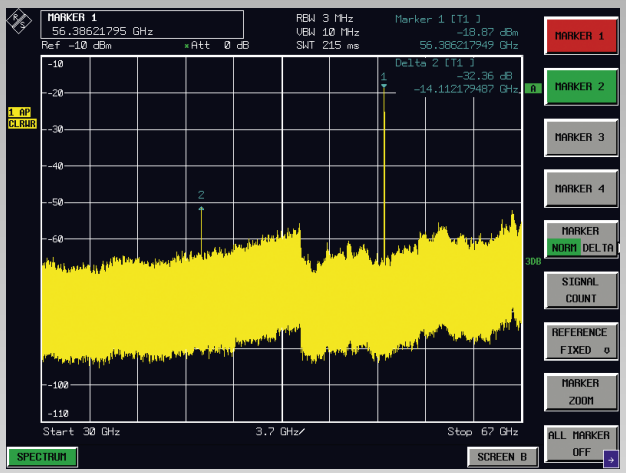

FIG 1 Measurement of a multiplier signal using the R&S®FSU67.

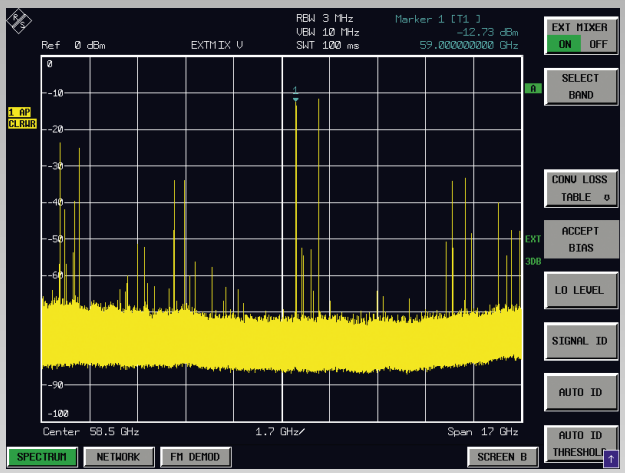

FIG 2 59 GHz signal, measured with an external mixer without software preselector.

FIG 3 The same 59 GHz signal, measured with an external mixer and software preselector.

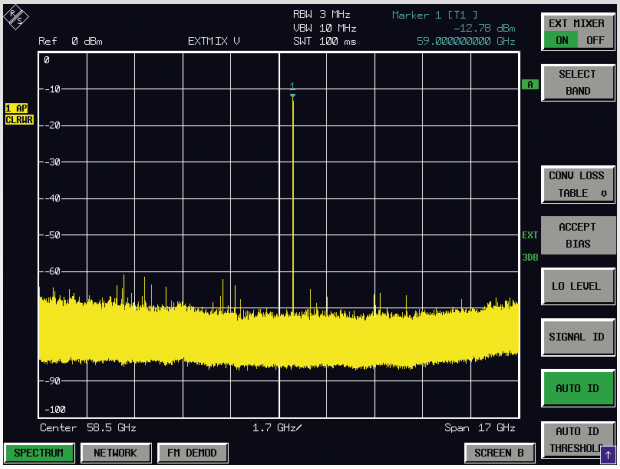

FIG 4 The 59 GHz signal, measured with the R&S®FSU67.

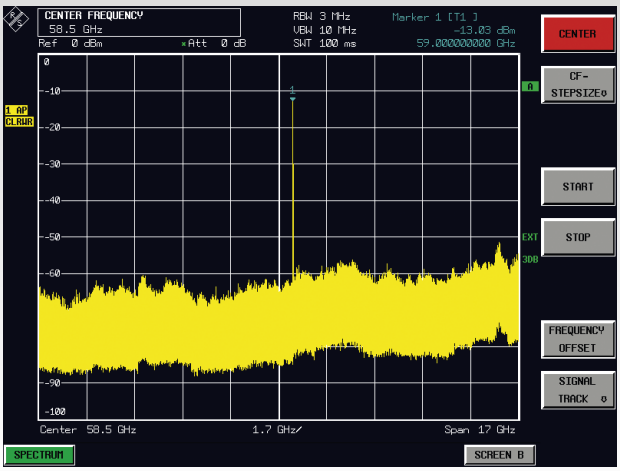

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FIG 5
R&S®FSU67: The first spectrum analyzer worldwide for the frequency range 20 Hz to 67 GHz.

R&S®FSU67 Spectrum Analyzer

Spectrum analysis – entire frequency range now covered from 20 Hz to 67 GHz

The world´s first spectrum analyzer that covers the entire frequency range up to 67 GHz. The R&S®FSU67 now even makes the range between 50 GHz and 67 GHz available for spectrum analysis free of image response and thus clearly expands the limit at which cumbersome setups with external harmonic mixers become necessary.

Expanding the limits of conventional T&M technology

In the past, measurements in the spectral range were possible only up to 50 GHz when using conventional and easy-to-operate test setups. To measure frequencies beyond this limit, you usually had to expand the test configuration to a complex test setup by adding external harmonic mixers.

These days are over. With its R&S®FSU67 (FIG 5), Rohde&Schwarz is the first manufacturer worldwide to offer a spectrum analyzer in coaxial design that covers the entire frequency range up to 67 GHz and thus clearly goes beyond the conventional limits of T&M technology. The analyzer simplifies measurements in this frequency range as it is able to eliminate all the drawbacks of harmonic mixers (box). The frequency concept of the analyzer with fundamental mixing and image rejection up to 67 GHz ensures unambiguous signal representation right from the start, thus preventing problems in signal identification.

In addition, the complete frequency range is measured via one single input connector, i.e. no additional cabling of the test setup is required. FIG 1 shows this for a multiplier: Its output signal is already filtered for harmonics but subharmonics are still present. The R&S®FSU67 uses one sweep to measure these subharmonics, even for signals up to 67 GHz.

FIGs 2 to 4 show the measurement of a signal at 59 GHz with an external mixer as well as with or without a software preselector in comparison with the measurement of the same signal with the R&S®FSU67. The difference is significant: Even if the software preselector is used, you can still see a considerable number of unwanted signals when the measurement is performed with an external mixer (FIG 3); in contrast, nothing but the real signal is displayed when the measurement is carried out with the R&S®FSU67.

The internal step attenuator, which covers a range from 0 dB to 75 dB, optimally adapts the analyzer to the level of the input signal. The level measurement range is thus covered from 30 dBm to inherent noise without needing additional hollow waveguide step attenuators. And the R&S®FSU67, like all members of the R&S®FSU family, has a calibrated level measurement accuracy. This means that the measurement

Good reasons to avoid external mixers:

- External harmonic mixers have no image rejection and generate a variety of signal responses. The correct mixture product can only be determined by filtering or shifting the local oscillator frequency. This procedure is used by software preselectors. With non-stationary, e.g. pulsed, signals, however, such signal identification routines quickly hit their limits.
- The connection of external harmonic mixers involves additional cabling for IF and LO signals and calls for a separate setup. Harmonics measurements must therefore often be performed in two stages (without and with an external mixer).
- The conversion loss of the external mixers is affected by the accuracy of the mixer calibration, the additional cabling, and the correct setting of the LO level. Despite careful measurements, the resulting level measurement uncertainty is greater than that produced with a spectrum analyzer that has a similar frequency range.
- When using external mixers, the measurement signal is directly applied to the mixer input. If a level decrease is necessary in order to operate the mixer in the linear range, additional hollow waveguide step attenuators are required.

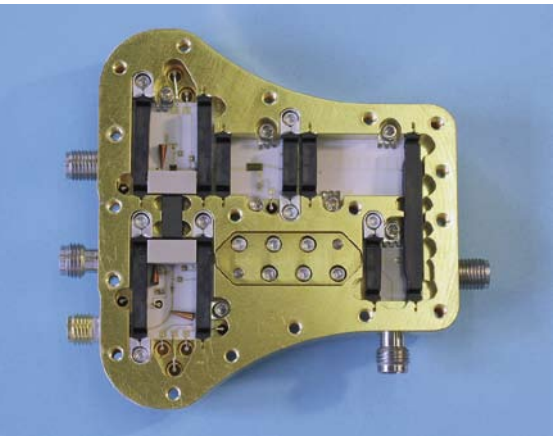

FIG 6 Heart of the R&S®FSU 67: the microwave frontend module with an input frequency from 50 GHz to 67 GHz.

uncertainties that occur when working with external mixers are now a thing of the past in the frequency range up to 67 GHz.

Microwave technology at its best

The conversion of signals above 50 GHz to the range below 26.5 GHz is performed by an additional frontend provided in the R&S®FSU 67. The components used in this frontend were developed by Rohde&Schwarz in collaboration with the Chair for Microwave Engineering and High Frequency Technology at the University of Erlangen-Nuremberg.

Local oscillator design

A fractional N synthesizer forms the basis of the local oscillator. This synthesizer consists of a proprietary Rohde&Schwarz ASIC, a VCO up to 12 GHz as well as various dividers and other components from the microwave production department at Rohde&Schwarz. The frequency synthesis of the LO is implemented on ceramic substrates in microwave technology. This ensures the amplification of the signal generated by the synthesizer and the multiplication to the required frequency range from 39 GHz to 45 GHz.

Frontend design

To suppress unwanted spurious response, a preselection filter must be part of the heterodyne receiver concept. In the new frontend, this preselection filter is implemented in the form of a special fixed-frequency filter with a passband from 50 GHz to 67 GHz. Good spurious suppression is attained by skillfully setting the LO frequency and IF. The production of the fixed-frequency filter that is used places the highest of demands on mechanical precision: Milling tolerances of 20 µm have to be met for the filter housing.

The mixer that is used to convert the applied signals in the range from 50 GHz to 67 GHz is also a Rohde&Schwarz product and meets the highest of requirements:

- Fundamental mixing at input frequency 50 GHz to 67 GHz
- Minimum conversion loss
- Excellent spurious suppression
- Production-friendly and reproducible circuit design

The result is a completely integrated circuit design that is embedded as a ceramic substrate in the frontend module (FIG 6). The specifications attained for the overall instrument are quite impressive: With a displayed average noise level (DANL) of <–130 dBm (typ. –136 dBm) relative to a 1 Hz resolution bandwidth in the frequency range from 51 GHz to 57 GHz and <–120 dBm (typ. –124 dBm) up to 67 GHz, the R&S®FSU 67 surpasses competitors´ external mixers in level stability, ease of operation, and spurious suppression.

More information and data sheet at www.rohde-schwarz.com (search term: FSU 67)

Application-oriented measurement functions

Measurements on microwave components or systems are typical applications for the R&S®FSU 67. The instrument makes these measurements much easier by offering a variety of measurement functions:

Phase noise measurements on oscillators up to 67 GHz are supported by the R&S®FS-K40 option. This option not only determines the phase noise over a selectable frequency offset range up to 1 GHz and displays it with a logarithmic frequency axis but also calculates the residual FM and φM as well as jitter based on the result.

The R&S®FS-K7 option is available for **measuring analog-modulated AM, FM, and φM signals**. It allows you to comprehensively analyze the transients in the frequency and time domain.

The R&S®FSP-B10 option and an external generator such as the R&S®SMR or R&S®SMF make the R&S®FSU 67 a scalar network analyzer. The **transmission characteristics of filters and amplifiers**, for example, can thus be determined very easily. The spectrum analyzer also supports generators of other manufacturers.

Measurements with harmonic mixers beyond the 67 GHz limit are carried out by the R&S®FSU 67 (as also done by the 26.5 GHz, 46 GHz, and 50 GHz models) with the R&S®FSU-B21 option. The R&S®FS-Z75, -Z90, and -Z110 harmonic mixers as well as customer-specific mixers can be used. When equipped with the R&S®FSU-B21 option, the R&S®FSU 67 operates with three-port and two-port mixers. In this case, a software preselector supports you in identifying the signals.

Dr Wolfgang Dressel; Herbert Schmitt