# 5 GHz analysis bandwidth for testing automotive radars in the E band

The R&S®FSW85 signal and spectrum analyzer now supports analysis bandwidths up to 5 GHz together with the R&S®RTO2064 oscilloscope as an external A/D converter. The analyzer controls the oscilloscope and handles all of the steps involved in transferring, processing, equalizing and analyzing data.

Automotive FMCW radars typically operate in the frequency range from 76 GHz to 77 GHz, although some countries have granted approval for operation between 77 GHz and 81 GHz. Since the range resolution is proportional to the signal bandwidth, manufacturers of these components need high bandwidths during the development process in order to achieve the maximum range resolution.

## Spectrum measurements in the E band with the R&S®FSW85

The R&S®FSW85 signal and spectrum analyzer is the first choice for measuring radar sensors' RF parameters such as frequency, effective isotropically radiated power (EIRP) and occupied bandwidth and spurious emissions during development, production and verification. The analyzer scans the range from 2 Hz to 85 GHz (up to 90 GHz with the R&S®FSW-B90G option) and analyzes RF signals produced by radar sensors in the E band. No external harmonic mixers are required.

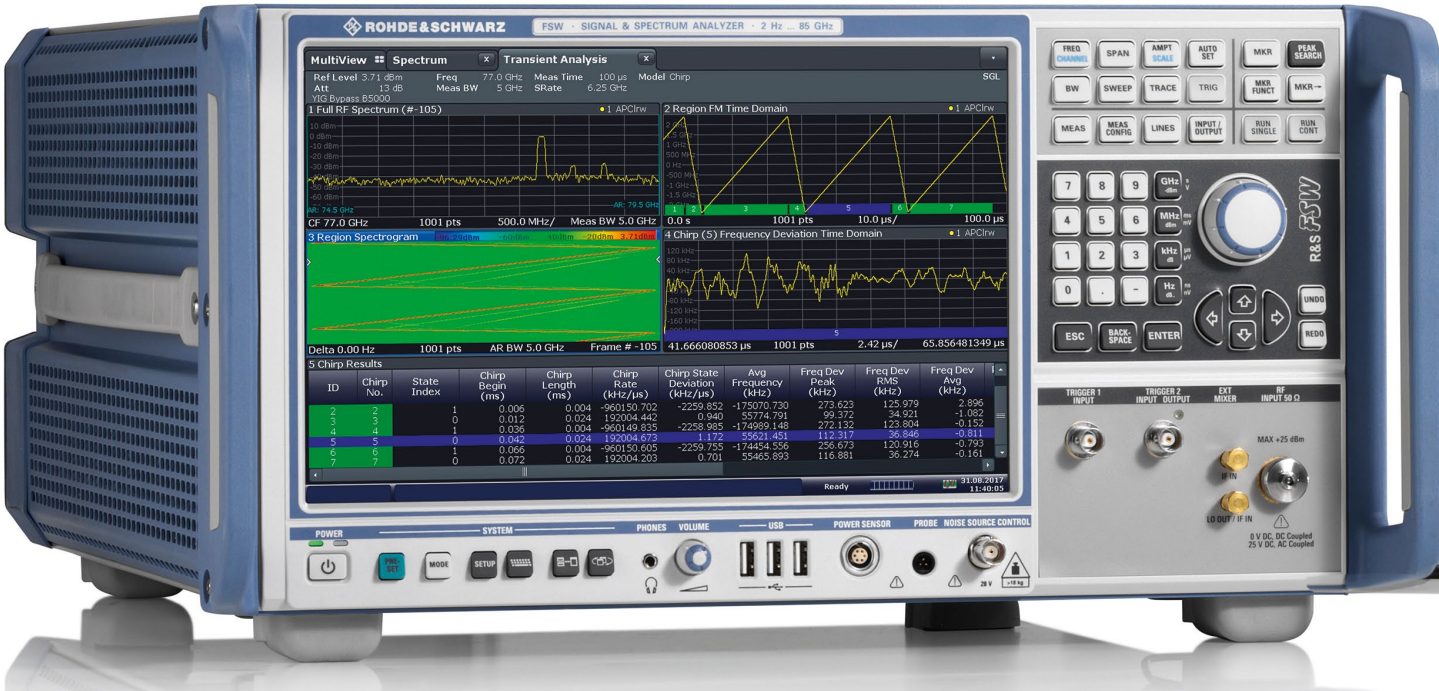
For frequencies between 8 GHz and 85 GHz, the analyzer is equipped with a narrowband YIG filter for hardware preselection in order to suppress unwanted mixing products.

Compared with solutions using harmonic mixers, the R&S®FSW85 has certain benefits:

- Continuous frequency range from 2 Hz to 85/90 GHz
- Suppression of unwanted mixing products by the built-in YIG filter
- Convenient level settings with the built-in RF attenuator
- Simplified setup with no additional cabling
- Wide dynamic range for spectrum emission measurements

The analyzer's already impressive signal-to-noise ratio can be further improved with the optional R&S®HA-Z24E

Fig. 1: The R&S®FSW85 supports an analysis bandwidth of 5 GHz together with the R&S®FSW-B5000 hardware option and the R&S®RTO2064 oscilloscope as an external A/D converter.



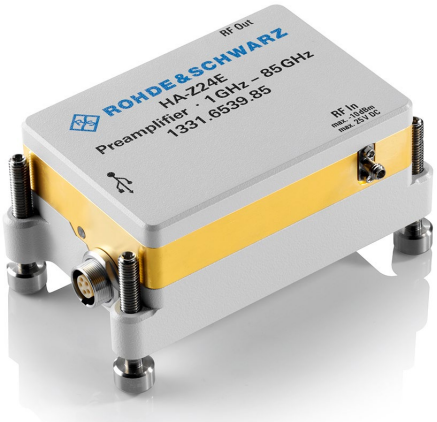



Fig. 2: Using the adjustable legs, the R&S®HA-Z24E external preamplifier can be set to just the right connecting height.

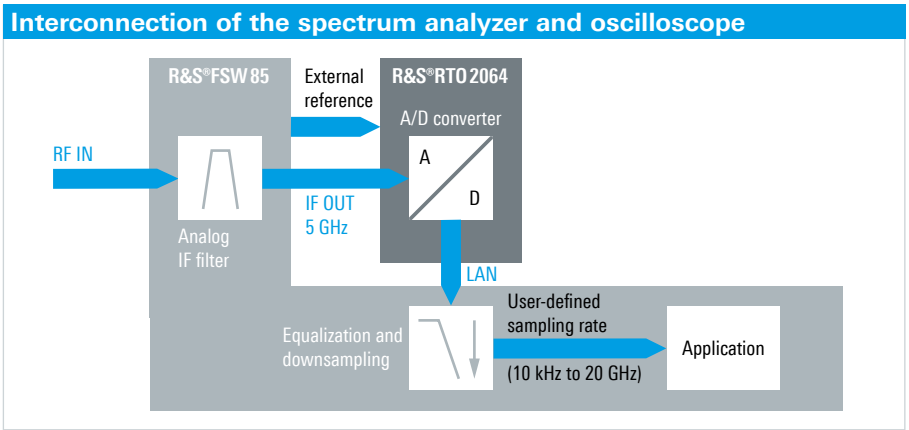



Fig. 3: Signal path for interconnection of the R&S®FSW85 signal and spectrum analyzer with the R&S®FSW-B5000 option and the R&S®RTO2064 oscilloscope for an analysis bandwidth of 5 GHz.

preamplifier between 1 GHz up to 85 GHz (Fig. 2). This is relevant during over-the-air measurements of radar signals.

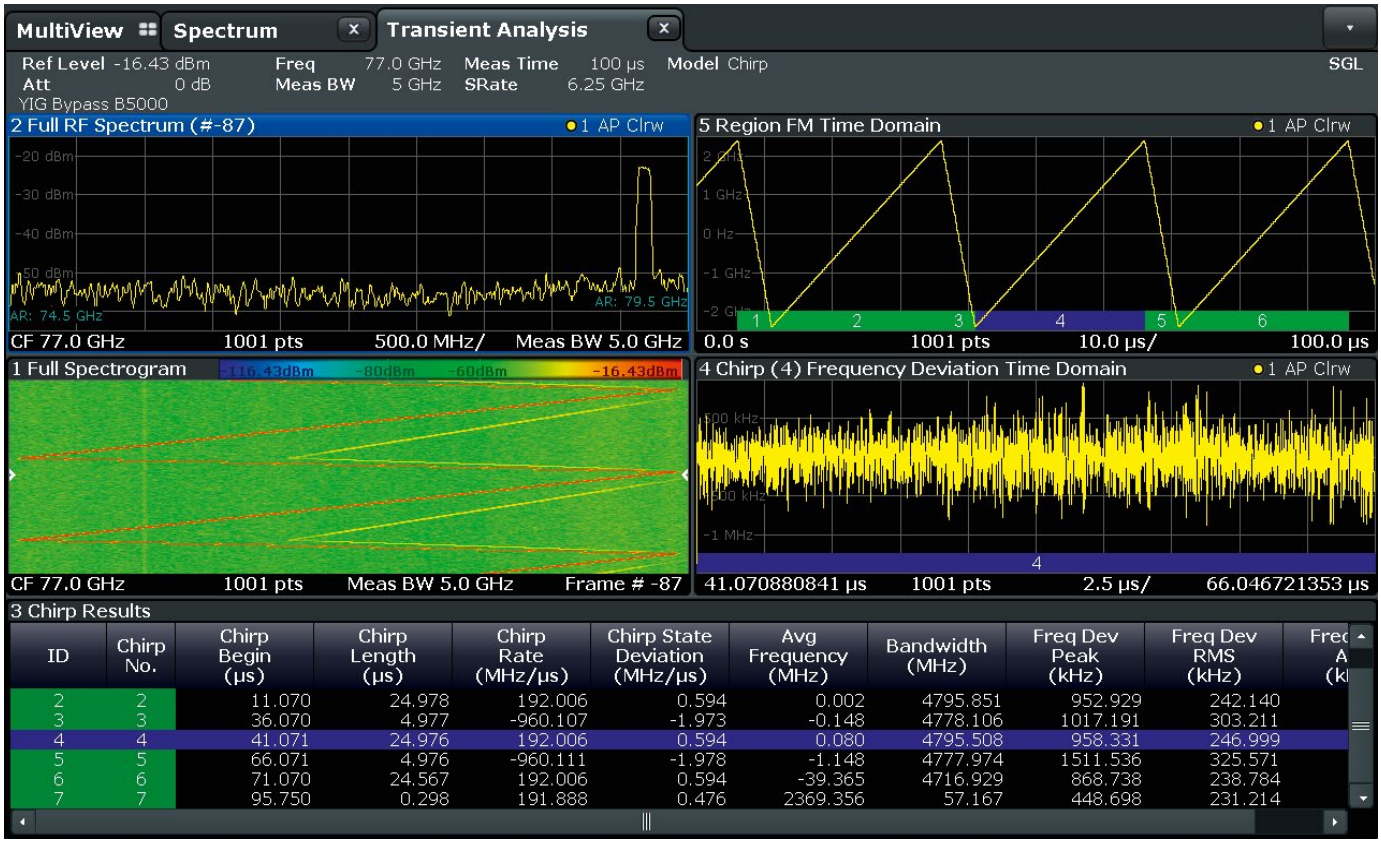
## 5 GHz analysis bandwidth

For demodulation and analysis of automotive radar signals in the E band (especially in research and development labs), analysis bandwidths up to 5 GHz are a must. When combined with the R&S®RTO2064 oscilloscope as an external A/D converter, the R&S®FSW85 is capable of supplying these bandwidths (Fig. 1). The analyzer must be equipped with the R&S®B5000 hardware bandwidth option for this application. The R&S®FSW85 mixes the input signal down to an intermediate frequency (IF) of 3.5 GHz, which is digitized by the R&S®RTO and sent back to the analyzer via the LAN (Fig. 3). The analyzer equalizes the signal and mixes it into the digital baseband. The equalized I/Q samples are subsequently fed to the measurement software on the R&S®FSW85. The signal path from the analyzer inputs to the A/D converter in the oscilloscope has been fully characterized in terms of the amplitude and phase response. From the user's perspective, this combination of instruments behaves like a single instrument. The R&S®FSW85 controls the oscilloscope and handles all of the steps involved in transferring, processing, equalizing and analyzing data.


## Analysis of FMCW signals

Most automotive radars use chirp sequences consisting of a number of very short linear frequency modulated continuous wave (LFMCW) chirps. A radar's range and speed resolution are dependent on parameters such as the signal bandwidth, chirp duration, chirp rate and signal linearity. Unwanted effects within the radar signal can influence the accuracy and performance of the radar system.

To analyze CW radar signals, the R&S®FSW-K60 transient measurement application can be used. Extensions for




| ID | Chirp No. | Chirp Begin (µs) | Chirp Length (µs) | Chirp Rate (MHz/µs) | Chirp State Deviation (MHz/µs) | Avg Frequency (MHz) | Bandwidth (MHz) | Freq Dev Peak (kHz) | Freq Dev RMS (kHz) | Freq A (k |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2 | 11.070 | 24.978 | 192.006 | 0.594 | 0.002 | 4795.851 | 952.929 | 242.140 | |
| 3 | 3 | 36.070 | 4.977 | -960.107 | -1.973 | -0.148 | 4778.106 | 1017.191 | 303.211 | |
| 4 | 4 | 41.071 | 24.976 | 192.006 | 0.594 | 0.080 | 4795.508 | 958.331 | 246.999 | |
| 5 | 5 | 66.071 | 4.976 | -960.111 | -1.978 | -1.148 | 4777.974 | 1511.536 | 325.571 | |
| 6 | 6 | 71.070 | 24.567 | 192.006 | 0.594 | -39.365 | 4716.929 | 868.738 | 238.784 | |
| 7 | 7 | 95.750 | 0.298 | 191.888 | 0.476 | 2369.356 | 57.167 | 448.698 | 231.214 | |

Fig. 4: R&S®FSW-K60 transient measurement application: analysis of chirp signals with the R&S®FSW-K60C extension.

this software support analysis of chirp signals (R&S®FSW-K60C) and frequency hopping signals (R&S®FSW-K60H). The application determines the start and end of individual chirp or frequency hopping signals in the I/Q data acquired by the R&S®FSW. The software calculates all of the performance parameters within a user-defined range, e.g. the measurement bandwidth and time.

Fig. 4 shows the R&S®FSW-K60C measurement application for analysis of chirp signals. In window 1 (Full Spectrogram), the complete content of the I/Q acquisition memory in the time domain (vertically downward) and frequency domain (horizontal) is visible. The color indicates the power level. In this example, six chirps were detected within a measurement interval of 100 µs and a bandwidth of 5 GHz.

Window 2 (Full RF Spectrum) isolates one line from the spectrogram, i.e. the line in the middle that is indicated with two white markers. At this instant, the chirp is just passing a frequency of 79.4 GHz (at the right in the window).

Window 5 (Region FM Time Domain) shows the frequency modulation (FM) vs. time. The green and blue bars indicate the six chirps that were detected. A video filter with 1 % of the demodulation bandwidth (i.e. 50 MHz) suppresses unwanted signals and the noise of the peak detector.

Window 4 (Chirp (4) Frequency Deviation Time Domain) shows the frequency error for one of the detected chirps (4) vs. time. The Chirp Results table lists all relevant parameters for the measured chirps.

## Summary

The R&S®FSW85 signal and spectrum analyzer is a user-friendly solution for measuring ultrawide automotive radar signals in the E-band up to 85/90 GHz. Equipped with the 5 GHz bandwidth option, the analyzer uses an R&S®RTO oscilloscope as an external A/D converter. The user operates this combination completely via the analyzer's user interface.

Typical applications include measurements on automotive FMCW radars and on other frequency agile, very short pulse radars. The R&S®FSW-K60 transient measurement option and its extension for chirp signals (R&S®FSW-K60C) as well as the R&S®FSW-K6 pulse analysis option for pulsed radars provide versatile measurement functions for such applications.

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