



**ROHDE & SCHWARZ**

Test and Measurement  
Division

**Service Manual**

**Power Sensor**

**R&S FSH-Z44**

**1165.2305.02**

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# 1 Performance Test

## Preliminary Remarks

Verifying the data sheet specifications for the Directional Power Sensor R&S FSH-Z44 requires a considerable amount of equipment and care. Since the equipment needed is presently available only at Rohde & Schwarz Central Service and at the Rohde & Schwarz Memmingen production site, a manufacturer's recalibration should be requested before the calibration interval expires.

A **quick test** is recommended for checking the sensor with simple means.

## Quick Test

The following tests are used to check the Directional Power Sensor R&S FSH-Z44 with simple means. If the tests are passed, compliance of the sensors with the specifications within the complete frequency and power range is largely ensured.

The test consists of:

- Zeroing
- Absolute measuring accuracy
- Directivity

## Test Instructions

- The tests are to be performed at an ambient temperature of 18 °C to 28 °C. The DUT should be connected to the (activated) R&S FSH base unit for at least 30 minutes before the tests are performed.
- The test limits used in the following sections are based on the data sheet but are valid only on the conditions defined for the corresponding test step. They are therefore not legally binding as accuracy specifications; only data sheet specifications are legally binding.
- The entries made on the Handheld Spectrum Analyzer R&S FSH are abbreviated as follows:
  - [<KEY>] Press front-panel key, e.g. [**SPAN**]
  - [<SOFTKEY>] Press softkey, e.g. [MARKER -> PEAK]
  - [<nn unit>] Enter value and confirm with unit, e.g. [**12 kHz**]Successive entries are separated by [:], e.g. [**BW : MANUAL RES BW : 3 kHz** ]
- The DUT and the reference power meter need to be connected directly with one another if possible, because connecting cables can cause measuring errors due to attenuation and reflection. If test fixtures are necessary, precision designs with low attenuation and reflection should be used

## Measuring Equipment and Accessories for Quick Test

Item	Type of unit	Recommended characteristics	Recommended units	R&S order number	Application
1	Spectrum analyzer	To connect the DUT	R&S FSH	1145.5850.03 1145.5850.13 1145.5850.23	Zeroing, absolute measuring accuracy, directivity, matching
2	Power meter	To connect the sensor specified in item 3	R&S NRP	1143.8500.02	Zeroing, absolute measuring accuracy
3	Power sensor	Measurement uncertainty (absolute) <0.12 dB in range from 200 MHz to 4 GHz at 4 W power	R&S NRP-Z23	1137.8002.02	Zeroing, absolute measuring accuracy
4	Signal generator	200 MHz to 4 GHz, 13 dBm	R&S SMT06	1039.2000.06	Absolute measuring accuracy, directivity
5	Power amplifier	200 MHz to 4 GHz, output power >5 W, gain $\geq 25$ dB			Absolute measuring accuracy, directivity
6	Harmonics filter	To suppress harmonics at the power amplifier output (harmonics suppression of $\geq 25$ dB required)			Absolute measuring accuracy, directivity

### Checking Zeroing

- Test setup - See Fig. 1-1
- Setting on signal generator - RF OFF (level switched off)
- Setting on R&S FSH
- [ **PRESET** ]
  - [ **MEAS: MEASURE: POWER SENSOR** ]
  - [ **ZERO: CONTINUE** ]
- Test of R&S FSH
- Message "Power Sensor Zero OK".
  - Display value within the limits of the test report.

## Checking Absolute Measuring Accuracy and Directivity

Test setup

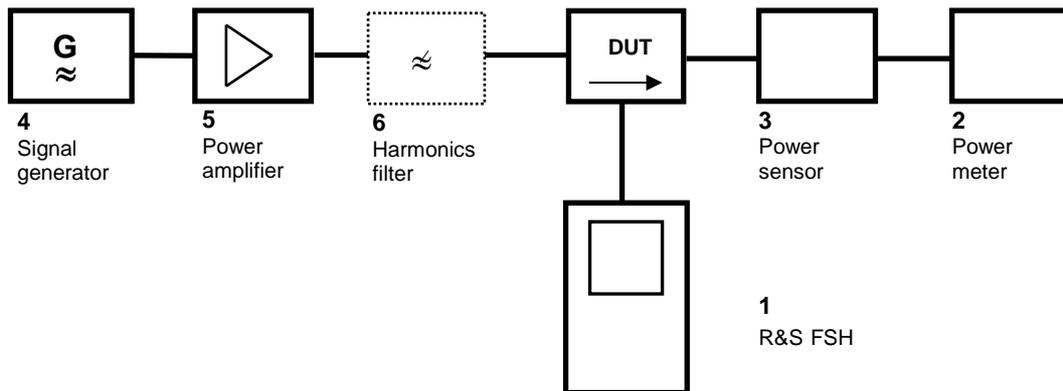


Fig. 1-1 Test setup for testing absolute measuring accuracy and directivity

Setting on signal generator - RF OFF (level switched off)

Setting on R&S FSH

- [ **PRESET** ]
- [ **MEAS: MEASURE: POWER SENSOR** ]
- [ **UNIT: Reflection...: dB (Return Loss)** ]
- [ **ZERO: CONTINUE** ]

Setting on power meter

- [ **(PRE)SET: (PRE)SET** ]
- [ **ZERO/CAL: ZERO/CAL** ]

Setting on power meter	- [ <b>FREQ: 200 MHz</b> ]
Setting on signal generator	- Frequency 200 MHz, level set so that the power meter displays (36±1) dBm
Setting on R&S FSH	- [ <b>FREQ: 200 MHz</b> ]
Test	- Read the level on the R&S FSH and on the power meter, and then record the level deviation of the R&S FSH in the test report and check it.
	- Read the return loss on the R&S FSH, enter it under item 3 (directivity) in the test report and test it.

Repeat framed settings/tests for the other frequency points; be sure not to forget the frequency setting on the power meter and on the R&S FSH.

## Test Report

**Quick Test****Directional Power Sensor R&S FSH-Z44**

Stock number: 1165.2305.02    Name: .....

Serial number: .....

Date: .....

Item no.	Characteristic	Min. value	Actual value	Max. value	Unit
1	Zeroing	-----		+ 8.0	dBm
2	Absol. measuring accuracy				
	0.2 GHz	-0.22	.....	+0.22	dB
	0.3 GHz	-0.20	.....	+0.20	dB
	0.5 GHz	-0.20	.....	+0.20	dB
	0.7 GHz	-0.20	.....	+0.20	dB
	1.0 GHz	-0.20	.....	+0.20	dB
	1.5 GHz	-0.20	.....	+0.20	dB
	1.8 GHz	-0.20	.....	+0.20	dB
	2.4 GHz	-0.20	.....	+0.20	dB
	3.0 GHz	-0.20	.....	+0.20	dB
	3.5 GHz	-0.20	.....	+0.20	dB
	4.0 GHz	-0.20	.....	+0.20	dB

Item no.	Characteristic	Min. value	Actual value	Max. value	Unit
3	Directivity				
	0.2 GHz	20	.....	-----	dB
	0.3 GHz	20	.....	-----	dB
	0.5 GHz	20	.....	-----	dB
	0.7 GHz	20	.....	-----	dB
	1.0 GHz	20	.....	-----	dB
	1.5 GHz	20	.....	-----	dB
	1.8 GHz	20	.....	-----	dB
	2.4 GHz	20	.....	-----	dB
	3.0 GHz	17	.....	-----	dB
	3.5 GHz	16	.....	-----	dB
	4.0 GHz	16	.....	-----	dB

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## **2 Adjustment**

### **Preliminary Remarks**

Adjusting the Directional Power Sensor R&S FSH-Z44 to the accuracy level specified in the data sheet requires the use of special measurement equipment beyond that offered by most calibration laboratories. Thus, the adjustment procedures are not described here.

Instead, sensors requiring repair or ones whose calibration interval has expired should be sent to Rohde & Schwarz Central Service, where the sensors will be recalibrated and readjusted.

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### 3 Repair of Directional Power Sensor R&S FSH-Z44

This section describes the design and simple repair and troubleshooting measures.

#### Design and Circuit Description

#### Block Diagram

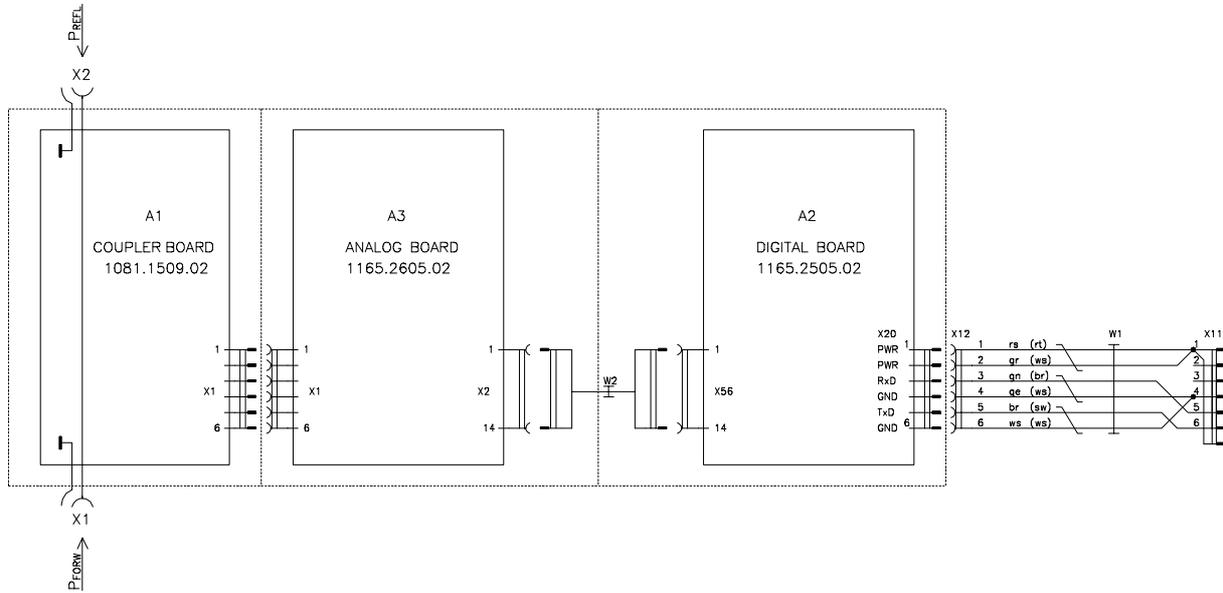


Fig. 3-1 Block diagram of Directional Power Sensor R&S FSH-Z44

## Description of the Block Diagram

The R&S FSH-Z44 can accurately measure the power of forward and return waves over a wide power and frequency range. It contains all modules necessary for analog and digital signal processing and returns completely corrected digital measurement values to the R&S FSH base unit via a serial interface.

### Coupler board A1

The directional coupler board A1 contains a loop directional coupler with frequency response compensation and an RF rectifier equipped with zero bias Schottky diodes for both measurement directions. The rectifiers supply a power-proportional output voltage for each direction; for the power display on the R&S FSH, measurement direction 1>2 (forward) is used, and the matching measurement result comes from the ratio of the return and forward power. Thus, the power frequency response of the sensor is largely determined by the loop coupler and RF rectifier for direction 1>2, while the blocking-to-forward resistance relevant for the matching measurements is primarily influenced by the loop coupler for direction 2>1 and the two RF connectors. Since the directional couplers are stable over a long life cycle (partly due to the protected position on the inside of the housing), the RF connectors are the first items that should be replaced if the blocking-to-forward resistance is not adequate (see page 3.7). If the directional coupler needs to be repaired, send the sensor to Rohde & Schwarz Central Service.

### Analog board A3

On the analog board A3, the output voltages of the RF rectifiers that are supplied via X1 are amplified while keeping noise and drift values low, and they are each digitized via an integrated A/D converter. One of the A/D converters also cyclically checks the various operating voltages of the sensor and measures the output voltage of a temperature sensor in order to compensate the temperature of the RF rectifiers. The A/D converters are connected to the controller board A2 via serial data interfaces, and this board also supplies the operating voltages for the analog board via X2. Since the analog board can only be adjusted together with the coupler board and digital board (i.e. not by itself), a complete adjustment procedure must be performed on the sensor following a repair or replacement (done only by Rohde & Schwarz Central Service).

### Controller board A2

This module largely contains the voltage feed for the sensor, i.e. the preparation of the different operating voltages from the 5 V supply voltage of the R&S FSH base unit, and a microcontroller for controlling instrument functions. These functions include communication with the R&S FSH base unit via a serial interface, control of the analog board and preparation of the digitized raw measurement values up to the final measurement result. Temperature, frequency (from the base unit) and custom characteristic data are used to correct measurement values. The characteristic data is stored in an EEPROM on the controller board, and its contents can be overwritten when an adjustment is performed.

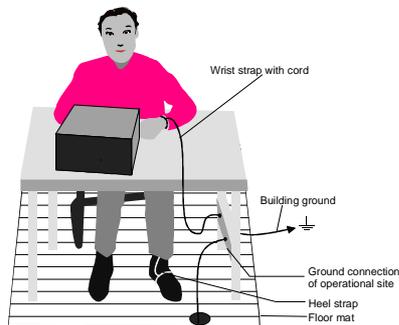
If the controller board is replaced, a complete adjustment of the sensor must be performed afterwards (only by Rohde & Schwarz Central Service) in order to load the custom characteristic data onto the (new) EEPROM.

## Module Replacement

The following section describes how to change the exterior housing and replace the connector cable and RF connectors. If one of the electronic modules (coupler board, analog board or controller board) is defective, the sensor must be sent to Rohde & Schwarz Central Service for repair.



### Caution!



- *Observe the safety instructions at the beginning of this manual.*
- *To avoid damaging electronic components, the instrument should only be opened on a workplace protected against electrostatic discharges. The following methods can be used separately or combined to ensure protection against electrostatic discharges:*
- *Anti-static wrist strap with grounding cable.*
- *Conductive flooring with foot strap.*

## Tools Required

Phillips head screwdriver	sizes 0 and 1	
Set-screw wrench	2.5 mm	} only for replacing RF connectors
Mandrel (round)	Ø(2 to 3) mm	



### Note!

*The numeric values in brackets refer to the items in the list of module parts and spare parts in Table 3-1 and section 5.*

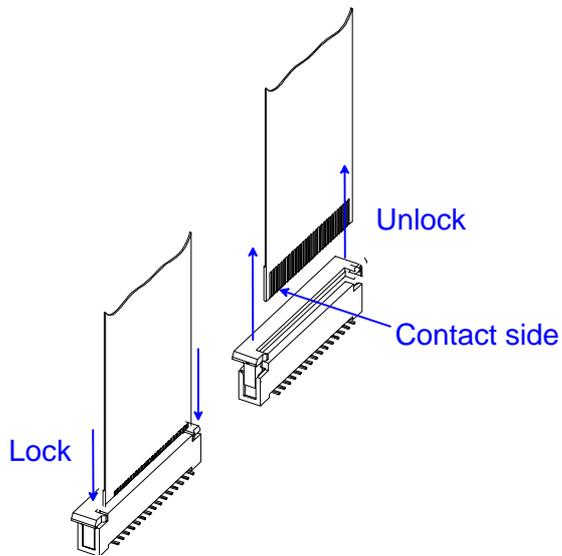


Fig. 3-2 Membrane cable W2



**Note:**

**Remove membrane cables:**

*Membrane cables can be removed only after unlocking the female connector.*

**Connect membrane cables:**

*Note the contact side and lock the female connector.*

## List of Modules

Table 3-1 List of modules/spare parts for the R&S FSH-44

Item No.	Designation	Electrical identification	Stock No.
20	INNER CONDUCTOR 2		1081.3353.00 *)
30	DISK 2		1081.3360.00 *)
40	SLEEVE		1081.3382.00 *)
50	N SOCKET	X1, X2	1081.1944.00
60	SCREW DIN912-M3X6		0423.9608.00 *)
90	COUPLER BOARD	A1	**)
160	CONTROLLER BOARD	A2	**)
170	ANALOG BOARD	A3	**)
190	COMBINATION SCREW DIN9600-M2.5X6		0071.5040.00 *)
210	CABLE	W1	1165.2411.02
270	COVER SHELL WITH SHIELDING		1081.1415.00
280	LABEL		1165.2463.00
300	SCREW M2.5X10.4		0071.5757.00 *)

\*) Available but not maintained in spare parts stock, i.e. delivery time may be longer.

\*\*\*) Spare part not available; to be replaced only by Rohde & Schwarz Central Service.

## Opening and Reassembly (Exchange of Plastic Cover Shells)

### Opening

- Undo and remove two Phillips head screws (300) next to the cable inlet.
- Pull the plastic cover shells (270) apart toward the rear and then completely dislodge them from one another by twisting them apart on the front side.



*Before opening, disconnect the sensor from the R&S FSH base unit!*

To open, undo screws

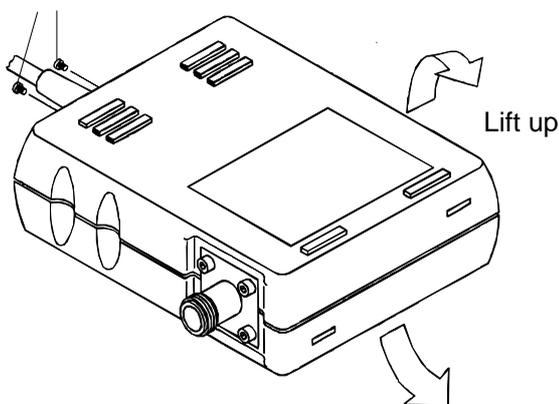


Fig. 3-3 Opening the sensor

### Reassembly

- Place the sensor in the upper cover shell in such a manner that the lettering of the two RF connectors (**1** and **2** on the metal housing) matches the lettering on the type label.
- Push the lower cover shell with bracket and recess on the front side into the corresponding slots of the upper shell and press the two halves together at the rear.
- Screw the housing into place on the rear side.



*When reassembling the sensor, make sure that RF connectors "1" and "2" match the lettering on the type label!*

## Replacement of the Cable

- Open sensor.
- Pull off shielding cover from analog board and controller board.
- Undo two screws (190) on flange of cable (210) and remove flange from housing
- Remove five screws (190) on controller board and remove board. (Note: The analog board is fastened with four screws).
- Disconnect sensor cable W1 from controller board.

## Installation

- Follow the reverse sequence to install the cable

## Replacement of the RF Connectors

### Removal

- Undo flange screws (60) and pull removable sockets (50) out of housing.
- Use mandrel to push out any inner conductors (20) (if damaged).
- Replace damaged parts.

### Installation (After Removing Inner Conductors)

- Replace disks (30).
- Insert the sleeves (40) in such a manner that the front bezels on the outer diameter point toward the RF connector.
- Push in the inner conductor (20).
- Plug the removable sockets (50) to inner conductor and screw on flange.

# Troubleshooting

Malfunctions may sometimes be due to simple reasons but may also result from defective components. These troubleshooting instructions permit malfunctions or errors to be traced down to the module level. Module replacement and further diagnostics of errors or malfunctions should be carried out by Rohde & Schwarz customer service. It is therefore recommended to send the unit to the nearest service center (see list of addresses at the beginning of this manual).



*Before opening, disconnect the sensor from the R&S FSH base unit!*

## Overview of Errors, Causes and Corrective Steps

This section provides an overview of possible errors, their causes and corrective steps.

### Problems that occur when connecting the sensor or activating the power measurement function on the R&S FSH base unit.

- **Error: The power sensor is not found (neither measured values nor error messages are displayed on the R&S FSH base unit).**

Troubleshooting instruction	Potential error source and further corrective steps
Disconnect sensor from base unit and check male and female connectors for damage.  ↓	Defective connection.  <i>Exchange sensor cable or connector block 8 (1157.3287.00) in the R&amp;S FSH.</i>
Check whether the error also occurs on a different base unit.	Error source within base unit.  <i>Replace defective cable in cable set or exchange mainboard.</i>  Error source within sensor.  <i>Open sensor and check connection of sensor cable W1 with controller board.</i>  <i>Replace sensor cable.</i>  <i>Send sensor in for repair (controller board possibly defective).</i>

- Error: R&S FSH base unit detected an error (error message Power Sensor Error ).

Troubleshooting instruction	Potential error source and further corrective steps
Disconnect sensor from base unit and check male and female connectors for damage.	Defective connection. <i>Exchange sensor cable or connector block 8 (1157.3287.00) in the R&amp;S FSH.</i>
⇓	
Check whether the error also occurs on a different base unit.	Error source within base unit. <i>Replace defective cable in cable set or exchange mainboard.</i>  Error source within sensor. <i>Open sensor and check connection of sensor cable W1 with controller board.</i> <i>Replace sensor cable.</i> <i>Send sensor in for repair (controller board possibly defective).</i>

- Error: The power sensor detected an error (error message Power Sensor Hardware Error).

Troubleshooting instruction	Potential error source and further corrective steps
⇓	
Check whether error also occurs on a different base unit.	The sensor detected an error during selftest or during communication (hardware fault or defective voltage supply).  Error source within base unit (e.g. voltage supply). <i>Replace mainboard.</i>  Error source within sensor. <i>Send sensor in for repair (analog board or controller board is defective).</i>

Problems during measurement

- Error: Measured power readings are erroneous.

Troubleshooting instruction	Potential error source and further corrective steps
Check the RF connectors for damage.	Removable socket(s) damaged.  <i>Replace the damaged RF connector (see instruction on page 3.7).</i>
Perform quick test as described in section 1.	The measured values are highly erroneous.  <i>Send in the sensor for repair (coupler board or analog board defective).</i>  The test limits are only slightly exceeded. This means that the sensor hardware is probably OK.  <i>Send in the sensor for calibration.</i>

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## 5 Documents

This section provides information for ordering spare parts and contains the relevant documents for the Rohde & Schwarz Directional Power Sensor R&S FSH-Z44.

### 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.

### Ordering Spare Parts

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

- Rohde & Schwarz stock 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 stock number to be used when ordering replacement parts and modules as well as power cables can be found further below.

## **Ordering Replacement Sensors**

Rohde & Schwarz maintains a replacement program for a number of power sensors. Within this program, it is possible to provide a fully operational power sensor to replace a defective one at short notice and at a fixed price. Please note that replacement sensors are used equipment but are always tested. They are therefore equivalent to new sensors even though they may exhibit slight signs of use. If required, the delivery of replacement sensors can include a new calibration. If interested, please contact your nearest Rohde & Schwarz office.

## Spare Parts

The Rohde & Schwarz stock numbers necessary for ordering replacement parts and modules can be found in the spare part lists provided below.

### List of R&S FSH-Z44 spare parts

The following table lists available spare parts together with their Rohde & Schwarz stock numbers.

Item No.	Designation	Electrical identification	Stock No.
20	INNER CONDUCTOR 2		1081.3353.00 *)
30	DISK 2		1081.3360.00 *)
40	SLEEVE		1081.3382.00 *)
50	N SOCKET	X1, X2	1081.1944.00
60	SCREW DIN912-M3X6		0423.9608.00 *)
90	COUPLER BOARD	A1	**)
160	CONTROLLER BOARD	A2	**)
170	ANALOG BOARD	A3	**)
190	COMBINATION SCREW DIN9600-M2.5X6		0071.5040.00 *)
210	CABLE	W1	1165.2411.02
270	COVER SHELL WITH SHIELDING		1081.1415.00
280	LABEL		1165.2463.00
300	SCREW M2.5X10.4		0071.5757.00 *)

\*) Available but not maintained in spare parts stock, i.e. delivery time may be longer.

\*\*\*) Spare part not available; to be replaced only by Rohde & Schwarz Central Service.