R&S®FMU36 Baseband Signal Analyzer

All-in-one solution for RFID, baseband, and IF signals

The R&S®FMU36 offers developers a variety of analysis capabilities as it includes an FFT spectrum analyzer and a time domain and vector signal analyzer. For applications such as RFID, where no RF measurements are required, it is a favorably priced solution for all measurement tasks to be performed on baseband and IF signals.

Wide range of applications

The R&S®FMU36 baseband signal analyzer (FIG 4) combines a wide dynamic range at low frequencies with a large demodulation bandwidth. Since FFT analysis as well as vector signal and time domain analysis are combined, it is suitable for baseband measurements in wireless and mobile radio applications (e. g. chipset development) as well as for measurements on audio signals, in mechanical vibration analysis, on ADSL modems, on the IF stages of receivers, on DC supplies (noise voltage), and in systems with low carrier frequencies such as RFID (for an example, see box on page 47).

Widest dynamic range also at low frequencies

Owing to direct sampling (without IF conversion), the R&S®FMU36 has an unrivaled dynamic range within its frequency range.

Low noise down to DC

Below 10 MHz, the inherent noise of the R&S®FMU36 is up to 20 dB lower than that of an RF spectrum analyzer (FIG 2). You can thus perform sensitive noise and noise voltage measurements even without additional preamplifiers.

Low phase noise

The analyzer also excels with regard to phase noise and is clearly better than an RF spectrum analyzer (FIG 3). At 10 MHz, it attains –145 dBc (1 Hz) at an offset of 100 kHz.

Short measurement times

Due to its high intermodulation suppression, the analyzer can be operated at full-scale capacity, thus achieving the desired dynamic range with large measurement bandwidths. This reduces measurement times. The example in FIG 1 shows the inherent TOI measurement at 10.5 MHz and a carrier offset of 1 MHz. At a span of 4 MHz, an intermodulation ratio of –90 dBc is measured at a speed of 100 sweeps/s.

Excellent demodulation characteristics

The bandwidth of 72 MHz for complex signals (36 MHz in the baseband) covers all mobile radio and wireless standards and offers enough room to meet future requirements. The maximum symbol rate of 25 MHz used in vector signal analysis will be increased to 50 MHz in future firmware versions.

The I/Q result memory has a large capacity so that long sequences can be stored even if sampling rates are high. In its basic design (16 Msamples), the

Condensed data of the R&S®FMU36

Frequency range	DC to 36 MHz
Resolution bandwidth	0.5 Hz to 20 MHz
Level measurement range	up to +25 dBm
Linearity	0.1 dB to –90 dBFS
Frequency response up to 36 MHz	<0.3 dB
Flatness of group delay	typ. 1 ns
ACPR for WCDMA 3GPP	typ. –73 dB
Noise floor	typ. –157 dBm (1 Hz)
S/N	typ. –147 dBc (1 Hz)
SSB phase noise (10 MHz, offset 10 kHz)	typ. –142 dBc (1 Hz)
Impedance	50 Ω / 1 MΩ, switch-selectable
I/Q memory	16 Msamples optional up to 705 Msamples
Standard firmware	FFT analyzer Vector signal analysis

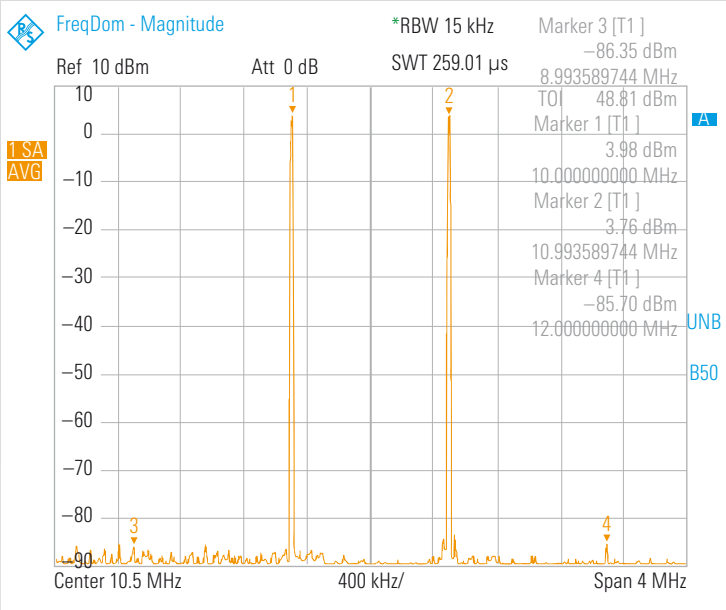


FIG 1 TOI measurement with 100 sweeps/s.

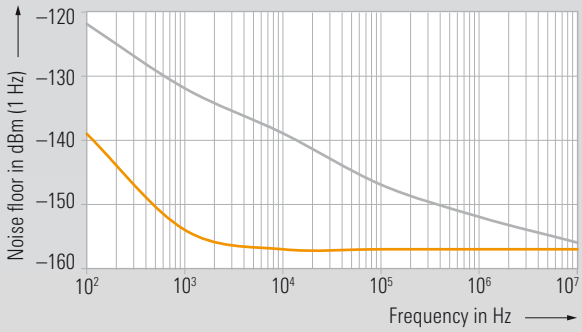


FIG 2 Comparison of noise floor in the R&S®FMU36 (orange) with that of an RF spectrum analyzer (grey).

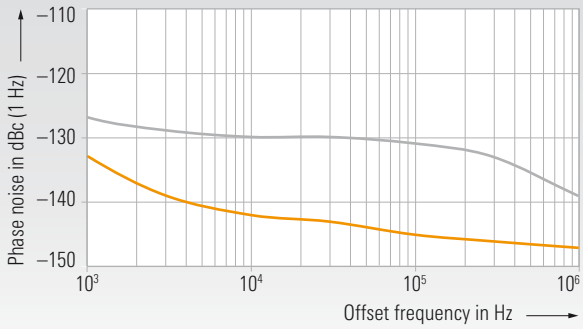


FIG 3 Comparison of phase noise at 10 MHz in the R&S®FMU36 (orange) with that of an RF spectrum analyzer (grey).

FIG 4 The R&S®FMU36 offers developers a variety of analysis capabilities as it includes an FFT spectrum analyzer as well as a time domain and vector signal analyzer.

R&S®FMU36 can already store up to 100 frames of a WCDMA signal. It can be extended to 705 Msamples. This allows a recording time of 8.5 s even at a maximum sampling rate of 81.6 MHz.

Flexible measurement inputs

To allow optimum matching to a source, the measurement inputs of the R&S®FMU36 are not limited to the common impedance of 50 Ω (single-ended). Baseband interfaces are usually differential and often do not support 50 Ω. The R&S®FMU36 meets this requirement with its balanced inputs that can be switched to 1 MΩ.

Comprehensive support of probes

Probes (R&S®FMU-Z1 option) that are fully supported by the analyzer up to the calibration at the probe tip are available to perform accurate and distortion-free measurements such as on chipsets. A typical example is the measurement on a printed board between baseband source and I/Q modulator where a 50 Ω test point is usually not available. Although the input impedance of the R&S®FMU36 can be switched over to 1 MΩ, measurements via a cable will cause extreme mismatch and high measurement uncertainties. The high-impedance probes normally used with oscilloscopes eliminate these drawbacks. The problems usually encountered in this approach such as incorrect level display or unknown frequency response are, however, unknown with the R&S®FMU36 which does the following:

- It identifies probes via their resistance coding and automatically takes the division factor into account in the level display.
- It supplies the appropriate signal for probe adjustment. The optimum and automatic setting of the time domain display with zoom is performed automatically.
- Probes are inserted into a female BNC via adapters and the analyzer measures the following at a keystroke:
  - Attenuation error
  - DC offset
  - Frequency response (magnitude and phase, FIG 5)

  The analyzer then compensates for the measured values digitally and saves the calibration data to the internal hard disk.

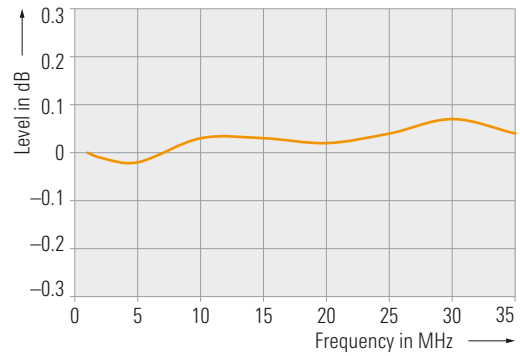


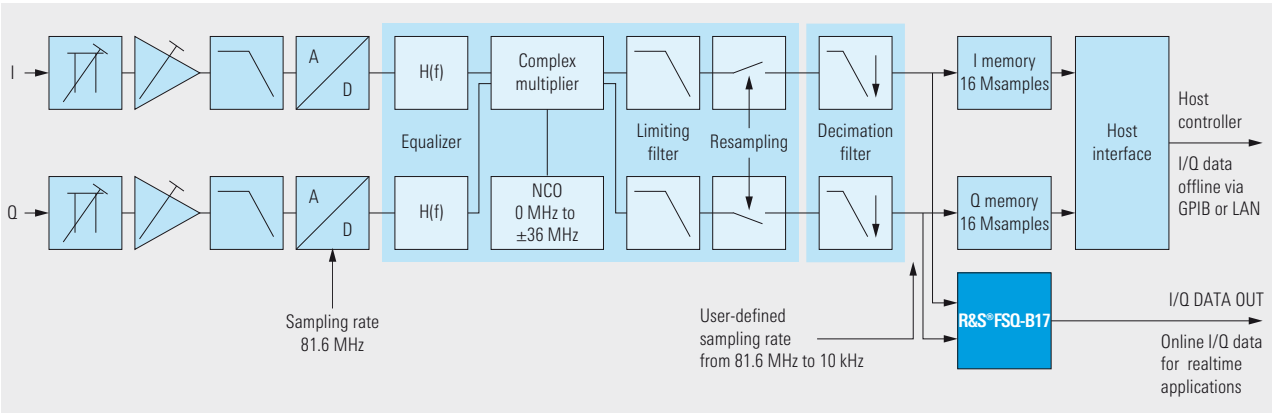
FIG 5 Typical frequency response with the R&S®FMU-Z1 high-impedance probe after calibration.

Online I/Q data

The R&S®FMU36 can process real (only I or Q) or complex (I + jQ) input signals. The analyzer converts IF and RF signals up to 36 MHz into the complex baseband using an NCO. To limit the data volume, the sampling rate can be adapted to the signal bandwidth (FIG 6). Data is stored in the I/Q memory and processed offline by the host controller.

If measurements that are not in line with standards are to be performed on a PC using the customer's own algorithms, the R&S®FMU36 provides the I/Q data via its IEC/IEEE bus or LAN interface. You can select any sampling

FIG 6 The block diagram of the R&S®FMU36 with the R&S®FSQ-B17 digital baseband interface option shows the essential components of analog and digital signal processing.



rate between 10 kHz and 81.6 MHz. Due to resampling and decimation with digital filters, the signals are always aliasing-free. For realtime applications, the I/Q data can also be output online via a low voltage differential signaling (LVDS) interface (R&S®FSQ-B17 option).

Calibrated within seven seconds

The excellent dynamic range (FIG 10) is supplemented by autocalibration to minimize the I/Q impairments. You only need seven seconds to measure

- gain imbalance
- quadrature error
- origin offset

using a reference signal and to calculate digital compensation filters.

Application example: measurements on RFID cards

RFID smart cards in accordance with ISO 14443 with a range of 10 cm, e. g. for employee ID cards, are widely used. They operate at 13.56 MHz, and the required test methods are described in ISO 10373-6. A test PCD (proximity coupling device) assembly with a PCD antenna and two sense coils in a bridge circuit (FIG 7) are used to perform the measurement. The main criterion here is to perform high-impedance measurements on this bridge – an ideal task for the R&S®FMU36.

To perform the measurement, the PCD feeds the PCD antenna and stimulates the card in the test PCD assembly. This card responds with a delay at a frequency offset of ±847 kHz. Tuned to the 12.713 MHz offset frequency, the R&S®FMU36 measures the frame delay time (FIG 8) and the transmit power of the card (load modulation, FIG 9) in the time domain magnitude mode. This measurement is only possible because the analyzer operates selectively in the time domain. The PCD transmits CW to supply the card even while the card is responding.

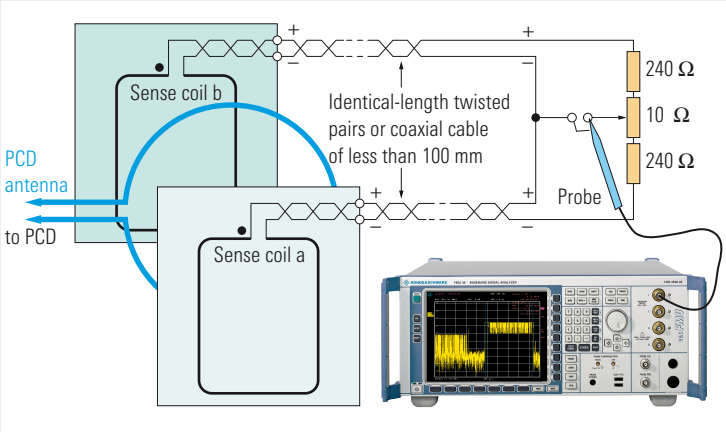


FIG 7 The R&S®FMU36 in an RFID test setup with a test PCD assembly in accordance with ISO 10373-6.

FIG 8 Frame delay time measurement of RFID card.

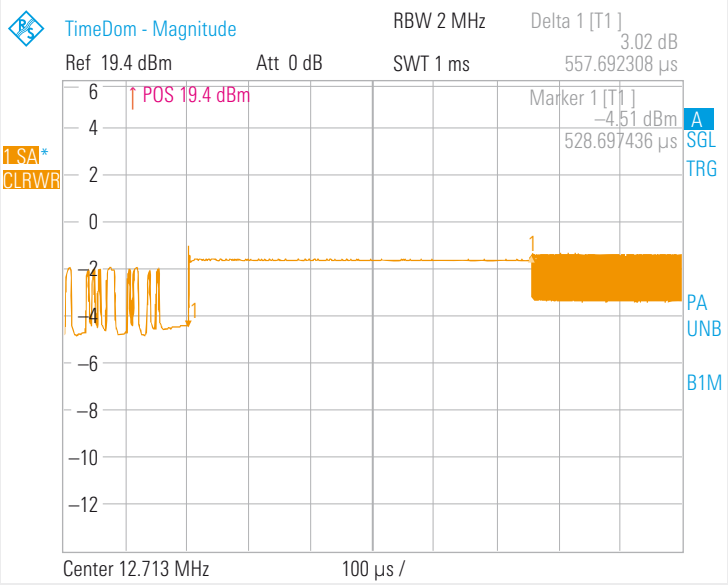
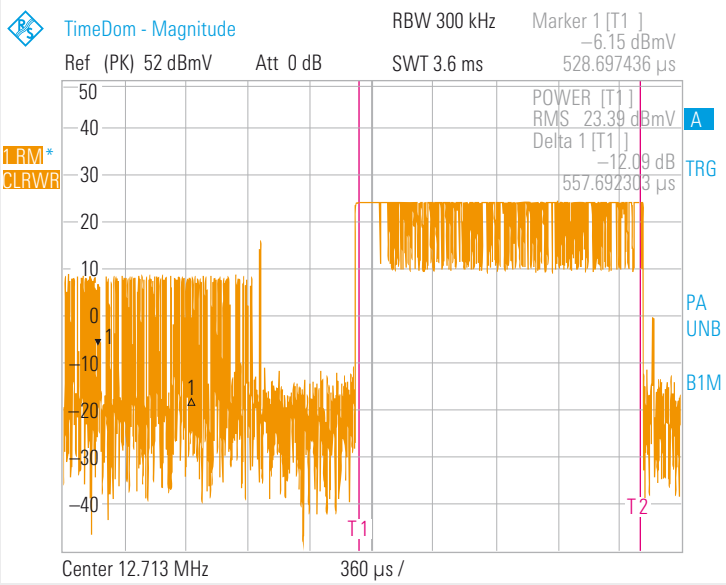


FIG 9 Right: Response of RFID card (card type B, BPSK); level measurement in dBmV between limiting lines. Left: The remnants of the signal coming from the PCD (amplitude shift keying).



The quality of this calibration (FIG 11) also makes the R&S®FMU36 ideal for measurements on high-quality modulation sources, e.g. vector signal generators. The delay difference between I and Q is corrected to typ. 100 ps so that the analyzer is also ideal for phase difference measurements.

Custom-tailored options

With its variety of custom-tailored firmware options, the R&S®FMU36 covers the complete wireless market: modulation measurements for WiMAX, WLAN, Bluetooth®, and analog modulation. It also covers the requirements for the CDMA standards including code domain power.

- 3GPP HSDPA BTS
- 3GPP WCDMA (FDD)
- GSM/GPRS/EDGE
- CDMA2000®
- 3GPP TD-SCDMA
- WiMAX 802.16-2004
- WiMAX 802.16e-2005
- WLAN 802.11a/b/g/j
- Bluetooth® 802.15.1
- AM/FM/φM demodulation

The most important hardware options:

- Digital baseband interface for outputting I/Q data in realtime
- I/Q memory extension up to 705 Msamples

The R&S®FMU36 is a universal measuring instrument whose high versatility is virtually unrivaled.

Manfred Müller

FIG 10 73 dB dynamic range during ACPR measurement on a 3GPP WCDMA signal.

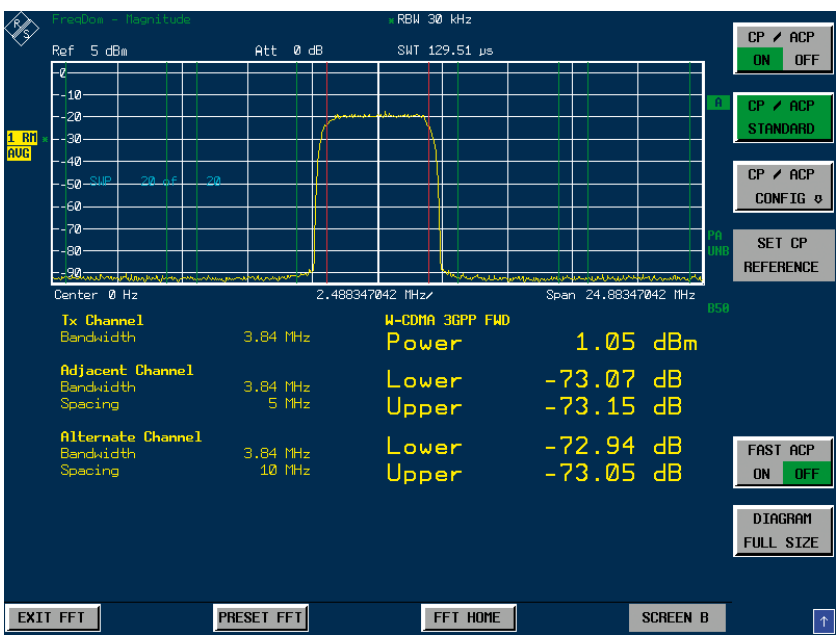


FIG 11 Smallest I/Q impairments at 5 MHz (corresponds to a QPSK with a symbol rate of 20 MHz), measured using the vector signal analysis in the R&S®FMU36.

QPSK
SR 20 MHz Sym&Mod Acc
Ref 10 dBm (PK 1 V) BB ANA 0 Hz

MODULATION ACCURACY (AVERAGE)

	Current Sweep			Statistic Count 100 of 100 (std AVG)					
	Result	Peak	atSym	RMS	AVG	StdDev	95pctl	Total Pk	Unit
EVM	0.139	0.214	34	0.138	0.134	0.035	0.187	0.238	%
Magnitude Err	0.068	0.132	257	0.079	0.068	0.040		0.227	%
Phase Error	0.07	-0.11	34	0.07	-0.00	0.07		-0.13	deg
CarrierFreq Err	-5.54			5.42	-5.42	93.84m		-5.10	Hz
Ampt Droop	0.00			0.00	0.00	-94.29			dB
Origin Offset	-65.55			-65.22	-65.24	-90.18			dB
Gain Imbalance	-0.01			-0.01	-0.01	-66.06			dB
Quadrature Err	-0.13			0.12	-0.12	0.02			deg
RHO	0.999998			0.999998	0.999998	0.000000			
Mean Power	13.14	13.16	244	13.14	13.14	-27.75		13.16	dBm
SNR (MER)	57.14			57.18	57.18	14.76			dB

More information, data sheet, and product brochure at www.rohde-schwarz.com (search term: FMU)