

R&S®FS-Z60/75/90/ Z110/140/170/220/325 Harmonic Mixers User Manual



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Version 03

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The User Manual describes the following R&S FS-Zxx models:

- R&S®FS-Z60 (40 GHz to 60 GHz) 1089.0799.02
- R&S®FS-Z75 (50 GHz to 75 GHz) 1048.0271.02
- R&S®FS-Z90 (60 GHz to 90 GHz) 1048.0371.02
- R&S®FS-Z110 (75 GHz to 110 GHz) 1048.0471.02
- R&S®FS-Z140 (90 GHz to 140 GHz) 3622.0708.02
- R&S®FS-Z170 (110 GHz to 170 GHz) 3622.0714.02
- R&S®FS-Z220 (140 GHz to 220 GHz) 3593.3250.02
- R&S®FS-Z325 (220 GHz to 325 GHz) 3593.3267.02

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1048.0242.02 | Version 03 | Harmonic Mixers

Throughout this document, R&S® is indicated as R&S.

1 Introduction

1.1 General Remarks

The harmonic mixers of the R&S FS-Zxx series are highly sensitive measuring accessories. Therefore, the following points should be observed during operation although the equipment is of a sturdy design.

Improper handling can cause the mixer to become faulty or damaged.

- Heavy shocks can cause the diodes in the mixer to be destroyed. Shock-proof packaging should therefore be used for storing or dispatching the mixer.
- The maximum power at the RF input and the LO input (see data sheet) must not be exceeded.
- Avoid electrostatic discharges near the connectors.
- When the mixer is not used, the LO/IF connector (SMA) as well as the RF port (waveguide) should be covered with the cap supplied with the unit.
- The function of the diodes should not be checked by means of an ohmmeter. This would lead to their destruction.
- Do not loosen the screws of the mixer. Repair of the mixer can only be done at the manufacturer's servicing department.
- Avoid scratching the contact surface of the waveguide flange.

The following conditions are necessary to operate the mixers:

The mixers can be operated with the following instruments from Rohde & Schwarz:

Instrument model	Necessary firmware version
R&S FSP40	For R&S FSU:
R&S FSU26/43/46/50/67	2.10 or higher with Windows NT
R&S FSQ26/40	3.10 or higher with Windows XP
R&S FSUP26/50	For R&S FSP:
R&S FSV30/40	2.11 or higher with Windows NT
R&S FSVR30/40	3.11 or higher with Windows XP
R&S FSW26/43/50	For R&S FSV
with option B21	1.40 or higher
	For R&S FSVR
	any firmware version
	For R&S FSW
	1.60 or higher

1.2 Typical Application

The harmonic mixers R&S FS-Z60, R&S FS-Z75, R&S FS-Z90 and R&S FS-Z110 are used for the frequency range extension of spectrum analyzers and signal analyzers (called "instrument" in this manual).

They allow measurements in the frequency ranges:

40 GHz to 60 GHz	R&S FS-Z60
50 GHz to 75 GHz	R&S FS-Z75
60 GHz to 90 GHz	R&S FS-Z90
75 GHz to 110 GHz	R&S FS-Z110

Due to the two-diode concept, these mixers do not require any biasing for operation so that measurements with higher level accuracy and reproducibility compared to single diode mixers can be performed.

The mixers of the R&S FS-Zxx series have been developed for use with R&S spectrum analyzers. Thus, the conversion loss data supplied, apply only when used in combination with R&S spectrum analyzers.

1.3 Description

The mixer R&S FS-Z60 is of two-port type, which means that only one coaxial cable is required for feeding the LO signal and tapping the IF signal. The two signals are separated by means of a diplexer in the instrument. The mixers R&S FS-Z75, R&S FS-Z90, and R&S FS-Z110 are of three port type which means that they have separate connectors for the LO input and the IF output signal. Biasing is not required. The two design concepts are shown in [Figure 1-1](#).

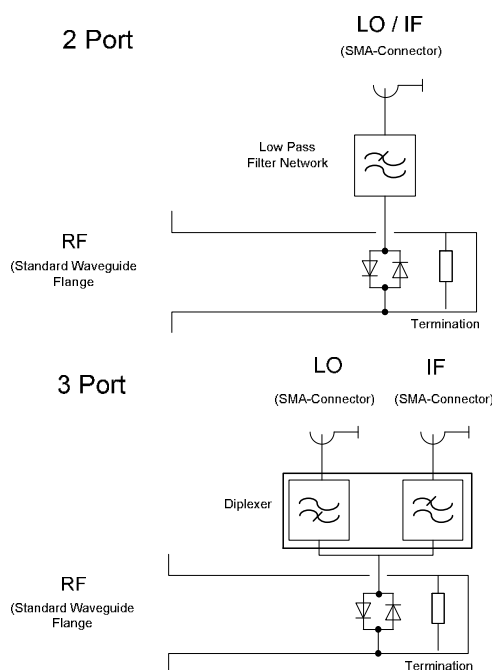


Figure 1-1: Design of R&S FS-Zxx harmonic mixers

The signal to be measured is fed into the input (RF) of the mixer (Standard waveguide flange).

The signal of the first local oscillator (LO) is applied to the mixer via the LO/IF SMA connector for the 2 port type, and via the LO SMA connector for the 3 port type, respectively.

Nonlinearities produce harmonics of the LO signal which are used to convert the input signal to a lower intermediate frequency (IF).

The signal converted to the intermediate frequency is tapped via the LO/IF connector on the 2 port mixer type, or the separate IF connector on the 3 port type, respectively, and fed into the corresponding connector of the analyzer. Since the LO signal and IF signal are fed and tapped via the same coaxial cable in case of a two port mixer, it is necessary to separate the two signals by means of a diplexer, which is integrated in the Rohde & Schwarz instruments listed above.

The mixer does not have any preselection. Image products and other unwanted mixer products are displayed on the instrument in addition to the wanted mixer products.

Firmware functions (AUTO ID) are available to identify the input signals and separate them from image signals and other mixing products (see the operating manual of the used instrument for details).

The conversion loss of the harmonic mixers must be taken into account in order to display the level of the measured signal correctly. The conversion loss is dependent on the frequency and the characteristics of the mixer in use. Therefore correction loss data is supplied for each mixer (see section "Conversion Loss Data").

1.4 Conversion Loss Data

The conversion loss of a harmonic mixer is measured in the factory. The resulting data is supplied in a document, which contains the list of frequencies and the conversion loss measured at each individual frequency. In addition, a table with correction data is affixed to the mixer, which contains a smaller number of frequency points.

Correction data is also supplied in form of a file on a USB stick (or 3.5" floppy disc with older models) to facilitate level correction. This file contains conversion loss data of 50 frequency points and all further parameters required for operating the mixer with R&S spectrum analyzers.

The prerequisites to read this file are explained in section "[Prerequisites](#)".

The conversion loss data only refers to the frequency-dependent conversion loss of the mixer. The attenuation of the cable used to tap the IF should be considered separately (see section "[Parameters and Settings](#)").

High-quality low-loss coaxial cables should be used to feed the LO signal or tap the IF signal to obtain a low conversion loss for the mixer. The spectrum analyzer's option B21 comes with corresponding coaxial cables. It is highly recommended to always use these cables supplied with the B21.

2 Preparing for Use

To prepare a measurement with the external mixer, connect the mixer and the instrument in the specified order (also indicated in [Figure 2-1](#)).

1. First connect the waveguide flange of the harmonic mixer to the DUT.

Note: Do not connect the coax cables to the mixer prior to this step to protect them against mechanical stress.

2. Connect the coax cable(s) supplied with the B21 to the LO OUT / IF IN port of the instrument.

For 3 port mixers, connect another cable to the IF IN port of the instrument.

3. Connect the coax cable(s) from the LO OUT / IF IN port of the instrument to the LO/IF SMA connector (2 port type) or the LO SMA connector (3 port type) of the harmonic mixer.

For 3 port mixers, additionally connect the cable from the IF IN port of the instrument to the IF port of the mixer.

Note: Connect each cable to the analyzer first, before connecting it to the mixer. This makes sure that the coax cables are not electrostatically charged when connected to the mixer, which protects the mixer diodes against possible electrostatic discharge.

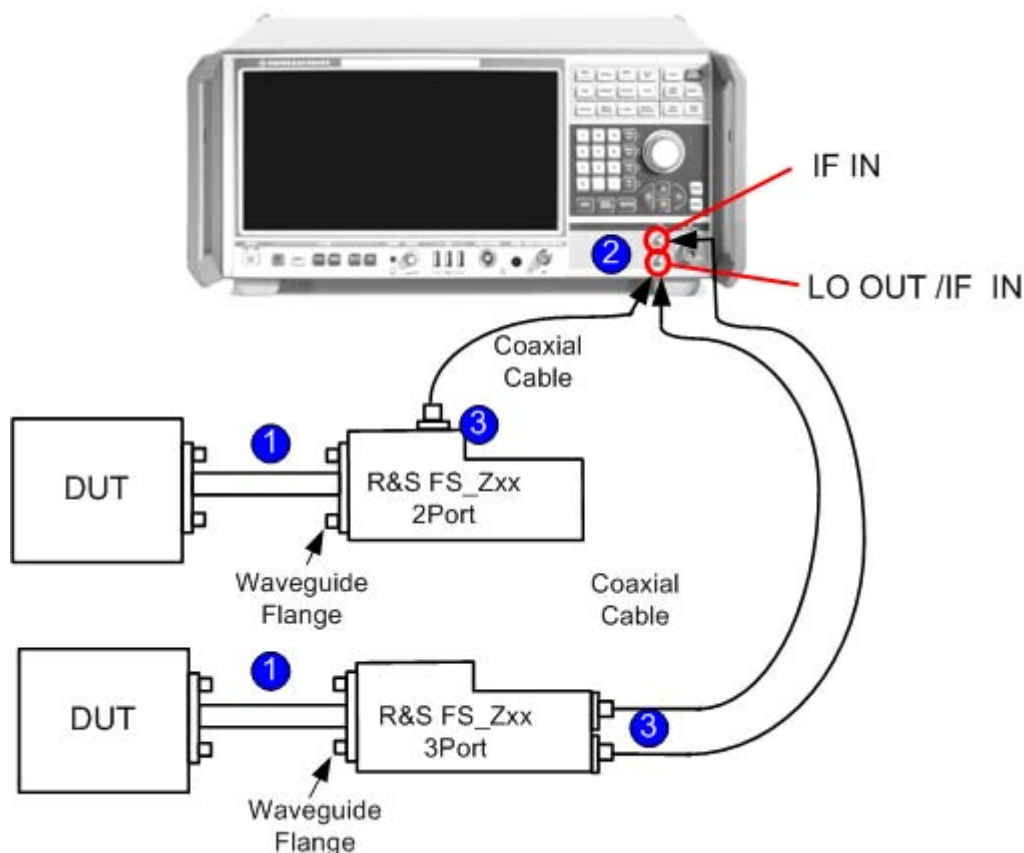


Figure 2-1: Measurement setup using a harmonic mixer

NOTICE**Risk of mixer damage**

Before initial use of the external mixer, be sure to read all safety instructions provided on the Documentation CD carefully and make sure that the following conditions and precautions are met:

- Provide sufficient mechanical and electrostatic protection during storage or transportation of the mixer. Heavy shocks can cause damage to the diodes in the mixer.
- Avoid electrostatic discharges near the connectors to protect the mixer diodes.
- Do not apply a torque exceeding 100 Ncm when connecting the LO/IF and IF cables; this may damage the LO/IF and IF connectors (SMA).
- Do not check the function of the diodes by means of an ohmmeter. The diodes can be destroyed by the battery voltage.
- Signal levels at the mixer's RF port and the LO port must be within the ranges specified in the data sheet; otherwise the mixer may be damaged. If the signal level to be measured is not known, perform a test measurement of the DUT with a waveguide attenuator and a power meter first.
- If cables other than the ones supplied with the B21 are used for IF and LO signals, ensure that they have a low insertion loss and that the connection is as short as possible. If the insertion loss increases in the LO path, the LO level of the mixer decreases, resulting in a higher conversion loss and thus a reduced dynamic range.
- Do not stress the cables used to provide the LO signal and tap the IF to avoid cable damage.
- When the mixer is not in use, cover the LO/IF and IF connectors (SMA), as well as the RF port (waveguide) with the provided caps to prevent environmental impact which may cause damage to the mixer.

Failure to meet these conditions may cause damage to the mixer or other devices in the test setup.

3 Operating Instructions



The following chapter contains detailed operating instructions for the R&S FSP, FSU, FSQ and FSUP analyzer families. The corresponding operating instructions for R&S FSV, FSVR and FSW instruments can be found in their operating manuals under the keyword "B21".

Conventions for settings to be made during the measurement:

- | | |
|------------------|--|
| [<KEY>] | Press a key on the front panel, e.g., [FREQ] |
| [<SOFTKEY>] | Press a softkey, e.g., [MARKER -> PEAK] |
| [<nn Dimension>] | Enter a value and terminate by entering the unit, e.g., [12 kHz] |
| {<nn>} | Enter values indicated in one of the following tables. |
- Successive entries are separated by [:], e.g., [**FREQUENCY : 15 kHz**]

3.1 Prerequisites



If a file with (old) calibration data stored on the hard drive should be replaced by a new file, proceed as described in section "Replacing Existing Data Files".

If not explicitly explained in the following, described operations are the same for R&S FSP and R&S FSU instruments.

Prior to the first use of the mixer, the conversion loss data file supplied on the memory stick must be imported to the hard drive of the used instrument.

Proceed as follows:

1. Connect the memory stick supplied with the harmonic mixer to a USB port of the instrument.
2. [**PRESET**]
Reset the instrument.
3. [**FREQ : EXTERNAL MIXER : EXT MIXER**]
Mixer option is enabled. Softkey EXT MIXER is switched to ON and all other softkeys (without ACCEPT BIAS) are activated
4. [**FREQ : EXTERNAL MIXER : SELECT BAND : band**]
Select the desired band for which new conversion loss data is to be copied (with cursor keys or rollkey and ENTER). Start and Stop frequencies are changed in correspondence with the selected band.

Mixer	Waveguide band
R&S FS-Z60	U
R&S FS-Z75	V
R&S FS-Z90	E
R&S FS-Z110	W

5. [**FREQ** : EXTERNAL MIXER : CONV LOSS TABLE : LOAD TABLE]

Use the Windows Explorer and the cursor keys/rollkey to browse for your desired conversion loss file. Select it with the cursor keys/rollkey and start copying with ENTER. The conversion loss file on USB stick is copied to the hard drive.

For each mixer (R&S FS-Z75, R&S FS-Z90 and R&S FS-Z110), three directories are provided on the USB stick. Each of them contains a conversion loss file corresponding to a different intermediate frequency and is named after this frequency, i.e., 404.4 MHz, 729 MHz and 1330 MHz. The conversion loss file to be loaded depends on the type of spectrum analyzer the mixer is used with. The relations are as follows:

Spectrum Analyzer	Intermediate Frequency / Directory of conversion loss file
R&S FSP40	404.4 MHz
R&S FSU26/43/46/50/67	404.4 MHz
R&S FSQ26/40	404.4 MHz
R&S FSUP26/50	404.4 MHz
R&S FSV30/40	729 MHz
R&S FSVR30/40	729 MHz
R&S FSW26/43/50	1330 MHz

6. [**FREQ** : EXTERNAL MIXER : SELECT BAND : ports]

Select PORTS table entry with cursor keys/rollkey in the row of the desired band and press ENTER. Use the cursor keys/rollkey to select "2" for a 2 port mixer or "3" for 3 port mixer in the subsequent popup table depending on the type of employed harmonic mixer. Then press ENTER.

To activate the conversion loss data file copied on hard drive, select the file for the corresponding band in menu *SELECT BAND*.

7. [**FREQ** : EXTERNAL MIXER : SELECT BAND : file]

To select the conversion loss file in the SELECT BAND table, go to the row of the desired band with up and down cursor keys. With right cursor key select the CONV LOSS TABLE column and press ENTER. The copied conversion loss file is listed in the subsequent popup table. Select it using the cursor up and down keys and press ENTER. The entry in column AVG CONV LOSS/dB for the selected band is now empty. In column CONV LOSS TABLE the conversion loss file name is listed instead (see [Figure 3-1](#) below).

3.2 Replacing Existing Data Files

To ensure that the new correction data of a re-calibrated mixer is used, the existing file with the same name must be deleted from the hard drive. Proceed as follows:

1. Connect the USB stick supplied with the harmonic mixer to the instrument
2. [PRESET]
3. If external mixer option is not activated (EXT MIXER softkey is switched to OFF) press [**FREQ** : EXTERNAL MIXER : EXT MIXER]
4. [**FREQ** : EXTERNAL MIXER : SELECT BAND : file]
To deactivate the currently used conversion loss file in the SELECT BAND table, move the cursor to the row of the desired band using the up and down cursor keys. With the right cursor key select the CONV LOSS TABLE column and press ENTER. In the appearing popup table select the entry NONE using the up and down cursor keys and press ENTER. The AVG CONV LOSS/dB table entry is highlighted. The CONV LOSS TABLE column is empty.
5. [**FREQ** : EXTERNAL MIXER : CONV LOSS TABLE : file]
Select the conversion loss file to be deleted with the up and down cursor keys in the TABLES table. Then press DELETE TABLE and reconfirm by selecting YES in the popup menu with the cursor keys and ENTER. The conversion loss file is now deleted from hard drive.
6. [**FREQ** : EXTERNAL MIXER : SELECT BAND : band]
Select the desired band for which new correction data is to be copied (with cursor keys or rollkey and ENTER). Start and Stop frequencies are changed in correspondence with the selected band.

Mixer	Waveguide band
R&S FS-Z60	U
R&S FS-Z75	V
R&S FS-Z90	E
R&S FS-Z110	W

7. [**FREQ** : EXTERNAL MIXER : CONV LOSS TABLE : LOAD TABLE]
Use the Windows Explorer and the cursor keys/rollkey to browse for your desired conversion loss file. Select it with the cursor keys/rollkey and start copying with ENTER. The conversion loss file on the USB stick is copied to the hard drive.

To activate the conversion loss data file copied on the hard drive, select the file for the corresponding band in menu *SELECT BAND*.

8. [**FREQ** : EXTERNAL MIXER : SELECT BAND : file]
To select the conversion loss file in the SELECT BAND table, move the cursor to the row of the desired band using the up and down cursor keys. With the right cursor key select the CONV LOSS TABLE column and press ENTER. In the appearing popup table the copied conversion loss file is listed. Select it using the up and down cursor keys and press ENTER. The entry in column AVG CONV LOSS/dB for the selected band is now empty. In column CONV LOSS TABLE the conversion loss file name is listed instead.
9. To leave the SELECT BAND menu press [↑] (MENU UP). The new correction data of the selected file is now used for level correction.

Example:

New correction data is to be copied to the hard drive for mixer R&S FS-Z75. Proceed as follows:

1. Connect the USB stick supplied with the harmonic mixer to the instrument.
2. [PRESET]
3. If external mixer option is not activated (EXT MIXER softkey is switched to OFF) press [**FREQ** : EXTERNAL MIXER : EXT MIXER]
4. [**FREQ** : EXTERNAL MIXER : SELECT BAND : file]
Select conversion loss table entry with cursor keys/rollkey in the V-band row and press ENTER. Select NONE entry with cursor keys and ENTER.
5. [**FREQ** : EXTERNAL MIXER : CONV LOSS TABLE]
Select the conversion loss file to be deleted with the up and down cursor keys in the TABLES table. Then press DELETE TABLE and reconfirm by selecting YES in the popup menu with the cursor keys and ENTER.
6. [**FREQ** : EXTERNAL MIXER : SELECT BAND : band]
Select the V band in the BAND column with cursor keys/rollkey and ENTER.
7. [**FREQ** : EXTERNAL MIXER : SELECT BAND : CONV LOSS TABLE : LOAD TABLE]
Use the Windows Explorer and the cursor keys/rollkey to browse for the new conversion loss file to be loaded. Select it with the cursor keys/rollkey and start copying with ENTER.
8. [**FREQ** : EXTERNAL MIXER : SELECT BAND : file]
Select CONV LOSS TABLE entry with cursor keys/rollkey in the V-band row and press ENTER. Select the R&S FS-Z75 file copied in step 7 with cursor keys and press ENTER.
9. Return to menu *EXTERNAL MIXER* by actuating key *MENU UP* [↑].

3.3 Parameters and Settings

Once the conversion loss data file supplied with the mixer has been copied to the hard drive and activated for the corresponding band, the LO level must be set to its nominal value using the function [**FREQ** : EXTERNAL MIXER : LO LEVEL : value] (see also section [3.5 Nominal Local Oscillator Level](#) on page 14). All additional parameters required are automatically set. The mixer is now ready for measurement.

Table 3-1: Parameters for operating R&S FS-Zxx waveguide mixers with R&S FSP

	R&S FS-Z60	R&S FS-Z75	R&S FS-Z90	R&S FS-Z110
Band	U	V	E	W
Frequency range / GHz	40 to 60	50 to 75	60 to 90	75 to 110
Order of harmonic	4 th : 40 to 52,3 GHz 6 th : 52,3 to 60 GHz	6 th	8 th	10 th
Harmonic even/odd	even	even	even	even
Ports	2	3	3	3
Bias / mA	0	0	0	0
IF / MHz	404.4	404.4	404.4	404.4
Nominal LO level / dBm	15.5	14.0	14.0	15.5



When using the FS-Z110 in combination with an R&S FSP instrument, the conversion loss table for the 10th harmonic also supplied on the USB stick must be selected. The local oscillator range of an R&S FSP instrument only covers the entire RF frequency range from 75 GHz to 110 GHz when using the 10th harmonic.

Table 3-2: Parameters for operating R&S FS-Zxx waveguide mixers with R&S FSU

	R&S FS-Z60	R&S FS-Z75	R&S FS-Z90	R&S FS-Z110
Band	U	V	E	W
Frequency range / GHz	40 to 60	50 to 75	60 to 90	75 to 110
Order of harmonic	4	6	6	8
Harmonic even/odd	even	even	even	even
Ports	2	3	3	3
Bias / mA	0	0	0	0
IF / MHz	404.4	404.4	404.4	404.4
Nominal LO level / dBm	15.5	14.0	14.0	15.5



The allocation of the conversion loss data file to a defined band is maintained when you switch off the instrument or reset it using the "Preset" key. After preset, simply select the corresponding band.

3.4 Notes on Level Correction

The correction data only takes into account the conversion loss of the mixer. The insertion loss of the cable used for tapping the IF signal must be taken into account separately in the correction of the level.

In contrast to the conversion loss of the mixer, the cable loss in the IF path is independent of the frequency. Depending on the spectrum analyzer the mixer is used with, the IF cable loss must be determined at the following frequencies:

Spectrum Analyzer	Intermediate Frequency
R&S FSP40	404.4 MHz
R&S FSU26/43/46/50/67	404.4 MHz
R&S FSQ26/40	404.4 MHz
R&S FSUP26/50	404.4 MHz
R&S FSV30/40	729 MHz
R&S FSVR30/40	729 MHz
R&S FSW26/43/50	1330 MHz

The cable loss is then simply taken into account with a level offset (function [**AMPT** : REF LEVEL OFFSET : value]).

3.5 Nominal Local Oscillator Level

The nominal local oscillator (LO) level is the power at the mixer's LO input port, for which the supplied conversion loss tables are derived. The LO level must be set to this value. However, to compensate for losses of the LO cable, the LO level can be set into the power range as specified in the mixer's datasheet. For the specified level uncertainty the conversion loss tables are valid within this power range. Independent of the used spectrum analyzer, the nominal LO levels of the mixers are:

Mixer	Nominal LO level [dBm]
R&S FS-Z60	15.5
R&S FS-Z75	14.0
R&S FS-Z90	14.0
R&S FS-Z110	15.5

The LO level is set by the function [**FREQ** : EXTERNAL MIXER : LO LEVEL : value]. You can also check the value of the nominal LO level in the calibration protocol delivered with the mixer.

4 Measurement Accuracy

The measurement of signal levels always involves some uncertainty. Depending on the type of measurement, this uncertainty is due to various sources of errors (see section "Errors from Mismatch"). Basically, these sources of errors originate from the used instrument and the harmonic mixer.

Measurement errors due to a too low signal/noise ratio are not taken into account in the following.



Ensuring measurement accuracy

In order to ensure correct measurement and avoid signal distortion, consider the following:

- Ensure the ambient temperature does not exceed the range specified in the data sheet.
- Do not loosen the screws of the mixer or the screws at the SMA connector. Otherwise the calibration data becomes invalid and measurements may provide inaccurate results. The mixer can only be repaired by the manufacturer's servicing department.
- The flanges of the waveguides between the mixer and the DUT should be connected without offsets or air gaps (e.g. due to canting). The contact surface of the waveguide flange should not be soiled or scratched. Only proper connections ensure accurate results.

4.1 Errors from the Used Instrument

When using the harmonic mixers, the measurement accuracy can be influenced by the following sources of errors due to the instrument:

- **Absolute error:** the absolute error made when a signal is directly fed into the LO/IF port or IF input of the spectrum analyzer (see B21 IF input level uncertainty specification).
- **IF amplifier error:** the error due to switching the IF gain. It typically amounts to 0.2 dB.
- **Log linearity error:** the error made during AD conversion (see nonlinearity of displayed level specification).
- **Error on switching the bandwidth:** see bandwidth switching uncertainty/error specification
- **Bandwidth error:** see resolution bandwidth uncertainty

The error specifications are given in the instrument's data sheet.

4.2 Errors from the Harmonic Mixer

The following sources of errors from the harmonic mixer can contribute to the overall measurement error:

- Uncertainty
- Deviation of the LO level from the ideal value

As for any measurement, measuring conversion loss of mixers involves some errors which have different causes. These errors are included in the specified uncertainty.

Despite the two-diode concept, there is some dependency between the mixer conversion loss and the LO level. If during measurement another LO level is applied to the mixer than the level for measurement of conversion loss in the factory, the actual conversion loss can deviate from that taken into account by the conversion loss data. The resulting measurement uncertainty, however, is already taken into account in the uncertainty given in the specifications. The values only apply if the LO level is set to its nominal value taking into account possible LO cable losses or into its level range as specified in the mixer's data sheet.

4.2.1 Errors from Mismatch

An ideal mixer with an input reflection coefficient of 0 would absorb the total input power offered to it irrespective of the output impedance of the signal source. Mismatch results from the fact that the reflection coefficient of a real mixer is however > 0 . The measurement result thus also depends on the output reflection coefficient of the source which is generally > 0 . The following equation applies to the measurement uncertainty M_U due to mismatch:

$$M_U = 100 \cdot [(1 \pm r_g \cdot r_l)^2 - 1] \quad (\text{Equation 1})$$

with M_U measurement uncertainty in %
 r_g magnitude of the source reflection coefficient
 r_l magnitude of the mixer reflection coefficient.

The following approximation applies:

$$M_U \approx \pm 200 \cdot r_g \cdot r_l . \quad (\text{Equation 2})$$

Taking the values of the input or output VSWR of the mixer or DUT, the corresponding reflection coefficients can be calculated as follows:

$$r = \frac{s - 1}{s + 1} \quad (\text{Equation 3})$$

with r reflection coefficient
 s VSWR

The mismatch of the mixer IF output and the instruments IF input is also a possible source of error. However, the resulting error can be calculated using the above equations. Due to low VSWR at the IF inputs the resulting error can be neglected.

4.2.2 Total Measurement Error

The sources of errors contributing to the total measurement error depend on the type of measurement. The sources of errors are listed below for the most important cases:

Measurement of the absolute level:

- | | |
|--|--|
| Sources of errors of the instrument: | <ul style="list-style-type: none"> • Absolute error • IF amplifier error • Linearity error • Error on switching the bandwidth • Bandwidth error (only with channel power and noise measurement) |
| Sources of errors of the harmonic mixer: | <ul style="list-style-type: none"> • Uncertainty |
| Error from mismatch: | <ul style="list-style-type: none"> • Mismatch between DUT output and mixer RF input |

Relative level measurement:

- | | |
|--------------------------------------|---|
| Sources of errors of the instrument: | <ul style="list-style-type: none"> • Linearity error |
| Conditions: | <ul style="list-style-type: none"> • Constant bandwidths and reference level setting • Measurements at a signal frequency¹ • Constant source output impedance |

A maximum error (worst case) can be calculated from these contributions by simply adding them up. The maximum error calculated in this way has confidence level of 100 %, i.e., the actual error from a measurement never exceeds the calculated values.

In practice, however, the maximum error seldom occurs. If the total error is the sum of individual errors the causes of which are independent of another, this is statistically a very rare event that all individual errors occur at the same time with their maximum value and same sign during a measurement.

What is more suitable for the practice is to calculate the total error with a certain confidence level, usually 95 % (see Application Note 1EF36 'Level Error Calculation for Spectrum Analyzers').

For systematic errors, i.e., for sources of errors of the instrument, a rectangular distribution is assumed, whereas the level uncertainty of the harmonic mixer is assumed to be normally distributed.

The following equation applies to the variance σ^2 of the individual errors of the instrument:

¹ If the signal frequency varies just a little between two signals to be measured (up to some MHz), the frequency response can be neglected. What appears is just the linearity error of the spectrum analyzer.

$$\sigma^2 = \frac{a^2}{3} \quad (\text{Equation 4})$$

with σ^2 the variance
 a the max. systematic error, in dB

Bandwidth errors are usually specified in %. Thus, the following applies:

$$\sigma^2 = \frac{\left(10 \cdot \lg\left(1 + \frac{RBW_{err}}{100}\right)\right)^2}{3} \quad (\text{Equation 5})$$

with σ^2 the variance
 RBW_{err} the bandwidth error, in %

If an error (e.g. uncertainty of conversion loss data of the mixer) is already given with a defined confidence level, i.e., the indication does not reflect the maximum value, the variance should be first calculated from the specified value.

The following equation applies to indications with a confidence level of 95 % and normal distribution

$$\sigma^2 = \left(\frac{a_{RSS}}{1,96}\right)^2 \quad (\text{Equation 6})$$

with σ^2 the variance
 a_{RSS} the systematic error with a confidence level of 95 % in dB

Errors from mismatch have a U distribution. Thus, the following equation applies to variance σ^2

$$\sigma^2 = \frac{\left(20 \cdot \lg(1 - r_g \cdot r_l)\right)^2}{2} \quad (\text{Equation 7})$$

with σ^2 the variance
 r_g the magnitude of the source reflection coefficient, i.e., the DUT
 r_l the magnitude of the load reflection coefficient, i.e., the mixer

The magnitude of the reflection coefficient can be calculated with the equation

$$r = \frac{s-1}{s+1} \quad (\text{Equation 8})$$

with r the reflection coefficient
 s the VSWR

Taking the variances σ_i of the different contributions, the combined standard deviation σ_{tot} is calculated using the equation

$$\sigma_{tot} = \sqrt{\sigma_1^2 + \sigma_2^2 + \dots + \sigma_n^2} \quad (\text{Equation 9})$$

The resulting standard deviation has a confidence level of 68 %. This value should be multiplied by 1.96 to obtain a confidence level of 95 %.

Example:

For the absolute level measurement of an input signal (output VSWR of signal source 1.2:1), the total error is to be determined with a confidence level of 95 %. The resolution bandwidth set is 100 kHz, the signal level is approx. 20 dB below the reference level. The bandwidth error should be assumed to be 10 %.

The data sheets for the mixer and the instrument contain the relevant specifications.

	Specified error	Variance σ_i^2	Remarks
Spectrum analyzer			
Absolute error (with external mixing)	1.0 dB	0.33	comp. equation 4
IF amplifier error	0.2 dB	0.01	comp. equation 4
Linearity error	0.3 dB	0.03	comp. equation 4
Error on switching the bandwidth	0.2 dB	0.01	comp. equation 4
Bandwidth error	10 %	0.07	comp. equation 5
Harmonic mixer			
Uncertainty	3,0 dB	2,34	comp. equation 6
Mismatch			
VSWR RF input of mixer	3,5		
VSWR signal source output	1,2	0,10	comp. equation 7

The combined standard deviation for $\sigma_{tot} = 1.70$ can be calculated from variances σ_i^2 using equation 9. The total measurement error of 3.34 dB is obtained with a confidence level of 95 % by multiplying the standard deviation by a factor of 1.96.

An MS Excel® 5.0 spreadsheet (EXTERROR.XLS file) is supplied on the USB stick with the mixer to simplify such error calculations.

Table 4-1: MS Excel® 5.0 spreadsheet for error calculation

Error Calculation		
for FSP/FSU/FSUP/FSQ/FSV/FSVR/FSW + External Mixer		
	specified error	variance
Inherent errors		
Spectrum analyzer		
absolute error (IF input for external mixing)	[dB] 1.00	0.33
IF amplifier error	[dB] 0.20	0.01
log linearity error	[dB] 0.30	0.03
bandwidth switching error	[dB] 0.20	0.01
bandwidth error	[%] 10.00	0.07
External mixer		
uncertainty of conversion loss data (95% confidence level)	[dB] 3.00	2.34
combined variance		2.80
combined standard uncertainty		1.67
rss error (95% confidence level)	[dB]	3.28
Error due to source mismatch		
VSWR of external mixer (RF port)	3.50	
VSWR of DUT	1.20	0.10
combined variance		2.90
combined standard uncertainty		1.70
error including source mismatch (95%)	[dB]	3.34

The different errors are to be entered in the yellow fields in the specified unit. The calculated error with a confidence level of 95 % is output in the dark blue fields.

The error output under "rss error (95 % confidence level)" takes into account all individual errors due to the instrument and mixer.

Errors due to mismatch between DUT and mixer input are taken into account in the value for 'error including source mismatch (95 %)'.

5 Maintenance and Troubleshooting

5.1 Maintenance

The harmonic mixers FS-Z60/75/90/110 are maintenance-free. Clean the contact surface of the waveguide flange with alcohol and a soft cloth at regular intervals.

NOTICE

Do not scratch the contact surface.

To keep measurement errors at a minimum level the mixer should be returned to the manufacturer for recalibration at regular intervals (see specifications for calibration intervals in the data sheet).

5.2 Troubleshooting

Troubleshooting as such is not possible in the harmonic mixers of the R&S FS-Zxx series. Defective mixers require repair and new measurement of conversion loss by the manufacturer.

Damages are generally recognizable by increased conversion loss up to complete dropout.

NOTICE**Risk of blowing the diodes**

Do not check the function of the diodes by means of an ohmmeter. The diodes can be destroyed by the battery voltage.

**Risk of measurement errors**

Do not loosen the screws of the mixer and the screws for fastening the SMA connector. Otherwise the calibration data becomes invalid and measurements may provide inaccurate results.

**Risk of invalid data**

The label with conversion loss data also serves as a seal. Conversion loss data becomes invalid if this seal is broken.

6 Checking Rated Specifications

6.1 Measurement Equipment and Accessories

Table 6-1: Measurement Equipment and Accessories

Item	Type of equipment	Specifications recommended	Equipment recommended	R&S Order No.	Page
1	Spectrum analyzer		R&S FSP40 + B21 ¹⁾ or R&S FSU26 + B21 or R&S FSU43 + B21 or R&S FSU46 + B21 or R&S FSU50 + B21 or R&S FSQ26 + B21 or R&S FSQ40 + B21 or R&S FSUP26 + B21 or R&S FSUP50 + B21 or R&S FSV30 + B21 or R&S FSV40 + B21 or R&S FSVR30 + B21 or R&S FSVR40 + B21 or R&S FSW26 + B21 or R&S FSW43 + B21 or R&S FSW50 + B21 ¹⁾ Option B21 R&S Order No. 1155.1758.01 for R&S FSP, 1157.1090.03 for R&S FSU, 1157.1090.04 for R&S FSUP 1310.9597.02 for R&S FSV 1310.9597.02 for R&S FSVR 1313.1100.26 for R&S FSW26 1313.1100.43 for R&S FSW43 1313.1100.43 for R&S FSW50	1164.4391.40 1166.1660.26 1166.1660.43 1166.1660.46 1166.1660.50 1155.5001.26 1155.5001.40 1166.3505.26 1166.3505.50 1307.9002K30 1307.9002K40 1311.0006.30 1311.0006.40 1312.8000K26 1312.8000K43 1312.8000K50	24
2	Signal generator	Frequency range up to 2 GHz	SMBV100A with SMBV-B103	1407.6004.02 1407.9603.02	24
3	Signal source	-15 dBm < Output level < -5 dBm Output VSWR < 2.0 : 1 Frequency range: R&S FS-Z60: 40 GHz to 60 GHz R&S FS-Z75: 50 GHz to 75 GHz R&S FS-Z90: 60 GHz to 90 GHz R&S FS-Z110: 75 GHz to 110 GHz Waveguide flange R&S FS-Z60: UG-383/U-M R&S FS-Z75: UG-385/U R&S FS-Z90: UG-387/U R&S FS-Z110: UG-387/U-M	R&S FS-Z60: R&S SMR60 R&S FS-Z75: R&S SMF 100A + R&S SMF-B144 + R&S SMZ75 + R&S SMZ-B75E R&S FS-Z90: R&S SMF 100A + R&S SMF-B144 + R&S SMZ90 + R&S SMZ-B90E R&S FS-Z110: R&S SMF 100A + R&S SMF-B144 + R&S SMZ110 + R&S SMZ-B110E	1134.9008.60 1167.0000.02 1167.7204.03 1417.4004.02 1417.6107.02 1167.0000.02 1167.7204.03 1417.4504.02 1417.6607.02 1167.0000.02 1167.7204.03 1417.5000.02 1417.7103.02	24
4	Power meter		R&S NRVD	0857.8008.02	24
5	Power sensor	Frequency range up to 2 GHz RSS error referred to indicated power ≤ 0,8% Meter noise ≤ 20 pW	R&S NRV-Z4	0828.3618.02	24

Item	Type of equipment	Specifications recommended	Equipment recommended	R&S Order No.	Page
6	Power meter	Capability for waveguide sensors R&S FS-Z60: 40 GHz to 60 GHz R&S FS-Z75: 50 GHz to 75 GHz R&S FS-Z90: 60 GHz to 90 GHz R&S FS-Z110: 75 GHz to 110 GHz	R&S FS-Z60: Anritsu ML4803A + Anritsu MP715A4		24
7	Power sensor	Frequency range R&S FS-Z60: 40 GHz to 60 GHz R&S FS-Z75: 50 GHz to 75 GHz R&S FS-Z90: 60 GHz to 90 GHz R&S FS-Z110: 75 GHz 110 GHz Waveguide flange R&S FS-Z60: UG-383/U-M R&S FS-Z75: UG-385/U R&S FS-Z90: UG-387/U R&S FS-Z110: UG-387/U-M Input VSWR < 1.5 : 1 Meter noise ≤ -30 dBm Error (RSS) ≤ 4 %	R&S FS-Z75: Agilent E4419A V8486A R&S FS-Z90: Anritsu ML4803A + Anritsu MP717A4 R&S FS-Z110: Agilent E4419A W8486A		24
8	Attenuator	Attenuation 10 dB VSWR ≤ 1.15 : 1 Waveguide flange R&S FS-Z60: UG-383/U-M R&S FS-Z75: UG-385/U R&S FS-Z90: UG-387/U R&S FS-Z110: UG-387/U-M	R&S FS-Z60: Millitech FXA-19-R10G0 R&S FS-Z75: Millitech FXA-15-R10G0 R&S FS-Z90: Millitech FXA-12-R10G0 R&S FS-Z110: Millitech FXA-10-R10G0		24
9	Waveguide transitions	required only for R&S FS-Z60: V-coaxial male to WR-19 transition	Anritsu 35WR19V		24

6.2 Test Instructions

Consider the following when executing performance checks:

- Prior to the performance check of the harmonic mixer, and after a warm-up time of at least 30 minutes, a total calibration of the R&S FSP/FSU/FSQ/FSUP/FSV/FSVR/FSW has to be carried out. Only in this case the compliance with the guaranteed data can be ensured.
- The settings are defined from the Preset state.
- Values provided in the following sections are not guaranteed. Only the technical specifications of the harmonic mixer data sheet are binding.

Conventions used to describe the measurement settings and procedures:

- [<KEY>] Press a key on the front panel, e.g., [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., [SPAN: 15 kHz]

6.2.1 Checking the Conversion Loss

Test equipment:	- spectrum analyzer	(Table 6-1, Item 1)	
	- signal generator	(Table 6-1, Item 2)	
		frequency range	up to 2 GHz
	- power meter	(Table 6-1, Item 4)	
	- power sensor	(Table 6-1, Item 5)	
		frequency range	up to 2 GHz
		RSS error referred to indicated power	$\leq 0.8 \%$
		meter noise	$\leq 20 \text{ pW}$
	- signal source	(Table 6-1, Item 3)	
		-20 dBm < output level < -5 dBm	
		output VSWR	< 2.0 : 1
		frequency range	
		R&S FS-Z60:	40 GHz to 60 GHz
		R&S FS-Z75:	50 GHz to 75 GHz
		R&S FS-Z90:	60 GHz to 90 GHz
		R&S FS-Z110:	75 GHz to 110 GHz
		waveguide flange	
		R&S FS-Z60:	UG-383/U-M
		R&S FS-Z75:	UG-385/U
		R&S FS-Z90:	UG-387/U
		R&S FS-Z110:	UG-387/U-M
	- attenuator	(Table 6-1, Item 8)	
		attenuator	10 dB
		VSWR	$\leq 1,15 : 1$
		frequency range	
		R&S FS-Z60:	40 GHz to 60 GHz
		R&S FS-Z75:	50 GHz to 75 GHz
		R&S FS-Z90:	60 GHz to 90 GHz
		R&S FS-Z110:	75 GHz to 110 GHz
		waveguide flange	
		R&S FS-Z60:	UG-383/U-M
		R&S FS-Z75:	UG-385/U
		R&S FS-Z90:	UG-387/U
		R&S FS-Z110:	UG-387/U-M

- power meter (Table 6-1, Item 6)
capability for waveguide power sensors
- power sensor (Table 6-1, Item 7)
 - meter noise ≤ -30 dBm
 - RSS error ≤ 4 %
 - input VSWR $< 1.5 : 1$
 - frequency range
 - R&S FS-Z60: 40 GHz to 60 GHz
 - R&S FS-Z75: 50 GHz to 75 GHz
 - R&S FS-Z90: 60 GHz to 90 GHz
 - R&S FS-Z110: 75 GHz to 110 GHz
 - waveguide flange
 - R&S FS-Z60: UG-383/U-M
 - R&S FS-Z75: UG-385/U
 - R&S FS-Z90: UG-387/U
 - R&S FS-Z110: UG-387/U-M
- waveguide transition (Table 6-1, Item 9)
required only for R&S FS-Z60
V-coaxial male to WR19

6.2.1.1 Determining the Absolute Level Error

This measurement determines the overall level error $L_{err, abs}$, which consists of the level error of the used analyzer $L_{err, analyzer}$ plus the level error of the used IF cable $L_{err, cable}$.

To measure the level error $L_{err, analyzer}$ of the used spectrum analyzer, execute the B21 IF performance test described in the corresponding instrument manual.

The following instructions determine the level error $L_{err, cable}$ of the used IF cable

- Test setup:
- connect power sensor (Table 6-1, Item 5) to the power meter (Table 6-1, Item 4) and execute function 'ZERO' when there is no signal applied to the power sensor.
 - connect power sensor directly to RF output of signal generator (Table 6-1, Item 2).
- Signal generator settings:
- frequency 404.4 MHz for FSP/FSQ/FSU/FSUP instruments
729.9 MHz for FSV/FSVR instruments
1330 MHz for FSW instruments
 - level -10 dBm
- Measurement:
- determine output power of the signal generator with the power meter. To achieve higher accuracy it is recommended to compensate the frequency response of the power sensor.
 - connect the IF cable delivered with the B21 to RF output of the signal generator and RF input of the power sensor.

Evaluation: The signal level measured directly at the RF output of the signal generator minus the power measured with the IF cable between generator and power sensor is the level error $L_{err\ cable}$. The level error $L_{err\ abs}$ is sum of $L_{err\ analyzer}$ and $L_{err\ cable}$

$$L_{err\ abs} = L_{err\ analyzer} + L_{err\ cable}$$

The determined absolute error $L_{err\ abs}$ should be noted in [Table 6-2](#) (Item 1) of the performance test report.

6.2.1.2 Determining the Output Level of the Signal Source

- Test setup:
- connect power sensor ([Table 6-1](#), Item 7) to the power meter ([Table 6-1](#), Item 6) and execute function 'ZERO' when there is no signal applied to the power sensor.
 - connect power sensor via attenuator ([Table 6-1](#), Item 8) to RF output of signal source ([Table 6-1](#), Item 3).

For R&S FS-Z60: Use waveguide transition V to WR19 ([Table 6-1](#), Item 9) at the output of the signal source to adapt it to the waveguide flange of the attenuator.

Signal source settings:

- level -8 dBm
- frequency f_{fresp}

See [Table 6-2](#) (Item 2) of performance test report for values of f_{fresp} .

Power meter settings: Determine signal level L_{gen} and note it in [Table 6-2](#) (Item 2). To achieve higher accuracy it is recommended to compensate the frequency response of the power sensor.

6.2.1.3 Determining the Conversion Loss of the Mixer

- Test setup:
- connect harmonic mixer via attenuator ([Table 6-1](#), Item 8) to signal source [Table 6-1](#), Item 3).

For R&S FS-Z60: Use waveguide transition V to WR19 [Table 6-1](#), Item 9) at the output of the signal source to adapt it to the waveguide flange of the attenuator.

- Connect front panel connector 'LO OUT / IF IN' of the used analyzer instrument with connector 'LO / IF' of the harmonic mixer in case of a 2 port mixer. In case of a 3 port mixer connect instrument front panel connector 'LO OUT / IF IN' with connector 'LO' of the harmonic mixer and 'IF IN' front panel connector with connector 'IF' of the mixer. Use the coaxial cables delivered with the B21.

Signal generator settings:

- frequency f_{fresp}

See [Table 6-2](#) (Item 3) of performance test report for values of f_{fresp} .

- Analyzer settings:
- [**PRESET**]
 - enable external mixer support ²
 - [**FREQ CENTER** : { f_{resp} }]
See [Table 6-2](#) (Item 3) of performance test report for values of f_{resp} .
 - select desired band of the measured mixer
 - Select desired band (R&S FS-Z60 band U, R&S FS-Z75 band V, R&S FS-Z90 band E, R&S FS-Z110 band W)
 - Select AVG CONV LOSS/dB table entry and set the conversion loss to 0 dB.
 - Select PORTS "2" for 2 port mixers and "3" for 3 port mixers in the mixer port entry, respectively
 - [**SPAN** : **100 kHz**]
 - [**BW** : RES BW MANUAL : **10 kHz**]
 - Set marker to peak [**MKR->** : PEAK]

The signal level L_{analyzer} is displayed by level reading of marker 1.

Evaluation: The conversion loss can be calculated as follows:

$$a_{\text{conv}} = L_{\text{gen}} - (L_{\text{analyzer}} - L_{\text{err abs}})$$

Compare the measured values with the limits given in [Table 6-2](#) (Item 3) of performance test report.

6.2.2 Checking the Noise Display

- Test setup:
- Connect front panel connector 'LO OUT / IF IN' of the used analyzer instrument with connector 'LO / IF' of the harmonic mixer in case of a 2 port mixer.
In case of a 3 port mixer connect instrument front panel connector 'LO OUT / IF IN' with connector 'LO' of the harmonic mixer and 'IF IN' front panel connector with connector 'IF' of the mixer. Use the coaxial cables delivered with the B21.

² For detailed information how to operate the external mixer settings please refer to the operating manual of the used instrument.

- Analyzer settings:
- [**PRESET**]
 - enable external mixer support
 - [**FREQ CENTER** : { f_{fresp} }]
- See [Table 6-2](#) (Item 3) of performance test report for values of f_{fresp} .
- select desired band of the measured mixer
- Select desired band (R&S FS-Z60 band U, R&S FS-Z75 band V, R&S FS-Z90 band E, R&S FS-Z110 band W)
 - Select AVG CONV LOSS/dB table entry and set the conversion loss to { a_{conv} }. See [Table 6-2](#) (Item 3) of performance test report for value of a_{conv} at { f_{fresp} }
 - Select PORTS "2" for 2 port mixers and "3" for 3 port mixers in the mixer port entry, respectively
- [**SPAN** : 10 kHz]
 - [**BW** : RES BW MANUAL : 1 kHz]
 - [**BW** : VIDEO BW MANUAL : 10 Hz]
 - [**TRACE** : AVERAGE]
 - [**TRACE** : SWEEP COUNT : 30 ENTER]
 - [**AMPT** : -35 dBm]
 - [**SWEEP** : SINGLE SWEEP]
- set marker to peak
- [**MKR->** : PEAK]
- Evaluation: The noise level is displayed by the level reading of marker 1. Compare the measured values with the limits given in [Table 6-2](#) (Item 4) of performance test report

Item No.	Characteristic	Test described on page	Min. value	Actual value	Max. value	Unit
3	Checking the conversion loss	24				
	Conversion a_{conv} of harmonic mixer					
	f_{resp}					
	R&S FS-Z60, 4th harmonic:		-		25	dB
	40 GHz		-	_____	25	dB
	41 GHz		-	_____	25	dB
	42 GHz		-	_____	25	dB
	43 GHz		-	_____	25	dB
	44 GHz		-	_____	25	dB
	45 GHz		-	_____	25	dB
	46 GHz		-	_____	25	dB
	47 GHz		-	_____	25	dB
	48 GHz		-	_____	25	dB
	49 GHz		-	_____	25	dB
	50 GHz		-	_____	25	dB
	51 GHz		-	_____	25	dB
	52 GHz		-	_____	25	dB
	53 GHz		-	_____	25	dB
	54 GHz		-	_____	25	dB
	55 GHz		-	_____	25	dB
	56 GHz		-	_____	25	dB
	57 GHz		-	_____	25	dB
	58 GHz		-	_____	25	dB
	59 GHz		-	_____	25	dB
	60 GHz		-	_____	25	dB
	R&S FS-Z60, 6th harmonic:					
	40 GHz		-	_____	30	dB
	41 GHz		-	_____	30	dB
	42 GHz		-	_____	30	dB
	43 GHz		-	_____	30	dB
	44 GHz		-	_____	30	dB
	45 GHz		-	_____	30	dB
	46 GHz		-	_____	30	dB
	47 GHz		-	_____	30	dB
	48 GHz		-	_____	30	dB
	49 GHz		-	_____	30	dB
	50 GHz		-	_____	30	dB
	51 GHz		-	_____	30	dB
	52 GHz		-	_____	30	dB
	53 GHz		-	_____	30	dB
	54 GHz		-	_____	30	dB
	55 GHz		-	_____	30	dB
	56 GHz		-	_____	30	dB
	57 GHz		-	_____	30	dB
	58 GHz		-	_____	30	dB
	59 GHz		-	_____	30	dB
	60 GHz		-	_____	30	dB

Item No.	Characteristic	Test described on page	Min. value	Actual value	Max. value	Unit
4	Checking the noise display	27				
	f_{resp}					
	R&S FS-Z60:					
	40 GHz		-	_____	-110	dBm
	41 GHz		-	_____	-110	dBm
	42 GHz		-	_____	-110	dBm
	43 GHz		-	_____	-110	dBm
	44 GHz		-	_____	-110	dBm
	45 GHz		-	_____	-110	dBm
	46 GHz		-	_____	-110	dBm
	47 GHz		-	_____	-110	dBm
	48 GHz		-	_____	-110	dBm
	49 GHz		-	_____	-110	dBm
	50 GHz		-	_____	-110	dBm
	51 GHz		-	_____	-110	dBm
	52 GHz		-	_____	-110	dBm
	53 GHz		-	_____	-110	dBm
	54 GHz		-	_____	-110	dBm
	55 GHz		-	_____	-110	dBm
	56 GHz		-	_____	-110	dBm
	57 GHz		-	_____	-110	dBm
	58 GHz		-	_____	-110	dBm
	59 GHz		-	_____	-110	dBm
	60 GHz		-	_____	-110	dBm
	R&S FS-Z75:					
	50 GHz		-	_____	-98	dBm
	51 GHz		-	_____	-98	dBm
	52 GHz		-	_____	-98	dBm
	53 GHz		-	_____	-98	dBm
	54 GHz		-	_____	-98	dBm
	55 GHz		-	_____	-98	dBm
	56 GHz		-	_____	-98	dBm
	57 GHz		-	_____	-98	dBm
	58 GHz		-	_____	-98	dBm
	59 GHz		-	_____	-98	dBm
	60 GHz		-	_____	-98	dBm
	61 GHz		-	_____	-98	dBm
	62 GHz		-	_____	-98	dBm
	63 GHz		-	_____	-98	dBm
	64 GHz		-	_____	-98	dBm
	65 GHz		-	_____	-98	dBm
	66 GHz		-	_____	-98	dBm
	67 GHz		-	_____	-98	dBm
	68 GHz		-	_____	-98	dBm
	69 GHz		-	_____	-98	dBm
	70 GHz		-	_____	-98	dBm
	71 GHz		-	_____	-98	dBm
	72 GHz		-	_____	-98	dBm
	73 GHz		-	_____	-98	dBm
	74 GHz		-	_____	-98	dBm
	75 GHz		-	_____	-98	dBm

Item No.	Characteristic	Test described on page	Min. value	Actual value	Max. value	Unit
4	Checking the noise display f_{resp} R&S FS-Z90:	27				
	60 GHz		-	_____	-101	dBm
	61 GHz		-	_____	-101	dBm
	62 GHz		-	_____	-101	dBm
	63 GHz		-	_____	-101	dBm
	64 GHz		-	_____	-101	dBm
	65 GHz		-	_____	-101	dBm
	66 GHz		-	_____	-101	dBm
	67 GHz		-	_____	-101	dBm
	68 GHz		-	_____	-101	dBm
	69 GHz		-	_____	-101	dBm
	70 GHz		-	_____	-101	dBm
	71 GHz		-	_____	-101	dBm
	72 GHz		-	_____	-101	dBm
	73 GHz		-	_____	-101	dBm
	74 GHz		-	_____	-101	dBm
	75 GHz		-	_____	-101	dBm
	76 GHz		-	_____	-101	dBm
	77 GHz		-	_____	-101	dBm
	78 GHz		-	_____	-101	dBm
	79 GHz		-	_____	-101	dBm
	80 GHz		-	_____	-101	dBm
	81 GHz		-	_____	-101	dBm
	82 GHz		-	_____	-101	dBm
	83 GHz		-	_____	-101	dBm
	84 GHz		-	_____	-101	dBm
	85 GHz		-	_____	-101	dBm
	86 GHz		-	_____	-101	dBm
	87 GHz		-	_____	-101	dBm
	88 GHz		-	_____	-101	dBm
	89 GHz		-	_____	-101	dBm
	90 GHz		-	_____	-101	dBm

Item No.	Characteristic	Test described on page	Min. value	Actual value	Max. value	Unit
4	Checking the noise display f_{resp} R&S FS-Z110:	27				
	75 GHz		-	_____	-105	dBm
	76 GHz		-	_____	-105	dBm
	77 GHz		-	_____	-105	dBm
	78 GHz		-	_____	-105	dBm
	79 GHz		-	_____	-105	dBm
	80 GHz		-	_____	-105	dBm
	81 GHz		-	_____	-105	dBm
	82 GHz		-	_____	-105	dBm
	83 GHz		-	_____	-105	dBm
	84 GHz		-	_____	-105	dBm
	85 GHz		-	_____	-105	dBm
	86 GHz		-	_____	-105	dBm
	87 GHz		-	_____	-105	dBm
	88 GHz		-	_____	-105	dBm
	89 GHz		-	_____	-105	dBm
	90 GHz		-	_____	-105	dBm
	91 GHz		-	_____	-105	dBm
	92 GHz		-	_____	-105	dBm
	93 GHz		-	_____	-105	dBm
	94 GHz		-	_____	-105	dBm
	95 GHz		-	_____	-105	dBm
	96 GHz		-	_____	-105	dBm
	97 GHz		-	_____	-105	dBm
	98 GHz		-	_____	-105	dBm
	99 GHz		-	_____	-105	dBm
	100 GHz		-	_____	-105	dBm
	101 GHz		-	_____	-105	dBm
	102 GHz		-	_____	-105	dBm
	103 GHz		-	_____	-105	dBm
	104 GHz		-	_____	-105	dBm
	105 GHz		-	_____	-105	dBm
	106 GHz		-	_____	-105	dBm
	107 GHz		-	_____	-105	dBm
	108 GHz		-	_____	-105	dBm
	109 GHz		-	_____	-105	dBm
	110 GHz		-	_____	-105	dBm

Contacting customer support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz product, contact our customer support center. A team of highly qualified engineers provides support and works with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz products.

Contact information

Contact our customer support center at www.rohde-schwarz.com/support, or follow this QR code:



Figure 1-1: QR code to the Rohde & Schwarz support page

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