

Test Port Adapter – Rohde & Schwarz Interchangeable Port Connector Application Note

An RF Test Port Adapter system is implemented and delivered with some Rohde & Schwarz RF test instruments. These interchangeable port connectors are used on instruments capable of operating at frequencies of 26 GHz and above, and include spectrum analyzers, signals generators and EMC test receivers.

This Application Note identifies the Test Port Adapter types, their parameters, compatibility and usage.

Note:

Please find the most up-to-date document on our homepage:

<http://www.rohde-schwarz.com/appnote/1MA100>

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1 Abstract

The Rohde & Schwarz RF 'Test Port Adapter' system is found on some Rohde & Schwarz test instruments that operate at frequencies of 26 GHz and above.

The primary purpose of the RF Test Port Adapter system is to provide a sacrificial interface to a test instrument, thus protecting the instrument RF front panel connector from mechanical damage. After prolonged use, it may simply be exchanged without a need for service to the instrument Co-axial RF connectors for higher frequencies tend to be more fragile. The Test Port Adapter system offers the side benefit that an RF port can temporarily be configured with a more rugged connector, if an application does not require the highest frequencies supported by an instrument.

The Test Port Adapter consists of the RF front-end interface on the test instrument called the Test Port Adapter Body, and a removable Test Port Adapter Head which connects to the Test Port Adapter Body. The adapter head provides the interface to a cable or device under test.

The Rohde & Schwarz RF Test Port Adapter system is also called the 'Interchangeable Port Connector System'. This document uses the term 'Test Port Adapter'.

Note that R&S instruments that do not support the Test Port Adapter system will have a panel mounted RF port, providing direct connection to RF cables, etc. Considerable care must be taken to ensure that RF connectors applied to the port are undamaged, clean and mechanically compatible to ensure the longevity of the instrument RF port. Failure to observe these requirements could lead to the instrument RF connector becoming damaged or wearing prematurely. More information on RF connector care may be found in ["Guidance on Selecting and Handling Coaxial RF Connectors used with Rohde & Schwarz Test Equipment"](#), 1MA99.

2 The RF Test Port Adapter System

The Test Port Adapter system comprises two parts:

- Test Port Adapter Body – Manufacturer fitted RF instrument port.
- Test Port Adapter Head - Provides the RF interconnection between the Test Port Adapter Body and the desired RF coaxial interface.

Fig. 2-1 shows an example of the Test Port Adapter Body on a typical R&S microwave instrument. It is easily identified and separated from standard RF connectors due to its mechanical design. It is important to realize that standard commercially available coaxial RF connectors cannot be interfaced directly with the Test Port Adapter Body.



Fig. 2-1: Example of the R&S Test Port Adapter Body

Fig. 2-2 shows the same instrument fitted with two different interchangeable Test Port Adapter Heads.

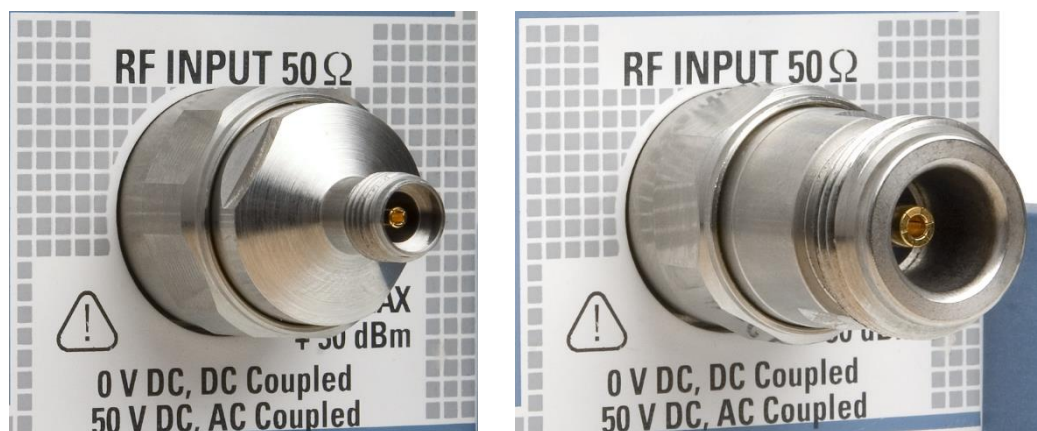


Fig. 2-2: Test instrument with Test Port Adapter Head attached.
2.92 mm, female (left) and Type N, female (right).

The Test Port Adapter system offers several advantages, including:

- Damage to the standard RF interface on the Adapter Head (N, 3.50 mm etc.) is easily overcome through simply exchanging the Adapter Head. Therefore, no service costs or lengthy repair waiting times are incurred.
- The Adapter Heads support several standard RF interfaces. This helps to reduce the need for additional in-line RF adapters. This flexibility is particularly useful where mechanical robustness is required, for example, use of a 2.40 mm to N-type adapter makes for a mechanically weak interface.

3 Test Port Adapter Bodies

The RF port on the instrument supports the Test Port Adapter Body. Two versions exist, each supporting a different frequency range:

- Low frequency range (for instruments up to 33 GHz, usable DC to 40 GHz)
- High frequency range (DC to 50 GHz)

These are distinguishable by mechanical differences. These are shown in [Fig. 3-1](#) on the opposing interface of the associated Test Port Adapter Heads.

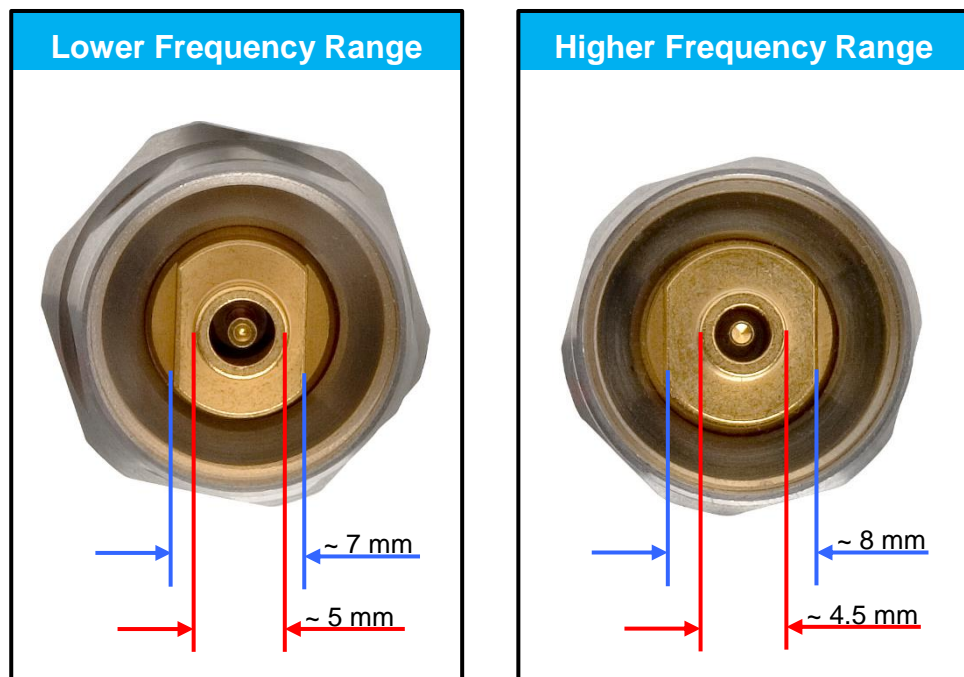


Fig. 3-1: Test Port Adapters – Differences in the mechanical interfaces depending upon the frequency range.

[Fig. 2-1](#) shows that the Test Port Body supports a slot. Correspondingly, the Test Port Adapter has a “key” shown in [Fig. 3-1](#) (blue dimensions), that fits into the Test Port Body, but only if both parts support the same frequency range.

4 Test Port Adapter Heads

4.1 Supported Test Port Adapter Heads

For each of the Test Port Adaptor Bodies, Rohde & Schwarz provides a selection of different Adapter Heads to interface to standard commercially available precision RF coaxial connectors (Table 4-1).

Please consult instrument datasheets for more information about supplied or compatible Test Port Adapter Heads.

Test Port Adapter Body type	RF connector type	Upper frequency limit	Gender	R&S Part number
Low frequency (40 GHz)	Type N	18 GHz	Male	1021.0541.00
			Female	1021.0535.00
	Precision 3.5 mm	26.5 GHz	Male	1021.0529.00
			Female	1021.0512.00
High frequency (50 GHz)	Type N	18 GHz	Male	1036.4783.00
			Female	1036.4777.00
	Precision 2.92 mm	40 GHz	Male	1036.4802.00
			Female	1036.4790.00
	Precision 2.4 mm	50 GHz	Female	1088.1627.02

Table 4-1: Test port adapter heads for Rohde & Schwarz microwave instruments

The physical structure of an RF coaxial connector defines the upper frequency limit of operation. This is the primary consideration when choosing an Adapter Head¹. Most commercial RF connectors are named after, and are referred to by the inside diameter of the outer conductor.

Rohde & Schwarz instruments that do not have the RF Test Port Adapter system will always be fitted with an RF connector type that supports the maximum frequency limit of the instrument, e.g. the R&S®ZNB40 vector network analyzer operates to 40 GHz and therefore is supplied with 2.92 mm connectors. Considerable care must be taken to avoid damaging these instrument mounted RF connectors.

¹ The power handling capability of the Adapter Head is not a concern since the Adapter Head can tolerate power levels above the power handling limitations imposed by the instrument hosting the Adapter Head.

4.2 Connecting a Test Port Adapter Head to the Body

The process of applying the Test Port Adapter Head to the Body on the instrument is straightforward, but care must be taken to avoid mechanical damage:

1. Check that the Test Port Adapter Head and Body support the same frequency range (See Fig. 3-1).
2. Carefully align the two connectors, bringing them together along a common axis (Fig. 4-1).
3. Align and slot the metal “key” of the Adapter into the “slot” on the Body.
4. The nut on the Adapter and the thread on the Body should now be in close proximity or touching. Using fingers, engage the Adapter nut with the thread of the Body through turning the nut clockwise.
5. Continue to finger tighten the nut and support the Adapter, ensuring that both the Adapter and the Body maintain a common axis about the connector central conductor.
6. If the connector assembly is clean and undamaged, it will be possible to finger tighten the assembly to within about half a turn of the required torque. If any resistance is experienced prior to this point, or if a spanner is required, then it is very likely that one or both of the connectors is damaged and should be taken apart and inspected immediately.
7. Once firmly coupled, the nut should be torqued to a prescribed limit using a calibrated torque wrench.

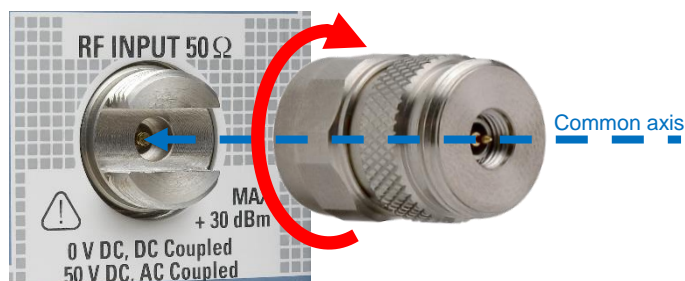


Fig. 4-1: Applying a Test Port Adapter Head to the RF Body on a test instrument

4.3 Female Adapter Heads

Fig. 4-2 is an example of a Test Port Adapter Head showing the RF connector structures seen at both ends of the Adapter. The left image shows the interface to the Test Port Adapter Body on the instrument. The right image shows the other end of the Adapter, in this example, a female Type N RF connector.



Fig. 4-2: Test Port Adapter - Interface to the Test Adapter Body (left) and at the opposite end, a female Type N RF connector (right).



Fig. 4-3: Test Port Adapter with female 2.92 mm RF connector.

Fig. 4-3 provides a further example of a Test Port Adapter, converting from the Test Port Adapter Body on the instrument to a female 2.92 mm RF connector.

4.4 Male Adapter Heads

Similarly, there are also Test Port Adapter Heads supporting male versions of commercially available RF coaxial connectors. Fig. 4-4 shows both ends of a Test Port Adapter Head supporting a male precision 3.5 mm interface. Examples of male Type N and 2.92 mm RF Test Port Adapter Heads are given in Fig. 4-5.



Fig. 4-2: Test Port Adapter - Interface to the Test Adapter Body (left) and at the opposite end, a male 3.5 mm RF connector (right).



Fig. 4-3: Test Port Adapter Heads with male N-type (left) and male precision 3.5 mm (right).

4.5 Recommended Torque Requirements

To provide accurate, repeatable RF measurements, the Test Port Adapter Head must be correctly torqued on to the instrument Test Port Body using a calibrated torque wrench.

Connector Type	Torque Limit		Nut opening	
	lb-inch	Nm	Inch	mm
Test Port Adapter system	17.7	2	0.709	18

Table 4-2: Test Port Adapter system torque wrench requirements

5 Mechanical compatibility between RF coaxial connector types.

Table 4-1 provides a list of precision coaxial RF connectors supported by the R&S Test Port Adapter system. However, mechanical compatibility exists between some of the small coaxial RF connector types and is summarized in Table 5-1.

Mechanical compatibility of RF connectors					
Connector name	1.85 mm	2.4 mm	2.92 mm	3.5 mm	SMA
1.85 mm	✓	✓	✗	✗	✗
2.4 mm	✓	✓	✗	✗	✗
2.92 mm	✗	✗	✓	✓	✓
3.5 mm	✗	✗	✓	✓	✓
SMA	✗	✗	✓	✓	✓

Table 5-1: Mechanical compatibilities of small threaded RF coaxial connectors

The table shows that there are two clear groups of mechanically compatible RF connectors. The two groups are defined by two mechanical parameters:

- Thread parameters
- Dimensions of the connector center pin

The two groups of RF connectors are summarized as:

- 1.85 mm and 2.4 mm ($\varnothing = 0.25$ inch, 36 threads per inch).
- 2.92 mm, 3.5 mm and SMA ($M7 \times 0.75-6G$: $\varnothing = 7$ mm, pitch = 0.75 mm, 6G tolerance)

Connector types within one group cannot be connected to types in the other group. Fig. 5-1 shows that the inner measurement of the center conductor of female 3.5 mm and 2.92 mm connectors are the same (0.92 mm). However, the same parameter on a 2.4 mm female connector is considerably smaller (0.51 mm) and therefore leads to incompatibility.

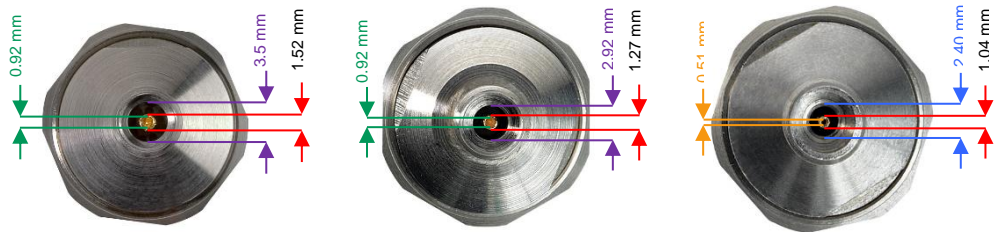


Fig. 5-1: Three different female connectors; 3.5 mm (left), 2.92 mm (center) and 2.4 mm (right). Note compatibility of center pins (0.92 mm) on the 2.92 mm and 3.5 mm connectors; and incompatibility with the center pin (0.51 mm) on the 2.4 mm connector.

Caution is advised when interfacing Subminiature Version A (SMA) connectors to 2.92 mm and 3.5 mm precision connectors. Orange ticks are used in Table 5-1 to highlight this concern. SMA connectors are easily identified by the use of a white PTFE² dielectric instead of the air dielectric used in precision connector types. The mechanical tolerances applied to SMA connectors are lower than other connector types, leading to considerable mechanical variance. Therefore, a poor quality SMA connector applied to a precision connector can result in permanent damage to one or both connectors.

Very Important:

- When using any threaded RF connector, use of a torque wrench is essential to ensure repeatable accurate measurements and to avoid damaging the RF connectors through over tightening. Each type of RF connector has a specified torque setting.
- When connecting two mechanically compatible types of connector, the upper frequency limit of the combined RF assembly will be limited by the connector with the lower operating frequency. Additionally, impedance mismatch will occur at the interface of the two connectors. For these reasons, it is always advisable to use one connector type throughout a test system, specified to cover the required frequency range.

Further important information on compatibility; cleaning; correctly connecting and recommended torque requirements of popular commercially available RF connectors is given in the R&S application note: [“Guidance on Selecting and Handling Coaxial RF Connectors used with Rohde & Schwarz Test Equipment”](#), 1MA99.

² PTFE - Polytetrafluoroethylene

6 Literature

1. Rohde & Schwarz, "Guidance on Selecting and Handling Coaxial RF Connectors used with Rohde & Schwarz Test Equipment", [1MA99](#).
2. Doug Skinner, "Guidance on using Precision Coaxial Connectors in Measurement", Version 3, National Physics Laboratory. 2007.
3. Rohde & Schwarz, Data Sheets of the Measurement Instruments listed in the Appendix

7 Appendix

The following three tables provide information about R&S spectrum analyzers; receivers and signal generator instruments that support the Test Port Adapter system. Some microwave instruments do not support the Test Adapter System and are therefore not listed here.

Test Port Adapter Body type	RF connector type	Upper frequency limit	Gender	R&S Part number	R&S Spectrum Analyzers			
					FSUP50, FSU50	FSVR40, FSV40, FSQ40	FSU46, FSU43, FSEK, FSP40	FSVR30, FSV30, FSUP26, FSU26, FSIO26, FSEM, FSET22, FSQ26, FSP30
Low frequency (40 GHz)	Type N	18 GHz	Male	1021.0541.00	x	x	x	A
			Female	1021.0535.00	x	x	x	✓
	Precision 3.5 mm	26.5 GHz	Male	1021.0529.00	x	x	x	A
			Female	1021.0512.00	x	x	x	✓
High frequency (50 GHz)	Type N	18 GHz	Male	1036.4783.00	A	A	A	x
			Female	1036.4777.00	✓	✓	✓	x
	Precision 2.92 mm	40 GHz	Male	1036.4802.00	A	A	A	x
			Female	1036.4790.00	A	✓	✓	x
	Precision 2.4 mm	50 GHz	Female	1088.1627.02 ⁽¹⁾	✓	A	✓	x

Table 7-1: R&S Spectrum Analyzers.

✓ Adapter delivered with instrument

A Accessory available from R&S

x Not compatible

⁽¹⁾ Also referred to as R&S product *FSE-Z5*

Please check with the instrument data sheets for specific details of which test port adapter heads are supplied by default.

Appendix

Test Port Adapter Body type	RF connector type	Upper frequency limit	Gender	R&S Part number	R&S Measurement Receivers	
					ESU40, ESIB40, FSMR50 ⁽²⁾ , FSMR43	ESR26, ESU26, FSMR26, ESIB26
Low frequency (40 GHz)	Type N	18 GHz	Male	1021.0541.00	x	A
			Female	1021.0535.00	x	✓
	Precision 3.5 mm	26.5 GHz	Male	1021.0529.00	x	A
			Female	1021.0512.00	x	✓
High frequency (50 GHz)	Type N	18 GHz	Male	1036.4783.00	A	x
			Female	1036.4777.00	✓	x
	Precision 2.92 mm	40 GHz	Male	1036.4802.00	A	x
			Female	1036.4790.00	✓	x
	Precision 2.4 mm	50 GHz	Female	1088.1627.02 ⁽¹⁾	A	x

Table 7-2: R&S Measurement Receivers.

✓ Adapter delivered with instrument

A Accessory available from R&S

x Not compatible

⁽¹⁾ Also referred to as R&S product *FSE-Z5*

⁽²⁾ FSMR50 is also delivered with a precision 2.4 mm female adapter.

Please check with the instrument data sheets for specific details of which test port adapter heads are supplied by default.

Appendix

Test Port Adapter Body type	RF connector type	Upper frequency limit	Gender	R&S Part number	R&S Signal Generators	
					SMW200A-B112/120/131/140/212/220, SMA100B-B131/140/140L, SMB100A-B140/140L, SMF100A-B144 ⁽³⁾ , SMR27, SMR30, SMR40, SMP04	SMA100B-B112/112L/120/120L, SMB100A-B112/112L/120/120L, SMF100A-B122, SMR20, SMP02, SMP22, SMP03
Low frequency (40 GHz)	Type N	18 GHz	Male	1021.0541.00	x	A
			Female	1021.0535.00	x	A
	Precision 3.5 mm	26.5 GHz	Male	1021.0529.00	x	A
			Female	1021.0512.00	x	✓
High frequency (50 GHz)	Type N	18 GHz	Male	1036.4783.00	A	x
			Female	1036.4777.00	A	x
	Precision 2.92 mm	40 GHz	Male	1036.4802.00	A	x
			Female	1036.4790.00	✓	x
	Precision 2.4 mm	50 GHz	Female	1088.1627.02 ⁽¹⁾	A	x

Table 7-3: R&S Signal Generators.

- ✓ Adapter delivered with instrument
- A Accessory available from R&S
- x Not compatible
- ⁽¹⁾ Also referred to as R&S product *FSE-Z5*
- ⁽³⁾ SMF100A-B144 is also delivered with a precision 2.4 mm female Test Port Adapter.

Please check with the instrument data sheets for specific details of which test port adapter heads are supplied by default.

About Rohde & Schwarz

The Rohde & Schwarz electronics group is a leading supplier of solutions in the fields of test and measurement, broadcast and media, secure communications, cyber security, radiomonitoring and radiolocation. Founded more than 80 years ago, this independent global company has an extensive sales network and is present in more than 70 countries. The company is headquartered in Munich, Germany.

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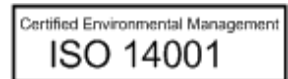
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Sustainable product design

- Environmental compatibility and eco-footprint
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