixing. The signal then passes a filter with a 3-dB bandwidth of approximately 400 MHz for filtering the first IF. The local oscillator frequency required for this conversion is also generated on the board. This signal is generated by three VCOs synchronized to 100 MHz, which in turn is synchronized to a Temperature Compensated 10-MHz Xtal Oscillator (TCXO). This TCXO is electrically calibrated.

The signal from the 1st IF filter is converted to the 2nd IF of 831.25 MHz. The signal is routed to an 831.25 MHz filter with a 3-dB bandwidth of 20 MHz for further signal processing. The filter is followed by the 3rd mixer, which converts to 31.25 MHz and utilizes an IF filter that has a -3-dB bandwidth of approximately 2 MHz.
The frequency range above 3°GHz in the R&S FSH6 is converted via two additional mixers to a first IF of 7231.25°MHz and to the same 2nd IF as in the FSH3 of 831.25 MHz. As LO signals the oscillator signals of the FSH3 are doubled.

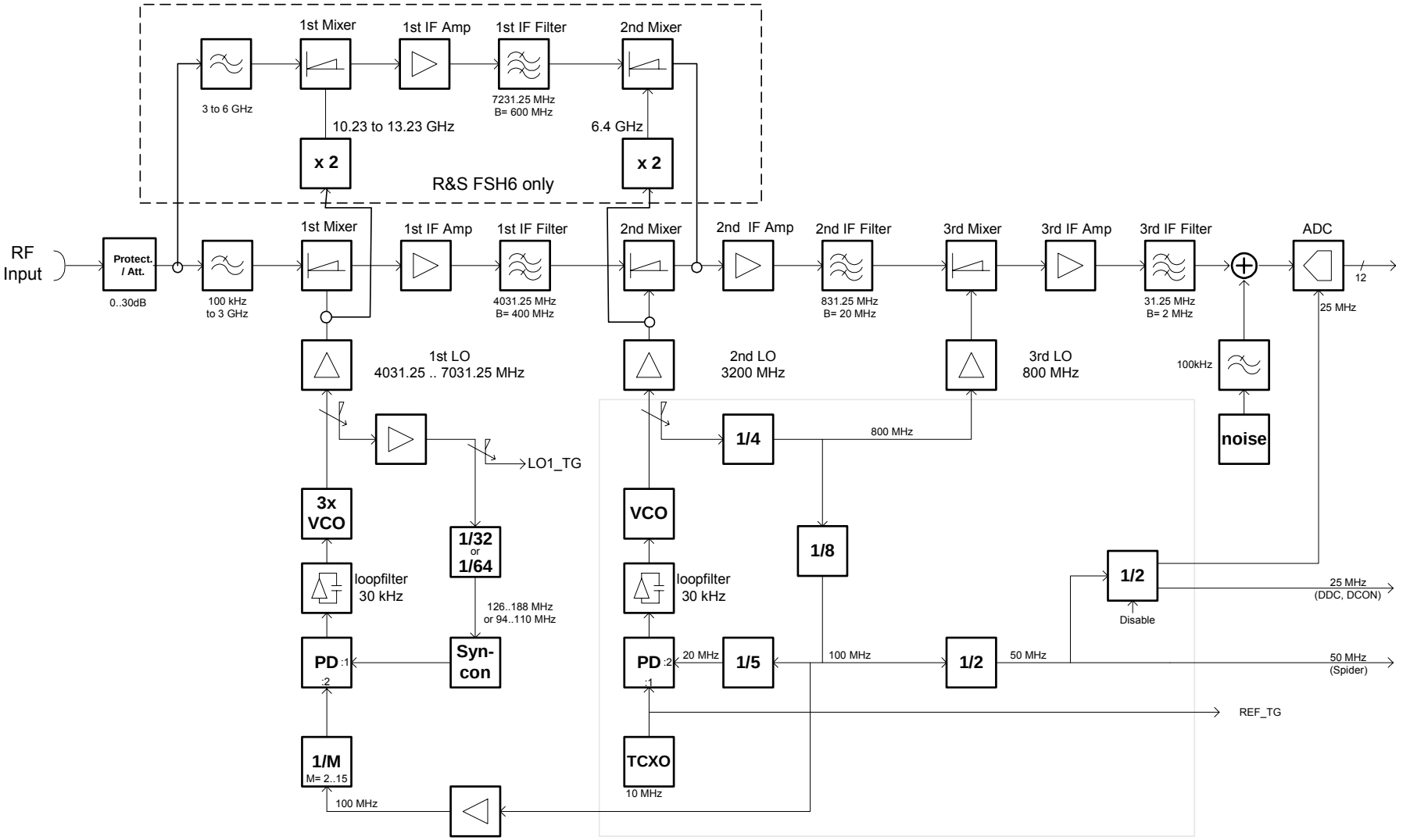


Fig. 3-2 Block Diagram: RF to IF Conversion and Synthesizer

Tracking generator (Model 1145.5850.13/23/26 only)

The LO frequency of the 1st mixer is routed via isolation amplifiers to the TG mixer. The other input of the mixer is a fixed frequency of 4031.25 MHz generated with a VCO locked to the TCXO frequency.

The resulting IF signal is routed to the generator output connector.

RF/IF control

The microcontroller available on the mainboard controls the RF/IF setting by programming registers via an internal serial bus.

For calibration purposes the level correction values are stored in an EEPROM. This EEPROM also contains module-specific information.

The temperature of the module is continuously measured, and the measured levels will be compensated for drift if the temperature change is too great.

Mainboard

The mainboard is a combination of the power supply and the functions controlled by a dedicated RISC controller (ARM 720).

Power and battery management

The ON/OFF key is de-bounced with the real-time clock in the controller. The ON/OFF function is completely software controlled. This implies that the controller must be operational in order for the the instrument to be switched ON. The µP-clock (50 MHz) is derived from the RF/IF board, thus requiring that this board be present. This frequency will always be present if the power adapter is connected or the instrument is in the ON state.

If the instrument is in the OFF state and the power supply is connected, the µP will control the charging function of the battery depending on the battery condition. The maximum charging current is 1000 mA, which drops to a trickle charge of about 100 mA if the battery is fully loaded. To prevent damage to the battery, the charging stops if the battery temperature reaches ≤ 0°C or > 45°C. In the OFF state, the charging current is approximately 90 mA.

This power supply and battery management arrangement uses a dedicated IC. The instrument can be switched ON only if the battery is in operating condition. Thus, if the battery is completely empty, the instrument cannot be switched ON until the charging current has re-loaded the battery, which takes several minutes.

Processing of measured data detectors

The measured data is processed in two dedicated ICs to reduce the sample rate of the input signal to a value that can be handled by the hardware. The DDC converts the digital IF signal to I/Q base band and filters the base band signals using low pass filters with programmable bandwidth. In addtiotion it delivers the AM or FM demodulated audio signal. The DCON Asic detects the envelope of the filtered and combined base band signal and calculates its logarithm. It contains also the video filter and the different detectors. In addition it is resposible for the sweep control of the FSH.

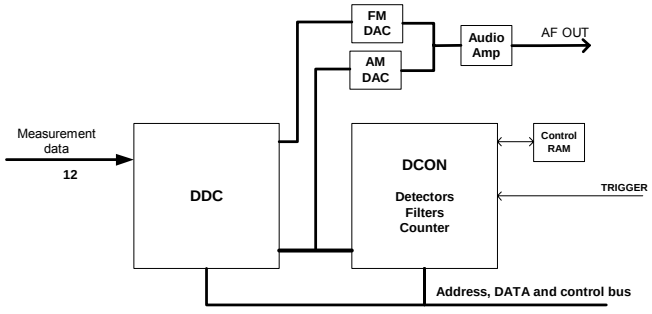


Fig. 3-3 Measured Data Processing

Resolution bandwidths (RBW)

The resolution bandwidths are implemented in the R&S FSH through digital processing in the DDC ASIC (Digital Down Converter). The RBW can be selected from within the range 1 kHz to 1 MHz in 1-, 3- or 10-unit increments. The DDC first mixes its input IF to the baseband using an NCO (Numeric Controlled Oscillator) and then filters the resulting IQ signals via a combination of HDF (High Decimation Filter) and an FIR (Finite Impulse Response) stages. At the end of the DDC processing chain, the IQ signal is split into magnitude and phase.

For AF demodulation the amplitude information is used. In the case of FM the phase information is used and fed to the headphone connector. In the analyzer mode the signal at the position of the marker can be demodulated. In this case the R&S FSH stops the sweep for a selectable period of time and demodulates the input signal. The volume can be adjusted.

For a standard log display of the analyzed spectrum, the magnitude data is converted from linear to logarithmic in the DCON ASIC (Digital CONtroller).

Video bandwidths (VBW)

The video filters can be adjusted between 10 Hz and 3 MHz in increments of 1/3/10. They are designed as digital lowpass filters for the video signals in the DCON ASIC. Software can couple the VBW to the RBW, or the VBW can be set independently.

Detectors

The R&S FSH uses a detector for the positive peak and the negative peak value. In the “sample” mode the measured value is routed directly to the display. In the RMS“ mode the detector determines the rms value of the input signal for one specific point in the display during the measured time.

Keypad control

Keypad control is a dedicated function of the controller. For the implementation of the rotary knob, an encoder is used that is detected with a dedicated CPLD (Complex Programmable Logic Device). This “One Time Programmable” CPLD is programmed during production.

Serial optical interface

The interface to an external PC has been implemented with optical technology to avoid electrical loops. The protocol is RS-232-based and is implemented in the instrument by the UART of the controller. It requires a special optical RS-232 cable for communication (R&S FSH-Z34, delivered with the instrument). The maximum baud rate is 115200.

Power sensor

The power sensor uses the display of the R&S FSH. Communication is achieved with a separate UART from the controller.

Color LCD module

The ¼ VGA passive matrix display is backlighted by an FCC backlight, whose light output can be adjusted to an optimum between visibility and battery use.

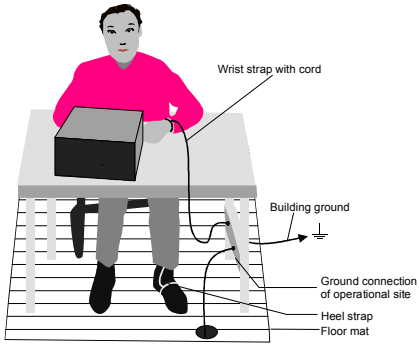
Module Replacement

This section describes the service concept and contains the spare parts list and the basic documents for the R&S FSH instrument.

Note: *The numbers indicated in brackets refer to items in the mechanical exploded drawings.*

Note: *The words "left" and "right" in the manual always refer to the front view of the instrument.*

Caution!



- *Please pay close attention to the safety instructions in the front section of this manual.*
- *Disconnect the power connector from the instrument before opening the case.*
- *Safeguard the replacement site against electrostatic discharge to prevent damage to electronic components of the modules.*
- *The following two methods of ESD protection can be used together or separately:*

  - Wrist strap with cord to ground connection

  - Conductive floor mat and heel strap combination

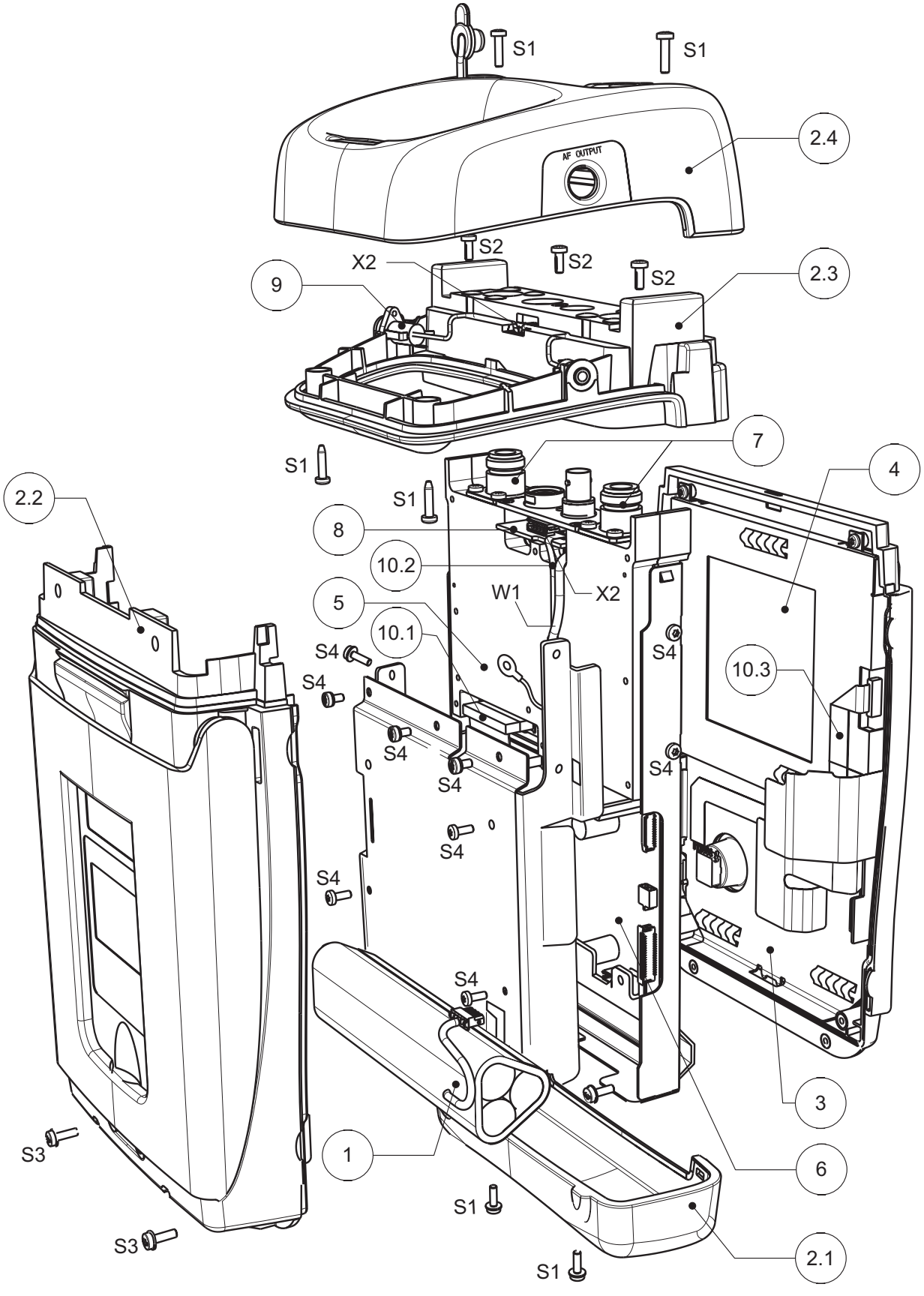


Fig. 3-4 Exploded View

Overview of the modules

Table 3-1 List of spare parts and order numbers

Reference	Part	R&S Order Number
1	Battery Pack for R&S FSH (R&S FSH-Z32)	1145.5796.02
2	Housing R&S FSH without top holster	1157.3258.00
2.4	Top holster for FSH without tracking generator	1157.3487.00
	Top holster for FSH with tracking generator	1157.3493.00
3	Front unit for R&S FSH3	1157.3241.00
	Front unit for R&S FSH6	1300.7591.00
4	LCD module	1157.3229.00
	LCD plane for FSH3	1300.7704.00
	LCD plane for FSH6	1300.7710.00
5	RF/IF module for R&S FSH3 without tracking generator	1157.3606.00
	RF/IF Module for R&S FSH3 with tracking generator	1157.3612.00
	RF/IF Module for R&S FSH6 without tracking generator	1300.7604.00
	RF/IF Module for R&S FSH6 with tracking generator	1300.7610.00
6	Mainboard for R&S FSH	1157.3570.00
7	N connector	1157.3235.00
8	Interconnection board	1157.3587.00
9	Input unit (power and audio connectors, including wire tree)	1157.3270.00
10	Set of cables for R&S FSH	1157.3329.00
21	AC mains adapter for R&S FSH (EU Version)	1157.3293.00
22	AC mains adapter for R&S FSH (UK Version)	1157.3306.00
23	AC mains adapter for R&S FSH (US Version)	1157.3312.00
	AC mains adapter for R&S FSH (AUS Version)	1157.3370.00

See exploded drawing on the previous page.

Opening the instrument

(See exploded drawing for related numbers.)

- Disconnect the power plug.
- Switch the instrument to OFF.
- Loosen the six (S1) screws and remove the top cover (2.4) and bottom cover (2.1).
- Disconnect the connector (X2).
- Loosen the three (S2) screws and remove the grip cover (2.3).
- Loosen the two (S3) screws and remove the rear case (2.2).
- Loosen the nine (S4) screws and remove the mainboard shielding.

Closing the instrument

- Mount the mainboard shielding and fasten the nine (S4) screws.

Note that the shielding of wire-tree (W1) is reconnected again.

- Mount the rear case (2.2) and fasten the two (S3) screws.
- Mount the grip cover and fasten the three (S2) screws.
- Connect the connector (X2).
- Mount the top cover (2.4) and bottom cover (2.1).
- Fasten the six (S1) screws .
- Perform the quick verification test.

  Refer to Chapter 2 "Adjustment".

Caution! *Note that the connecting cables are still connected.*

- ***Note:*** *When detaching the connectors, proceed with caution.*

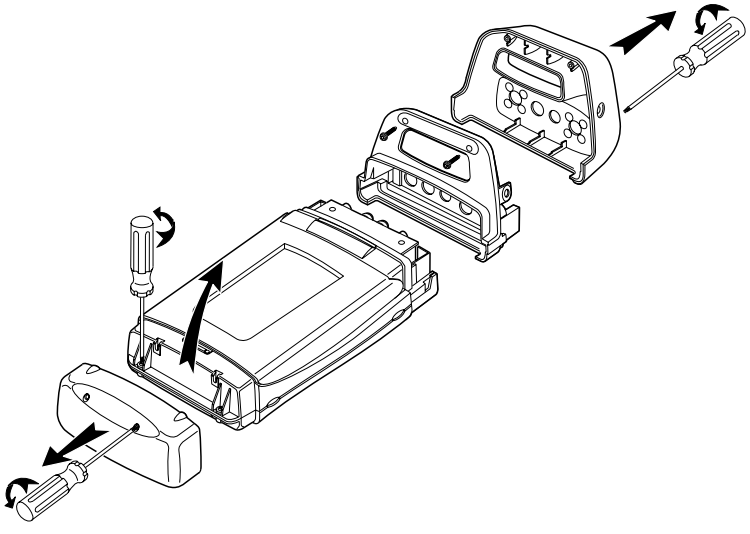


Fig. 3-5 Opening the instrument

Replacing the battery

- Open the instrument.
- Disconnect connector (X1).
- Replace the battery.
- Connect (X1).
- Close the instrument.
- Charge the battery.
- Perform the quick verification test.

  Refer to Chapter 2 "Adjustment".

- ***Note:*** *It is recommended that battery charging be performed with the instrument switched OFF and the AC power connected to the mains. The charging time for a full battery is about 4 hours.*

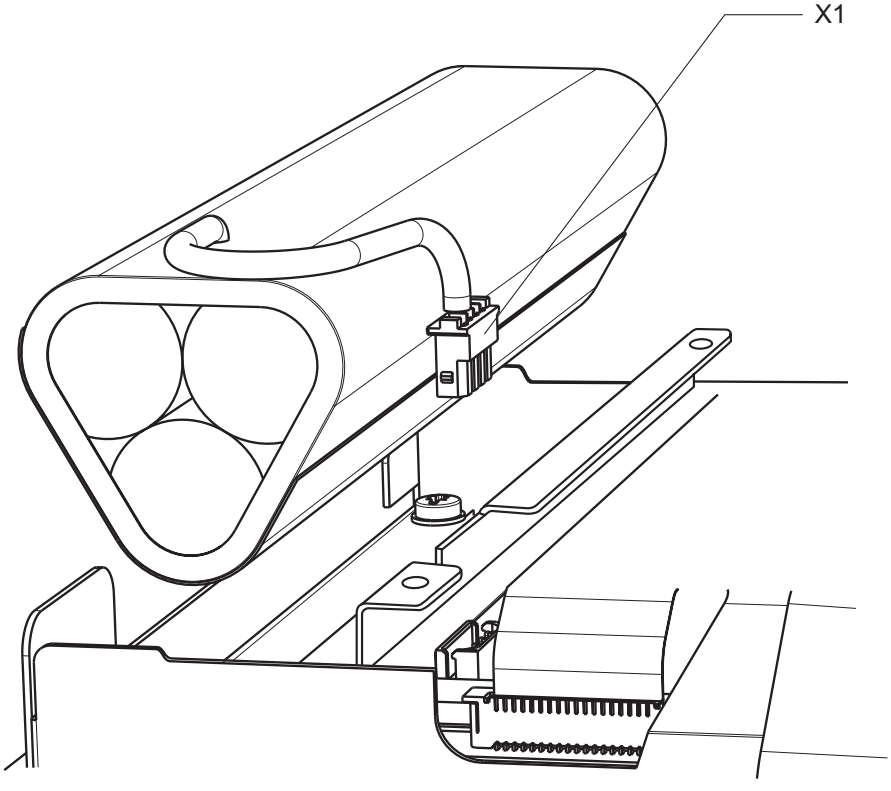


Fig. 3-6 Replacing the battery

Replacing the housing

Housing parts:

2.1: Bottom cover
2.2: Rear case
2.3: Grip cover
2.4: Top cover

Notes: *When replacing the rear case, the existing type plate must be placed on the new rear case, or the old series number must be written on the new type plate.*

When the grip cover is replaced, the "input unit power/audio connections" have to be placed in the new grip cover. See also Replacing the power/audio connections.

- Open the instrument.
- Replace the specific housing part.
- Close the instrument.
- Perform the quick verification test.

  Refer to Chapter 2 "Adjustment".

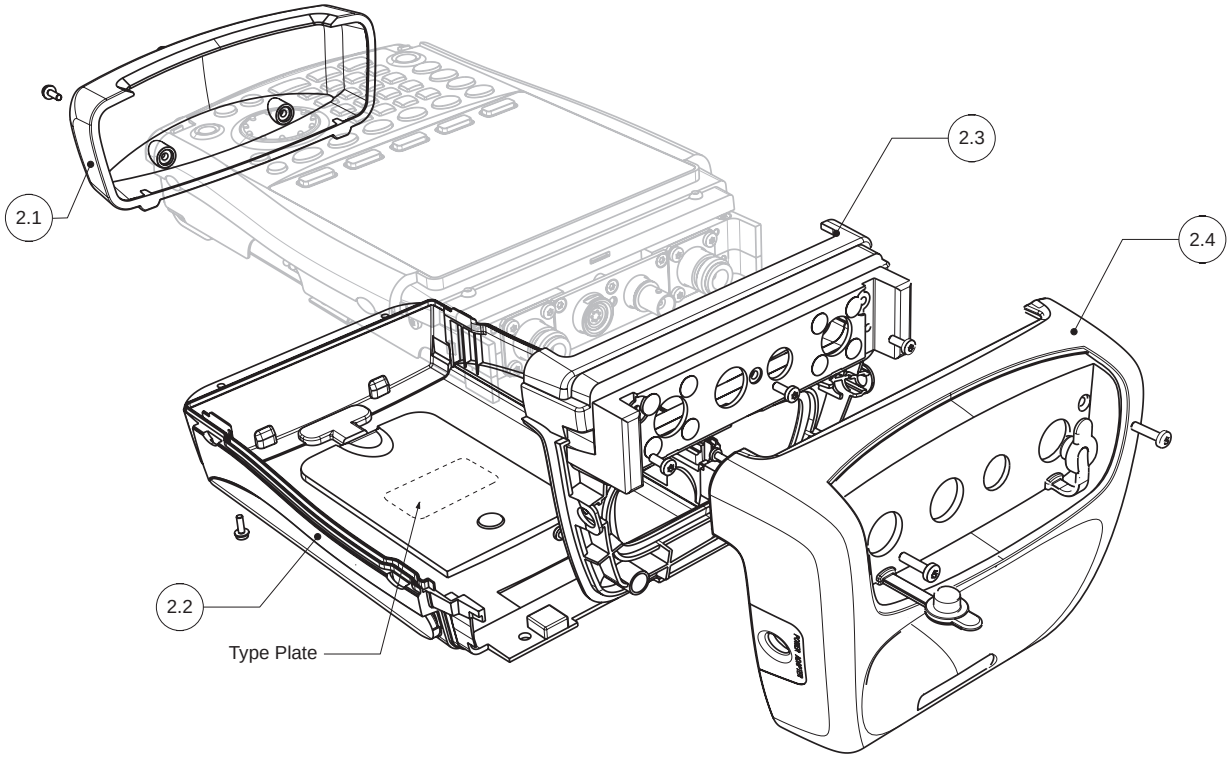


Fig. 3-7 Replacing the housing

Replacing the front unit for R&S FSH

- Open the instrument.
- Remove the battery .
- Remove the Main Unit:
  - Disconnect the connectors (X3), (X4), and (X5).
  - Remove the main unit by unscrewing the two (S5) screws.
- Remove the LCD colour module:
  - Losen the four (S6) screws.
  - Remove the LCD colour module.
- Use the new front unit to assemble the instrument again.

Before mounting the unit, make sure that no dust is present between the front unit and the LCD colour module.

- Mount the LCD colour module with the four (S6) screws.
- Mount the Main Unit with the two (S5) screws.
- Connect the connectors (X3), (X4), and (X5).
- Mount the battery.
- Close the instrument.
- Perform the quick verification test.

  Refer to Chapter 2 “Adjustment”.

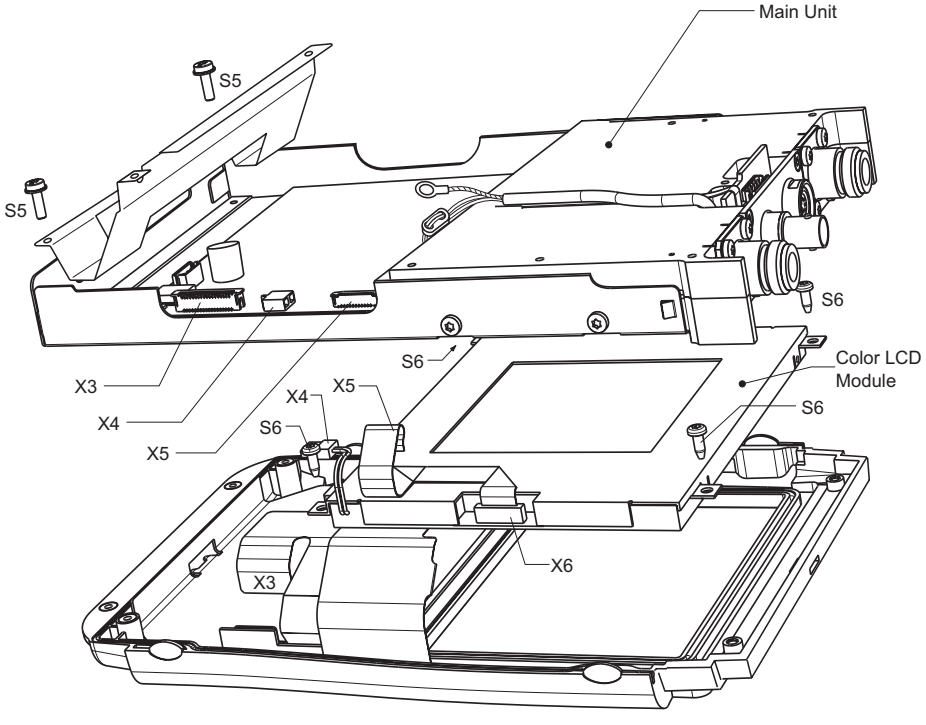


Fig. 3-8 Replace Front Unit

Replacing the Color LCD Module

- Open the instrument.
- Remove the battery
- Remove the Main Unit:
  - Disconnect the connectors (X3), (X4), and (X5).
  - Remove the main unit by unscrewing the two (S5) screws.
- Remove the LCD colour module:
  - Disconnect the connector (X6).
  - Losen the four (S6) screws.
  - Remove the LCD colour module.
- Use the new module to assemble the instrument again.

Before mounting the unit, make sure that no dust is present between the front unit and the colour module.

- Mount the LCD colour module with the four (S6) screws.
- Mount the Main Unit with the two (S5) screws.
- Connect the connectors (X3), (X4), and (X5).
- Mount the battery.
- Close the instrument.
- Perform the quick verification test.

  Refer to Chapter 2 "Adjustment".

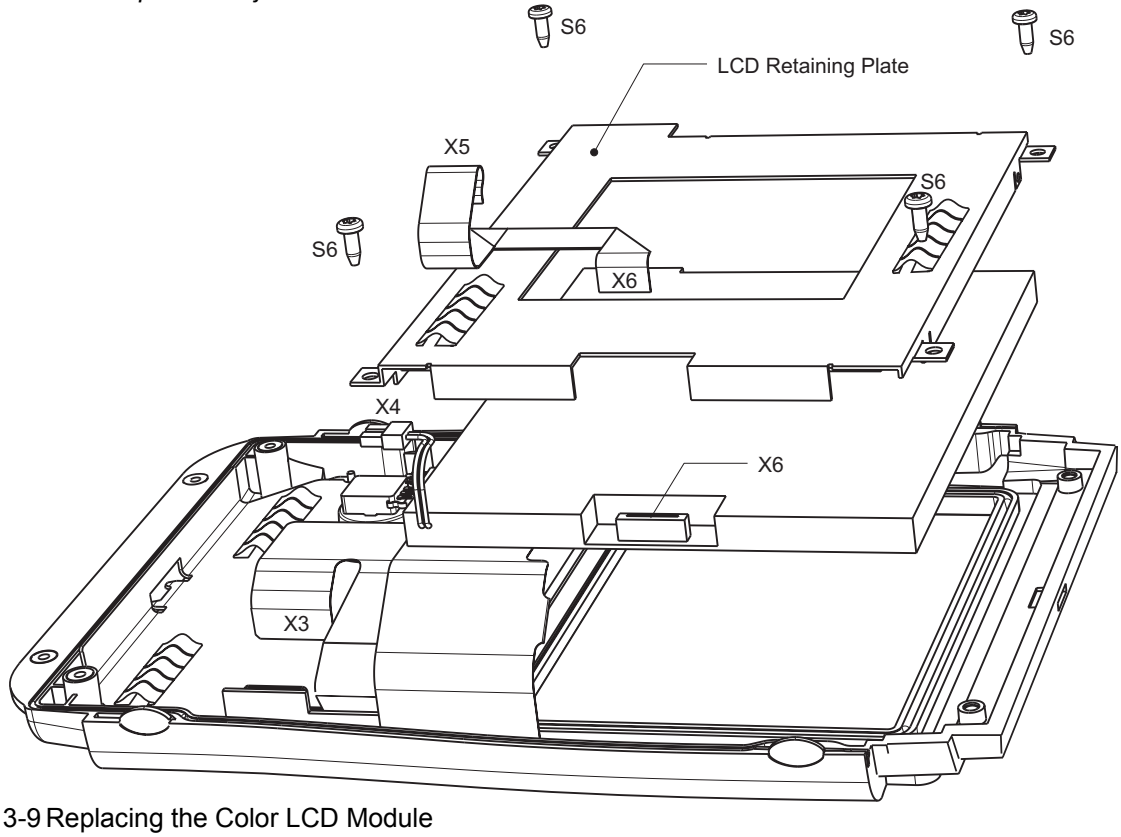


Fig. 3-9 Replacing the Color LCD Module

Replacing the RF/IF module

- Open the instrument.
- Disconnect the flat cable (X8) and remove the tape.
- Disconnect the connectors (X7) and (X9).
- Remove the RF/IF module by unscrewing (S7).
- Remove the binder and BNC connector block:
  - Loosen the four (S8) screws.
  - Remove the connector block.
- Mount the new RF/IF module.
- Mount the binder and BNC connector block with the four (S8) screws.
- Connect connectors (X7) and (X9).
- Mount the flat cable (X8), including the ferrite.
- Fasten the flat calbe with the tape.
- Close the instrument.
- Perform the manual adjustment.

  Refer to Chapter 2 "Adjustment".

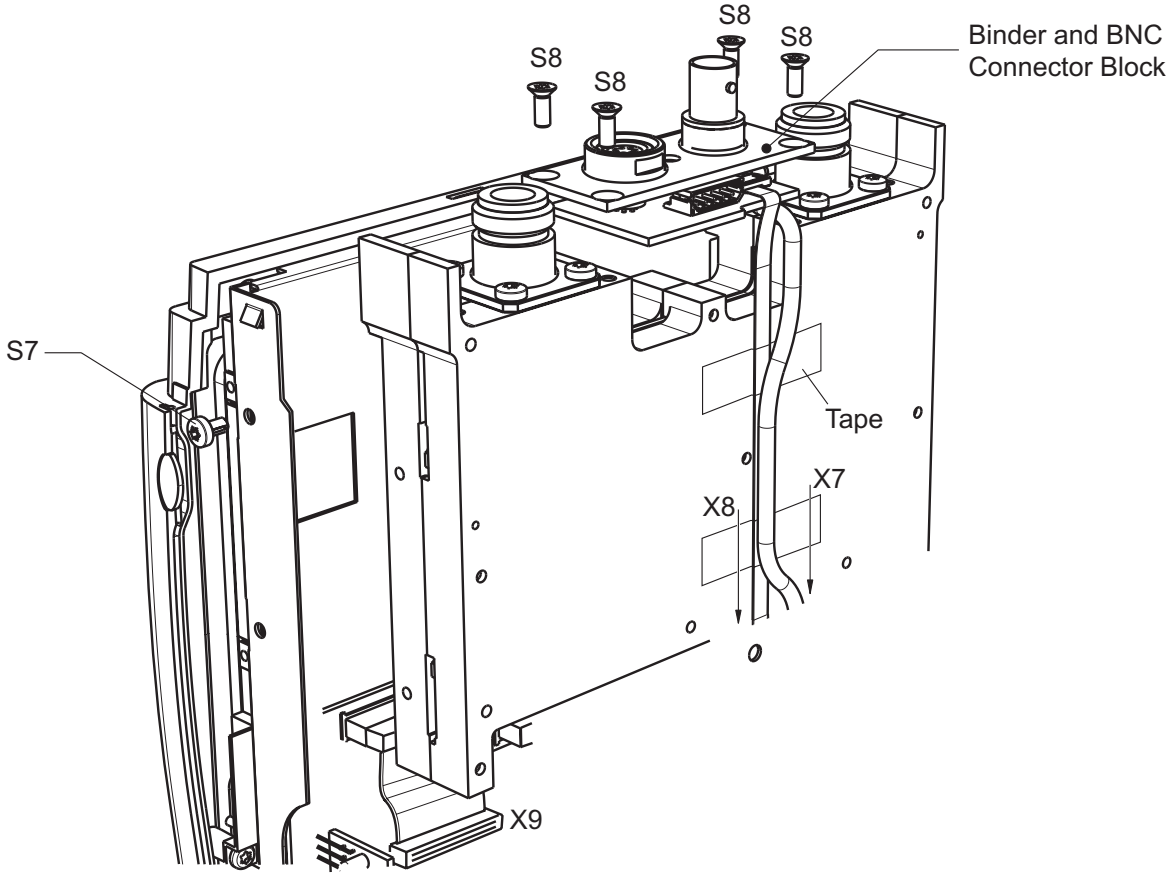


Fig. 3-10 Replacing the RF/IF Module

Replacing the mainboard

The mainboard contains information about the instrument like the serial number. Special tools are necessary to update this information after replacement of the mainboard. Therefore the exchange of the mainboard is possible in a R&S Service Center, only.

- Open the instrument.
- Remove the battery.
- Loosen the two (S5) screws.
- Disconnect the connectors (X3), (X4), (X5), (X7), (X8) and (X9).
- Loosen the three screws (S11) and the remove the board.

Note that the two lower screws are isolated.

- Remove the distance screw (S12)
- Mount the new board and fasten (S11) and (S12).
- Connect connectors (X3), (X4), (X5), (X7), (X8) and (X9).
- Mount the Battery.
- Close the instrument.
- Perform the manual adjustment.

  Refer to Chapter 2 "Adjustment".

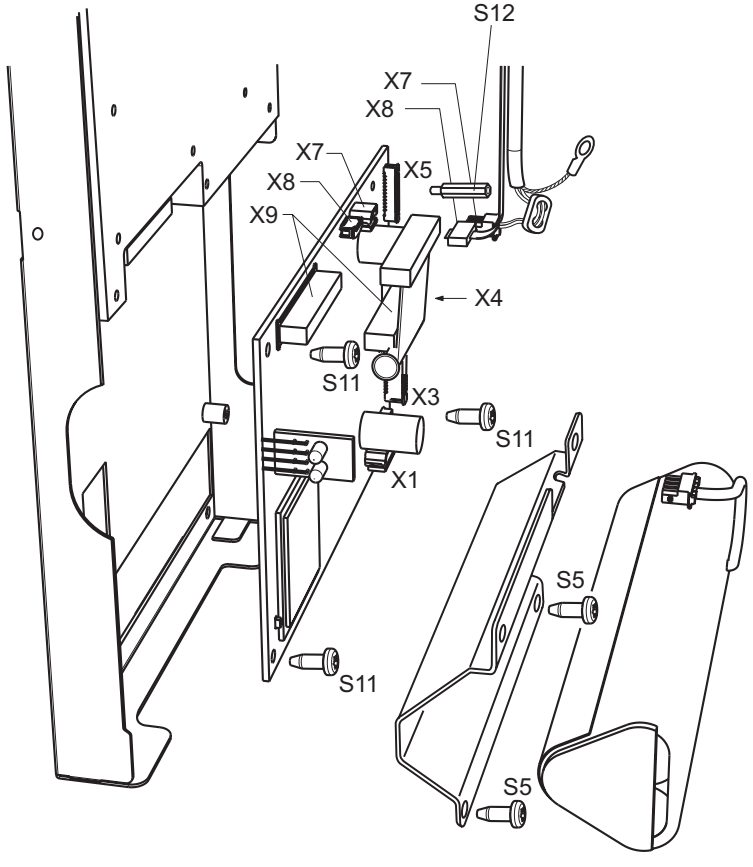


Fig. 3-11 Replacing the Main Board

Replacing the N connector

- Open the instrument.
- Remove the battery.
- Remove the RF/IF module by unscrewing (S7).
- Disconnect the flat cable (X8).
- Disconnect the connectors (X7) and (X9).
- Remove the binder and BNC connector block:
  - Loosen the four (S8) screws.
  - Remove the connector block.
- Loosen the two screws (S9) from front RF housing for each N connector.
- Loosen the 9 screws (S10) from the RF housing.
- Remove the front RF housing.
- Clean the center contact of solder left from the N connector to be replaced.
- Loosen the other two screws (S9) from the appropriate N connector.
- Mount the new connector by first screwing it into the rear RF housing.
- Solder the center connection.
- Mount the front RF housing (S10).
- Fasten the two screws (S9) to the front RF housing for each the N connector.
- Mount the binder and BNC connector block with the (S8) screws.
- Mount the flat cable (X8), including the ferrite.
- Connect the connectors (X7) and (X9).
- Mount the RF/IF module (S7).
- Mount the Battery and close the instrument.
- Perform the manual adjustment.
  Refer to Chapter 2 "Adjustment".

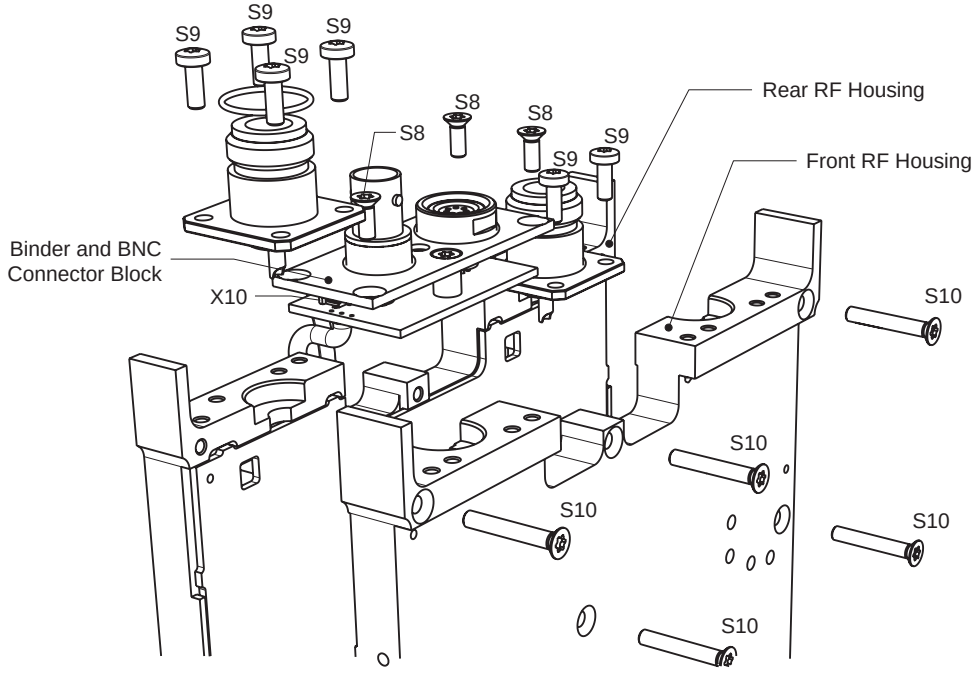


Fig. 3-12 Replacing the N-Connector

Replacing the binder and BNC connector block

(See exploded view for references).

- Open the instrument.
- Disconnect the flat cable (X10).
- Disconnect the connector (X7).
- Remove the binder and BNC connector block:
  - Loosen the four (S8) screws.
  - Remove the connector block.
- Mount the binder and BNC connector block with the four (S8) screws.
- Connect the connectors (X7).
- Mount the flat cable (X10).
- Close the instrument.
- Perform the quick verification test.

  Refer to Chapter 2 "Adjustment".

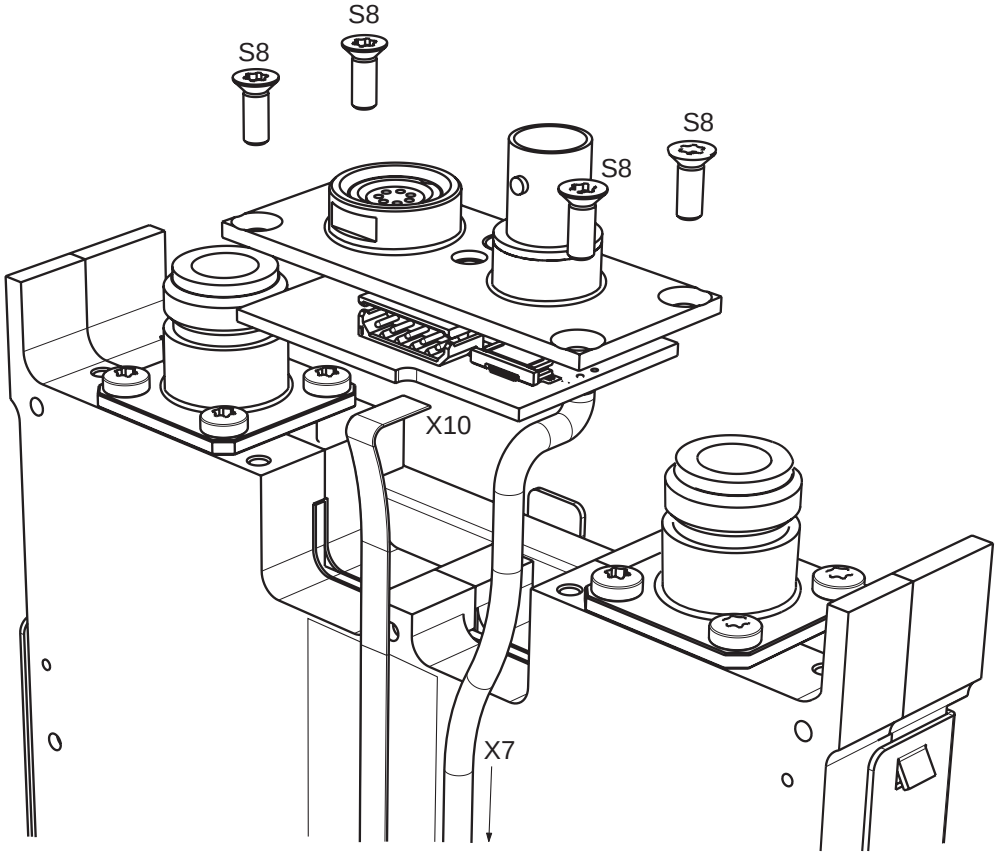


Fig. 3-13 Replacing the Binder and BNC connector block

Replacing the power/audio connections

- Remove the top cover.
- Disconnect the connector (X2)
- Remove the connection wire tree from the grip cover.
- Mount the wire tree again.
- Mount the top cover.
- Perform the quick verification test.

  Refer to Chapter 2 “Adjustment”.

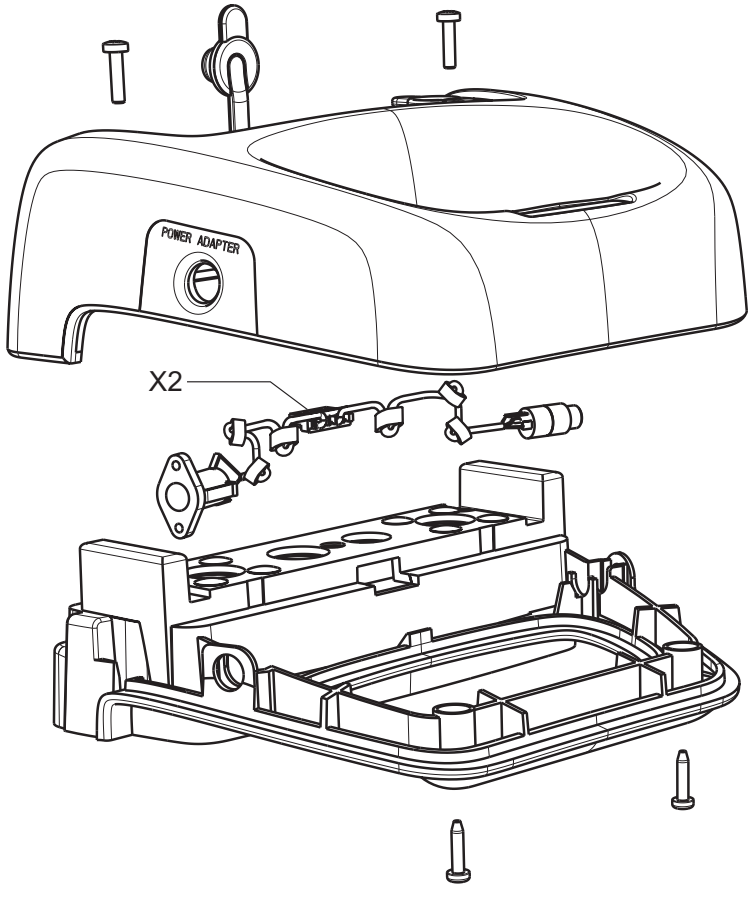


Fig. 3-14 Replacing the Power/ Audio Connections

Replacing a cable from the cable set

Note: *The cable set is needed in the event that a cable is damaged during the replacement of one of the modules.*

Cables from the set:
- 10.1: 50-p
  10.2: Flat flexible cable, 8 connections
  10.3: Flat cable 22-p

For replacement instructions, refer to the individual modules.

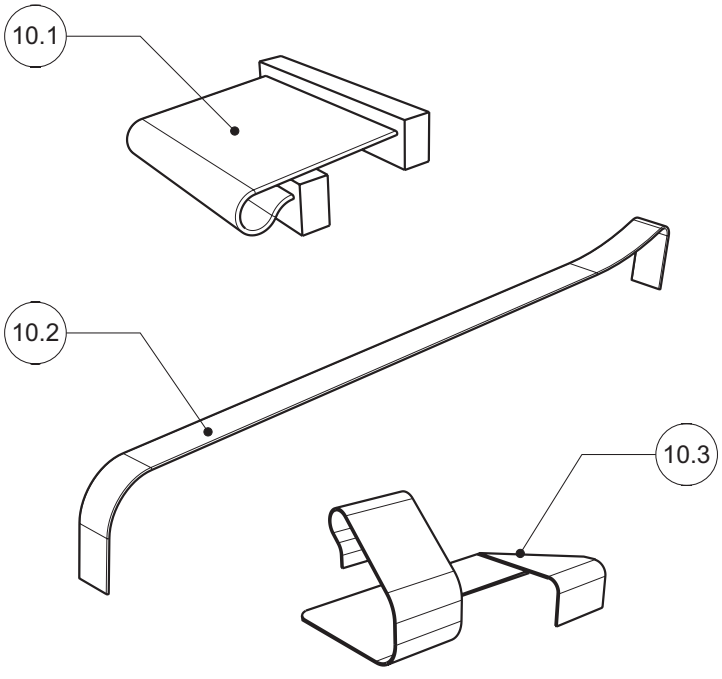


Fig. 3-15 Cable set

Troubleshooting

Malfunctions can have simple causes but can also be due to faulty components or modules.

These troubleshooting instructions can be used to locate causes of error down to the board level and to return the instrument to operability by replacing boards.

We recommend that the instrument be shipped to our experts at the service centers (refer to address list) for module replacement and further error correction.

Warning! *Do not plug or unplug boards without first disconnecting the battery and the AC Power Supply!*

Note: *When problems occur, first check whether any connections (cables, plug-in connections of boards, etc) are damaged or incorrectly connected.*

Overview of errors, causes, and possible corrective actions

This section lists various errors, the probable module causing the problem, and the suggested corrective action.

Troubleshooting problems in switching on the instrument

- **Error: R&S FSH cannot be switched on.**

Note: ***When the instrument is switched on,*** *a beep is issued to indicate that the instrument has started.*

Troubleshooting procedure	Possible cause of error and further steps
Verify that the AC power is present. ⇓	Connect the adapter to the mains and wait several minutes until the charger has recharged the battery.
Press the On button for > 5 s. ⇓	This will force the instrument to perform a software reset and a reset of the internal RAM. The instrument firmware will restart and all data will be reset.
Open the instrument and check the battery. ⇓	Voltage > 7.2 V.
Check the connectors from the AC power supply: X2 and X7 (refer to section “Repair”).	Power connector broken. *Replace the power and audio connections.* *Replace the mainboard (refer to “Replacing the module”).*

- **Error: Display remains dark although the beep indicated that the software was started.**

Troubleshooting procedure	Possible cause of error and further steps
Open the instrument and check X4 (backlight connector).	Backlight connection open or backlight converter broken. *Connect again, or replace the mainboard or LCD colour module.*

- **Error: Display has erroneous colours and characters.**

Troubleshooting procedure	Possible cause of error and further steps
Open the instrument and check X5 and X6 (LCD data).	Data connection broken, or circuitry on the mainboard defective. *Connect again, or replace the mainboard or LCD colour module*

- **Error: Frequency response not compliant with specification.**

  This response can only be corrected at the service center. ***Replace the RF/IF module*.**

- **Error: Level display very noisy.**

Troubleshooting procedure	Possible cause of error and further steps
Check the N connector. ⇓	The N connector is soiled. *Clean or replace the N connector.* *Replace the RF/IF module.*

- **Error: Several keys on the keypad do not respond.**

Troubleshooting procedure	Possible cause of error and further steps
Check X3.	The connection is not operational or the keypad is broken. *Correct the connection, or replace the front unit.*

- **Error: Power sensor does not respond properly.**

Troubleshooting procedure	Possible cause of error and further steps
Check X8 and X10.	The connection is not operating correctly, the binder connector is broken, the mainboard is broken, or the cables are broken. *Correct the connection.* *Replace the binder and BNC connector block.* *Replace the mainboard.* *Replace any broken cable in the cable set.*

4 Software Updates / Installing Options

This chapter provides information on software updates and how to install options on the R&S FSH. Additional manuals supplied along with software/firmware updates or with options obtained later can be recorded here.

Installing New R&S FSH Software

A new firmware version can be installed via the R&S website. You can download the newest software version, and the new software can be loaded onto the R&S FSH by using the setup program.

The instructions are included in the program.

Installing the Options

The following options are available with the R&S FSH:

Distance to Fault Measurement for R&S FSH	R&S FSH-B1	1145.5750.02
Remote Control via RS-232-C	R&S FSH-K1	1145.3458.02
Vector Transmission and Reflection Measurements	R&S FSH-K2	1145.3387.02

5 Documents

This chapter provides information on how to order spare parts, and it also contains the spare parts list.

Shipping of Instrument and Ordering of Spare Parts

Please contact your Rohde & Schwarz support center or our spare parts express service if you need to request service, repair your equipment, or order spare parts and modules.

The list of Rohde & Schwarz representatives and the address of our spare parts express service are provided in the front section of this service manual.

You will need to provide the following information in order for us to respond to your inquiries quickly and accurately and to determine whether the warranty for your instrument is still valid:

- Instrument model
- Serial number
- Detailed error description in case of repair
- Contact partner for checkbacks

Shipping of instrument

When shipping the instrument, be sure to provide sufficient mechanical and anti-static protection:

- Repack the instrument as it was originally packed. The antistatic packing foil prevents unintentional electrostatic charging from occurring.
- If you do not use the original packaging, include sufficient padding to prevent the instrument from slipping inside the package. Wrap antistatic packing foil around the instrument to protect it from electrostatic charging.

Shipping of a module

When shipping a module, be sure to provide sufficient mechanical and antistatic protection:

- Ship the module in a sturdy, padded box.
- Wrap the board in antistatic foil.
  If the packaging is antistatic but not conductive, additional conductive packaging is required. The additional packaging is not required if the enclosed packaging is conductive.

Ordering spare parts

To deliver replacement parts promptly and correctly, we need the following information:

- R&S order number (refer to the spare part lists in this chapter)
- Designation
- Number of units
- Instrument type for the replacement part
- Contact person for possible questions

The R&S order number to be used when ordering replacement parts and modules as well as power cables can be found further below.

Refurbished modules

- Refurbished modules are an economical alternative to original modules. It should be kept in mind that refurbished modules are not new, but repaired and fully tested parts. They may have signs of use but they are electrically and mechanically equivalent to new modules.

- To find out which refurbished modules are available, please contact your Rohde & Schwarz representative (or the central service division at Rohde & Schwarz in Munich).

Return of defective replaced modules

- Defective modules of the replacement program that can be repaired may be returned within 3 **months** after delivery of the replaced module. A repurchasing value is credited.
- Excluded are parts that cannot be repaired, e.g. PCBs that are burned, broken or damaged by repair attempts, incomplete modules, or parts that have endured heavy mechanical damage.
- Defective parts must be sent back with an **accompanying document of returned items** containing the following information:
  - R&S order number, serial number and designation of the removed part
  - **Precise** description of the error
  - R&S order number, serial number and designation of the instrument the part was removed from
  - Date of part removal
  - Name of the technician who exchanged the part
- A **document of returned items** is provided along with each replacement module.

Spare Parts

The R&S Order numbers necessary for ordering replacement parts and modules can be found in the spare part lists provided below.

List of R&S FSH spare parts

The following table lists available spare parts together with their R&S order numbers.

Reference	Part	R&S Order Number
1	Battery Pack for R&S FSH (R&S FSH-Z32)	1145.5796.02
2	Housing R&S FSH without top holster	1157.3258.00
2.4	Top holster for FSH without tracking generator	1157.3487.00
	Top holster for FSH with tracking generator	1157.3493.00
3	Front unit for R&S FSH3	1157.3241.00
	Front unit for R&S FSH6	1300.7591.00
4	LCD module	1157.3229.00
	LCD plane for FSH3	1300.7704.00
	LCD plane for FSH6	1300.7710.00
5	RF/IF module for R&S FSH3 without tracking generator	1157.3606.00
	RF/IF Module for R&S FSH3 with tracking generator	1157.3612.00
	RF/IF Module for R&S FSH6 without tracking generator	1300.7604.00
	RF/IF Module for R&S FSH6 with tracking generator	1300.7610.00
6	Mainboard for R&S FSH	1157.3570.00
7	N connector	1157.3235.00
8	Interconnection board	1157.3587.00
9	Input unit (power and audio connectors, including wire tree)	1157.3270.00
10	Set of cables for R&S FSH	1157.3329.00
21	AC mains adapter for R&S FSH (EU Version)	1157.3293.00
22	AC mains adapter for R&S FSH (UK Version)	1157.3306.00
23	AC mains adapter for R&S FSH (US Version)	1157.3312.00
	AC mains adapter for R&S FSH (AUS Version)	1157.3370.00

Note: *The reference can be found in the exploded drawing in Chapter 3.*

Important Note!

When replacing a module, please pay careful attention to the safety instructions and the repair instructions provided in chapter 3 and at the beginning of this service manual.

When shipping a module, be sure to provide sufficient mechanical and antistatic protection.