

# The effective way to measure key mixer performance parameters

Characterizing RF mixers that have an internal LO using the value-of-three R&S®FPC1500 spectrum analyzer.



## Your task

Mixers are frequency-converting components – the input signal has a different frequency than the output signal. A mixer has three connectors: RF (radio frequency), LO (local oscillator) and IF (intermediate frequency). Therefore, mixer characterization typically requires a four-port vector network analyzer. The key test parameters are conversion loss, isolation and reflection. Other parameters include harmonics, 1 dB compression point and intercept points. The relative importance of these individual characteristics varies based on the mixer application.

In the case of a downconversion mixer for a receiver system that operates at lower power level, harmonics and compression point measurements become less significant. In a manufacturing environment, the emphasis is on the cost of testing, so only key parameters are checked during a functionality test.

## Rohde & Schwarz solution

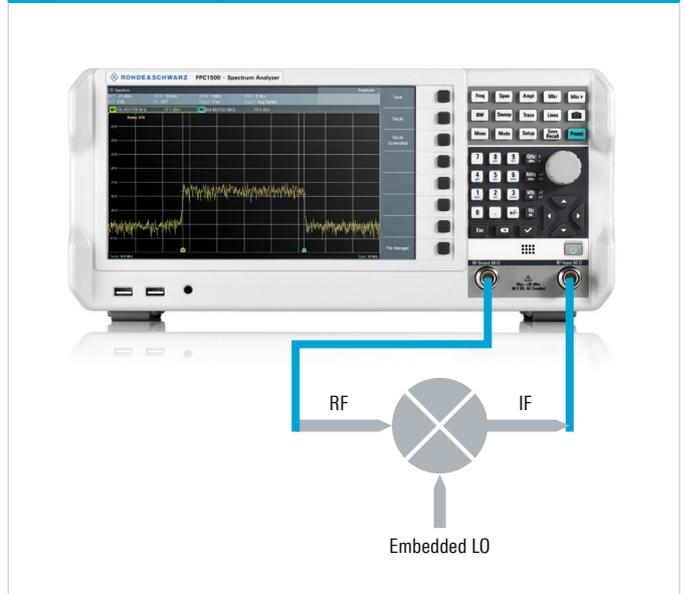
Some mixers do not require an external LO since they have an internal embedded LO. Such mixers would only have two connectors: RF and IF. These types of RF mixers with embedded LOs are commonly used in the satellite and military industries. Test setups for two-port mixers are simpler (Fig. 1). The R&S®FPC1500 can be used to measure the key performance test parameters: conversion loss, isolation and reflection (return loss).

## Application

### Conversion loss

Conversion loss is a measure of the efficiency of the mixer in converting the frequency from RF to IF. It measures the difference in power between the input RF power level and the output IF power level.

Fig. 1: Test setup with the R&S®FPC1500



$$\text{Conversion loss} = -10 \log \left| \frac{P_{\text{outIF}}(f_{\text{IF}})}{P_{\text{inRF}}(f_{\text{RF}})} \right| \text{dB}$$

A spectrum analyzer with tracking generator functionality makes scalar transmission measurement possible. The R&S®FPC1500 tracking generator features a frequency conversion option, making it ideal for measurements on mixers. Fig. 2 explains how the measurements are done, while the left screenshot in Fig. 4 illustrates the measurement result from a mixer with a 636.5 MHz internal LO.

### Isolation

Isolation is a measure of signal coupling between the ports of a mixer. RF-IF isolation is the attenuation value between RF and IF. This value shows how much RF input signal is attenuated towards IF. The measurement can be easily

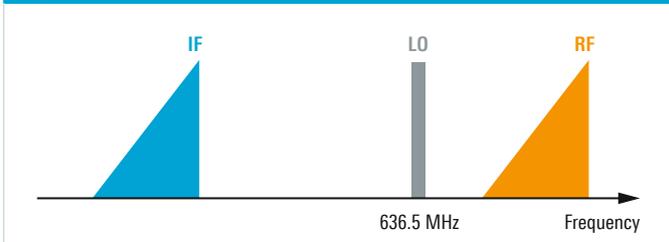
accomplished by measuring the IF port with the analyzer set to the RF frequency.

### Reflection

Reflection measurements show how good the impedance matching is at an individual port. Traditionally, a vector network analyzer is required for S-parameter measurements like the  $S_{11}$  RF input reflection.

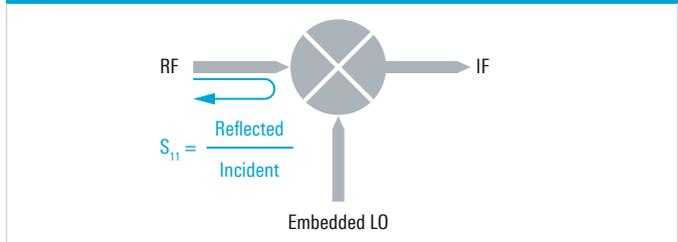
Thanks to the unique design of the R&S®FPC1500 that utilizes an internal VSWR bridge, the spectrum analyzer can perform one-port vector reflection measurements. The middle screenshot in Fig. 4 shows a mixer  $S_{11}$  return loss in dB, the right screenshot in Fig. 4 shows the mixer input impedance in a Smith chart.

**Fig. 2: Execution of measurement**



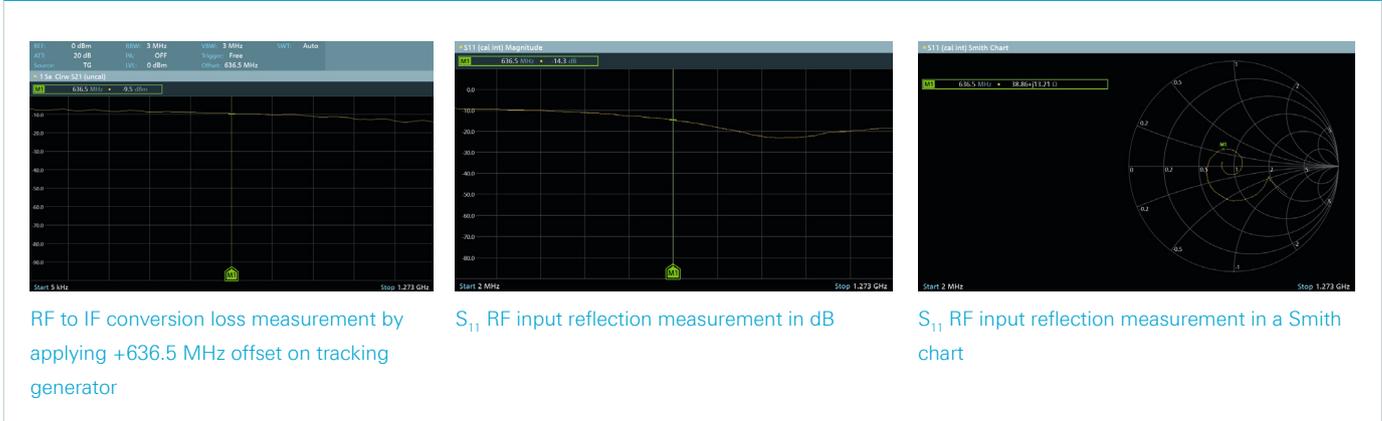
The tracking source (RF) starts sweeping from the LO frequency while the analyzer measures the lower sideband of IF (blue)

**Fig. 3: Measurement result**



Measurement result from a mixer with a 636.5 MHz internal LO

**Fig. 4: RF mixer measurement using the R&S®FPC1500**



RF to IF conversion loss measurement by applying +636.5 MHz offset on tracking generator

$S_{11}$  RF input reflection measurement in dB

$S_{11}$  RF input reflection measurement in a Smith chart

Designation	Type	Order No.
Spectrum analyzer with tracking generator, 5 kHz to 1 GHz	R&S®FPC1500	1328.6660.03
Spectrum analyzer frequency upgrade, 1 GHz to 2 GHz	R&S®FPC-B2	1328.6677.02
Spectrum analyzer preamplifier	R&S®FPC-B22	1328.6690.02
Vector network analysis (R&S®FPC1500 only)	R&S®FPC-K42	1328.7396.02
Calibration unit, one port, 2 MHz to 4 GHz	R&S®ZN-Z103	1321.1828.02

### Rohde & Schwarz GmbH & Co. KG

Europe, Africa, Middle East | +49 89 4129 12345  
 North America | 1 888 TEST RSA (1 888 837 87 72)  
 Latin America | +1 410 910 79 88  
 Asia Pacific | +65 65 13 04 88  
 China | +86 800 810 82 28 | +86 400 650 58 96  
 www.rohde-schwarz.com  
 customersupport@rohde-schwarz.com

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 PD 5216.0796.92 | Version 01.00 | October 2018 (ch)  
 The effective way to measure key mixer performance parameters  
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