R&S®TSMW Universal Radio Network Analyzer

Scanner for drive tests and I/Q streaming

ROHDE&SCHWARZ

R&S®TSMW Universal Radio Network Analyzer

At a glance

The R&S®TSMW universal radio network analyzer is a high-end platform for optimizing all conventional wireless communications networks. Two highly sensitive 20 MHz frontends for any input frequency from 30 MHz to 6 GHz, a dual-channel preselection and an FPGA-based software-defined architecture offer unsurpassed performance while providing maximum flexibility and operational readiness. In addition to functioning as a scanner for wireless communications networks, the R&S®TSMW is also an ideal digital I/Q baseband receiver for customer-specific applications.

Owing to its hardware platform, the R&S®TSMW universal radio network analyzer offers maximum flexibility. For example, the R&S®TSMW comes in handy as an LTE scanner, and it can be utilized together with the R&S®ROMES4 drive test software to roll out and optimize 3GPP EUTRA networks (R&S®TSMW-K29 LTE option). In addition to LTE, further wireless communications technologies such as GSM, WCDMA, CDMA2000® 1xEVDO, TETRA and WiMAX™ are supported simultaneously.

Moreover, the R&S®TSMW can be used as a realtime scanner for I/Q baseband data. The R&S®TSMW-K1 option offers a MATLAB® and a C++ interface via which I/Q measurement data can be transmitted and evaluated.

Key facts

- User-definable input frequency range from 30 MHz to 6 GHz
- Two independent RF and signal processing paths, each with a bandwidth of 20 MHz
- Integrated preselection for high intermodulation suppression while dynamic range is high
- Support of LTE FDD and TD-LTE measurements together with the R&S®ROMES4 drive test software
- Parallel measurements in GSM, WCDMA, LTE CDMA2000® 1xEVDO, TETRA and WiMAX™ networks
- I/Q baseband streaming with Gigabit LAN interface
- Integrated GPS with PPS

R&S®TSMW Universal Radio Network Analyzer

Benefits and key features

LTE network rollout and network optimization

- Automatic detection and measurement of P-SCH and S-SCH channels
- Easy detection of interference
- Cyclic prefix analysis with channel impulse response measurement
- Support of LTE-FDD and TD-LTE

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Parallel support of multiple wireless communications technologies

- Simultaneous measurements in GSM, LTE, WCDMA, CDMA2000® 1xEVDO, TETRA and WiMAX™
- Simple scanner setup
- Flexible assignment of the two receivers for maximum measurement speed
- Everything in one instrument

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All-in-one drive test solution with R&S®ROMES4

- Network optimization with scanner and test terminal
- Improvement of QoS
- Identification of interference

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Maximum flexibility when evaluating I/Q data with MATLAB® and C++ interface

- Seamless streaming of I/Q data in realtime
- Data access via MATLAB® or C++ interface
- Fast integration due to included example application based on MATLAB®

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Unsurpassed hardware platform performance and flexibility

- Broadband with 20 MHz bandwidth and maximum frequency range from 30 MHz to 6 GHz
- Parallel scanning of multiple technologies and frequency bands with outstanding measurement speed
- Top dynamic range and measurement accuracy owing to adaptive preselection
- Software defined radio architecture (SDR), updates from PC only
- Integration of SuperSense GPS with PPS

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LTE network roll-out and network optimization

Using the R&S®TSMW together with the R&S®ROMES4 drive test software opens the door to numerous measurement and analysis capabilities for LTE field tests.

Automatic detection and measurement of P-SCH and S-SCH channels

All that the R&S®ROMES4 software needs to "know" is the center frequency of an LTE signal. The R&S®TSMW can find all further information that is required, e.g. the bandwidth used, the physical cell ID, the cyclic prefix length used, or the synchronization channels (P-SCH and S-SCH). This is particularly relevant when a wireless communications network is growing both in size and complexity. The user does not require any detailed knowledge about the LTE network and its structure when carrying out measurements.

Immediately after the measurement is started, the power values of the physical cell IDs are displayed in a Top N chart. In addition to these values, the signal-to-interference-plus-noise ratio (SINR) is output. This value indicates whether interference is present on a signal. Both measurement results can be output at a maximum rate of 200 measurements per second.

Easy detection of interference

The R&S®ROMES4 drive test software and the R&S®TSMW can be used especially for detecting and reducing interference. Various interference scenarios – for example, reflections, co-channel interference or adjacent-channel interference – can impair a connection to a terminal and negatively affect the SINR. Owing to its design, a terminal cannot determine why the SINR is too low. A data connection accompanied by a deteriorating SINR would result in lower-order modulation. To achieve the highest data rates possible, 64 QAM modulation should be used. However, this modulation mode absolutely requires a high SINR.

Featuring a C/I of –20 dB to +40 dB and a sensitivity of up to –127 dBm, the R&S®TSMW finds co-channel interference without any problem. Signals can overlap each other and originate from different base stations – the R&S®TSMW detects and identifies the interferers. The user thus knows exactly which base stations are causing the problem, and which ones must be evaluated in greater detail in order to improve the SINR and, subsequently, to enhance the data throughput at this point.

Cyclic prefix analysis with channel impulse response measurement

By means of the channel impulse response measurement, the R&S®TSMW can measure multipath propagation and reflections and then display the results by using the R&S®ROMES4 software. Reflections can be measured in a time frame of –6 µs to +34 µs. This means that the eightfold length of a normal cyclic prefix can be measured. As a result, the user can detect violations of the guard interval (intersymbol interference, ISI).

A further interference factor may be an excessively high phase noise of the basis station. The R&S®TSMW's low inherent phase noise allows users to detect problems also in the base station.

Typical configuration of an LTE drive test system consisting of an R&S®TSMW and the R&S®ROMES4 software.

Equipment required for LTE drive tests

- R&S®TSMW universal radio network analyzer
- R&S®TSMW-K29 LTE scanner option
- R&S®TSMW-Z1 power supply
- R&S®ROMES4 drive test software
- R&S®ROMES4T1W R&S®TSMW all-technology driver for R&S®ROMES4

Parallel support of multiple wireless communications technologies

The R&S®TSMW can be adapted to the customer's application by using various options. Together with the R&S®ROMES4 software, up to seven different technologies can be measured and displayed at the same time, while the hardware resources can be scaled as needed.

Simultaneous measurements in GSM, LTE, WCDMA, CDMA2000® 1xEVDO, TETRA and WiMAX™

Multiple wireless communications technologies are often used simultaneously. Particularly during the rollout of new technologies such as 3GPP LTE or WiMAX™ IEEE 802.16e, wireless communications networks such as GSM/WCDMA, CDMA2000®, 1xEVDO or TETRA are already present. To keep the T&M effort and the related costs low, an all-in-one solution should be used. Rohde&Schwarz offers the perfect solution with its R&S®TSMW and the R&S®ROMES4 software.

Simple scanner setup

The user generally does not require expert knowledge about the wireless communications network to be tested. The R&S®TSMW detects all important information automatically. For example, the user only has to enter the following parameters: the UARFCN number in a WCDMA network, the band in a GSM network, the center frequency in a WiMAX™ or LTE network, and the channel number in a CDMA2000® 1xEVDO network. The R&S®TSMW then automatically detects and measures all detectable scrambling codes, channels, preamble indices and physical cell IDs. The measurement speed is not affected by the quantity of measured signals. Similar for TETRA, where all active channels within a 10-MHz-downlink band are detected and decoded automatically.

Flexible assignment of the two receivers for maximum measurement speed

Technologies to be measured can flexibly be distributed to two RF and signal paths. Measuring two technologies in parallel does not cause any reduction in measurement speed. If further technologies are added, they are time-distributed to the hardware resources. This feature enables the R&S®TSMW to offer maximum performance in multiple-technology measurements. Up to six wireless communications technologies can be measured at the same time.

Everything in one instrument

Wireless communications scanners such as the R&S®TSMW are primarily used when measurements must be performed independently of a test terminal. The R&S®ROMES4 software offers a Top N evaluation of all available signals for each technology. The user receives an overview of the strongest signals and can sort them by provider. Especially in CDMA2000® and WCDMA networks, this evaluation plays a crucial role in reducing pilot pollution.

Furthermore, neighbor cells that may not be found by a test terminal can be detected. Missing neigbor cells can be detected independently of the technology. This enables the user to identify coverage gaps or interference. The capability to demodulate the broadcast information of the broadcast channel (BCH) offers insight into the network configuration. Applications such as automatic neighborhood analysis or automatic interference detection can easily be carried out by applying this functionality.

The R&S®TSMW can also be used for benchmark purposes. Multiple technologies and multiple providers can be scanned simultaneously. Even when a new technology is being rolled out, networks already present can be monitored as well.

All-in-one drive test solution with R&S®ROMES4

When used together with the R&S®TSMW, the R&S®ROMES4 drive test software also supports test terminals. The R&S®TSMW can be used to detect and eliminate errors caused by a terminal.

Network optimization with scanner and test terminal

The R&S®ROMES4 drive test software not only evaluates measurement data from Rohde&Schwarz scanners. It also covers test terminals. These terminals establish either a voice or a data link. For example, a voice connection enables the user to measure speech quality or to generate a statistical evaluation about dropped calls. In the case of data links, the maximum possible transmission rate must be achieved. This is verified by means of data services such as an FTP download.

Improvement of QoS

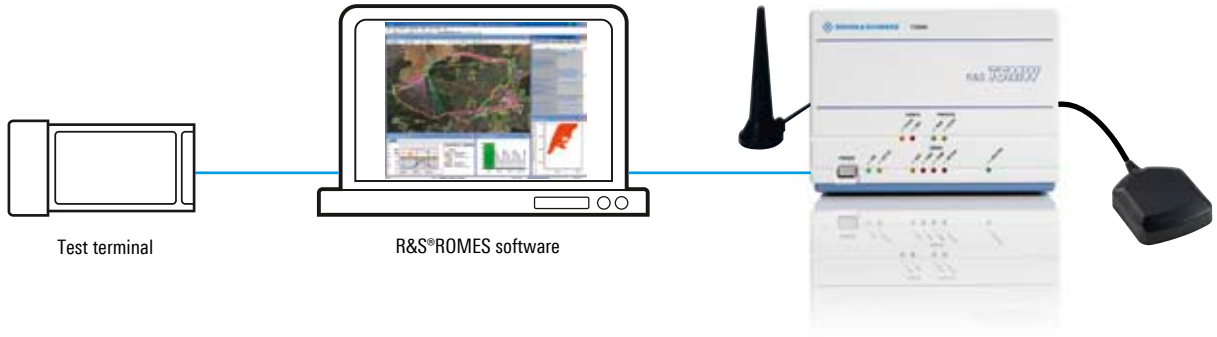
Example: HSDPA and HSUPA

During an FTP download, a test terminal displays the maximum current data transmission rate. If this rate is too slow with regard to the wireless communications technology being used, the channel quality indicator (CQI) measured by the test terminal can be implemented to trace the cause of the problem. If the CQI is too low, either the received signal may be too weak or the measured E_c/I_0 may be very low. In this case, pilot pollution may be the source of the problem. This means that the test terminal is receiving too many signals of equal strength. The R&S®TSMW can quickly determine the unwanted signals. If the received signals are too weak, this may indicate that the test terminal did not find a neighbor cell. The R&S®TSMW is network-independent because it does not rely on neighbor lists. Unknown neighbor cells can therefore be detected without any problem.

When combined with R&S®ROMES4, the R&S®TSMW can be used with the technologies listed in the following table.

Technology	Option
3GPP LTE	R&S®TSMW-K29
WiMAX™ IEEE 802.16e	R&S®TSMW-K28
GSM/WCDMA	R&S®TSMW-K21
CDMA2000® 1x EVDO Rev. A	R&S®TSMW-K22
TETRA	R&S®TSMW-K26

Typical drive test configuration



Maximum flexibility when evaluating I/Q data

Seamless streaming of I/Q data in realtime

A special asset of the R&S®TSMW is its R&S®TSMW-K1 digital I/Q data interface. Users of this option can, for example, perform technology-independent channel measurements. These measurements can be used to simulate realistic fading scenarios in a lab environment. To do this, I/Q data recorded by the R&S®TSMW can, for example, be replayed directly on a signal generator from Rohde&Schwarz. This data, which has been recorded under real-world conditions, can therefore be replayed again and again in the lab environment. The seamless streaming of I/Q data can be carried out with a maximum bandwidth of 20 MHz. The duration of an I/Q recording is determined solely by the size of the hard disk.

Data access via MATLAB® or C++ interface

Both a flexible MATLAB® interface and an equivalent C++ interface are available. They make it possible to perform measurements on the R&S®TSMW and to process results on the PC. Users can thus, for example, not only design and analyze receiver algorithms in MATLAB®, but also port them to C++ as a realtime version.

Fast integration due to included example application based on MATLAB®

The demo application included in the R&S®TSMW-K1 option is based on MATLAB® code and may be used for initial reference measurements in the frequency and time domains. Likewise, the demo application may be utilized as a skeletal structure for customized applications in order to quickly obtain the measurement results needed.

The demo application makes it possible to define the center frequency, the sampling rate and the measurement filter. In this context, the measurement filter is used primarily to define the bandwidth to be measured. In addition to I/Q streaming, single measurements or continuous measurements are possible. Users can define whether one or both of the receivers are to be used.

For professional applications, it is also possible to set the attenuation values, the activation of the preamplifier, and the data format of the digital I/Q data. To reduce the amount of data accumulated, the application offers bit resolutions of 8 bit, 12 bit, 16 bit and 20 bit. Users can therefore reduce the transmission rate on the LAN interface.

Materials included with the R&S®TSMW-K1 option

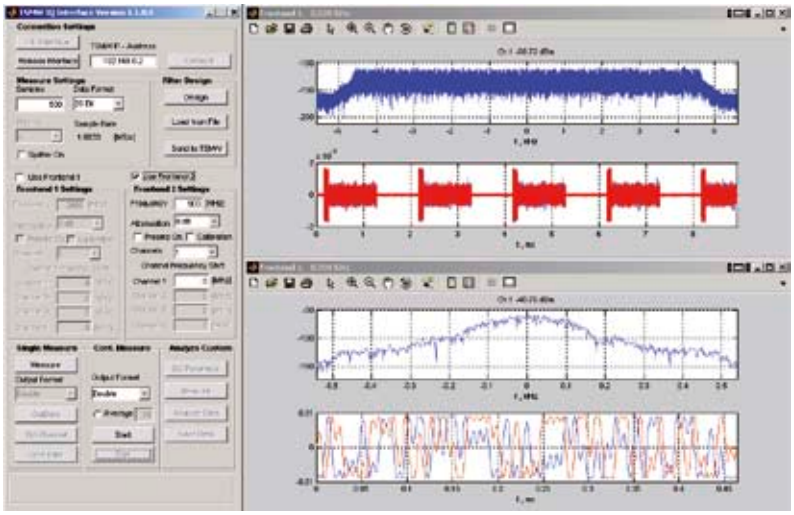
In addition to the demo application, the materials supplied together with the R&S®TSMW-K1 option include an operating and a programming manual. The programming manual supplies all information regarding the required MATLAB® functions and data structures. To enable users to immediately start operating the R&S®TSMW together with the demo application, a MATLAB® runtime license is included.

Equipment required for performing I/Q streaming

- R&S®TSMW universal radio network analyzer
- R&S®TSMW-K1 digital I/Q interface
- R&S®TSMW-Z1 AC power supply

Hardware requirements

- PC with Gigabit LAN interface
- Hard disk with SATA interface and min. data write rate of 75 Mbyte/s



The left-hand side of this screenshot shows the demo application for configuring the settings. The right-hand side shows the measurement result in the frequency domain (blue) and time domain (red/blue) for each receiver.

Unsurpassed hardware platform performance and flexibility

Broadband with 20 MHz bandwidth and maximum frequency range from 30 MHz to 6 GHz

The R&S®TSMW universal radio network analyzer from Rohde&Schwarz offers a hardware platform with maximum flexibility. The two integrated broadband receivers (30 MHz to 6 GHz) with a bandwidth of 20 MHz each and a separate preselection open the door to a variety of applications.

Parallel scanning of multiple technologies and frequency bands with outstanding measurement speed

The two receivers can be operated independently or in combination with one another. Depending on the application, the measurement speed can be increased in this manner, and the measurement bandwidth can be expanded.

Featuring a high measurement bandwidth of 20 MHz, the R&S®TSMW is optimally suited particularly for new wireless communications standards such as LTE or WiMAX™. Using the MATLAB®-based solution, even measurements during development can be performed on standards that have not yet been fully specified (LTE, for example). By virtue of the promising and widely used Gigabit Ethernet LAN interface, operation even at high measurement rates is no problem.

Top dynamic range and measurement accuracy owing to adaptive preselection

To achieve top measurement accuracy and dynamic range, the R&S®TSMW has an integrated preselection. Thus, multiple adjustable filters reduce intermodulation in advance. The analyzer can therefore detect signals with a sensitivity that is considerably below the noise level (noise figure 7 dB at 3.5 GHz).

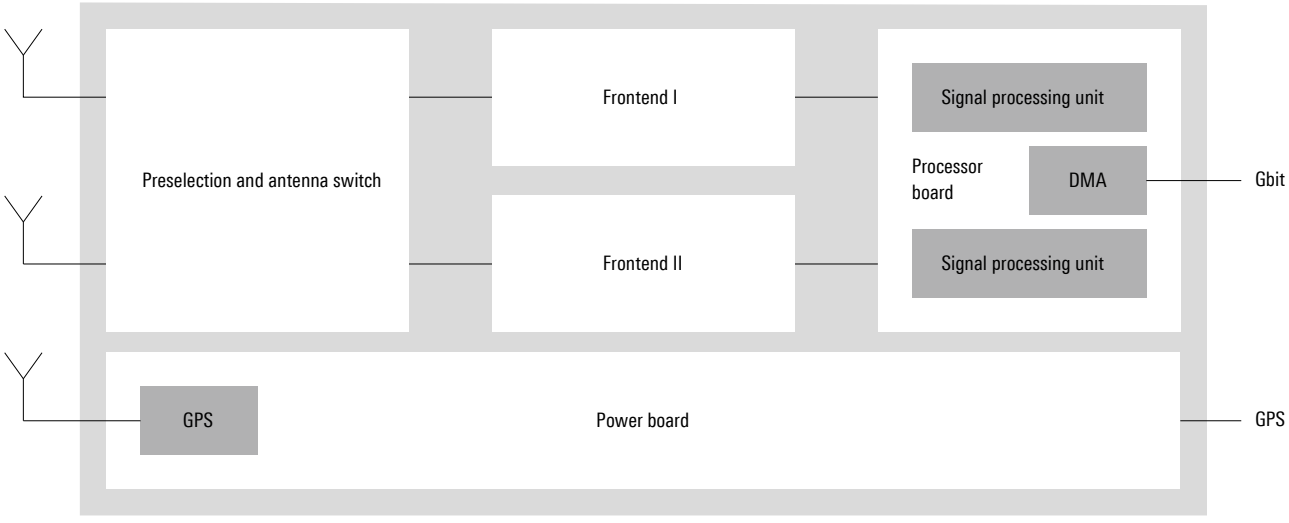
Update of hardware platform via software

The hardware platform can be updated and its functionality enhanced by means of software. This allows the R&S®TSMW to be expanded in the field to handle additional technologies without having to be sent in for an upgrade. Only the specific options required are added, for example when the user wants to convert an I/Q scanner to an LTE scanner.

Integration of SuperSense GPS with PPS

An integrated SuperSense GPS receiver with 16 channels and a refresh rate of 4 Hz allows the analyzer to be used also in areas with weak GPS signals.

Architecture of the dual-channel R&S®TSMW universal radio network analyzer



Specifications

Base unit data		
RF characteristics		
Frequency range		30 MHz to 6 GHz
Reference frequency	internal	1 × 10^{-6} aging per year
Level measurement uncertainty	S/N > 16 dB	< 1 dB at 30 MHz to 2500 MHz
		< 1.5 dB at 2.5 GHz to 6 GHz
Maximum permissible input level		5 dBm/0 V DC
Noise figure	preamplification ON	typ. 7 dB at 3.5 GHz
	preamplification OFF	typ. 19 dB at 3.5 GHz
Intermodulation-free dynamic range	preamplification ON: level 2 × –45 dBm	typ. –65 dBc (–12.5 dBm TOI) at 3.5 GHz
	preamplification OFF: level 2 × –35 dBm	typ. 70 dBc (0 dBm TOI) at 3.5 GHz
RF receive paths	independent	2
VSWR	30 MHz ≤ f ≤ 2.5 GHz	typ. 1.5
	2.5 GHz ≤ f ≤ 6 GHz	typ. 1.7
Preselection channels		5 per RF path, 3 used as tracking filters
LTE characteristics		
Frequency bands supported		no restrictions
Measurement modes		LTE-FDD and TD-LTE
Measurement speed	automatic detection of all 504 physical cell IDs	max. 200 measurements/s
Physical decoding accuracy		
Sensitivity for initial physical cell ID decoding		–123 dBm
Sensitivity after successful physical cell ID decoding		–127 dBm
SINR dynamic range		max. 42 dB
WiMAX™ characteristics		
Frequency bands supported		no restrictions
Measurement speed	automatic detection of all 114 preamble indices	5 measurements/s
Preamble decoding accuracy	frame duration 5 ms; FFT size 1024; bandwidth 10 MHz; 2.5 GHz	±1 dB (–30 dBm to –109 dBm)
Sensitivity for initial preamble decoding		< –97 dBm (RSSI)
Sensitivity after successful preamble decoding		< –112 dBm (RSSI)
SINR dynamic range		–20 dB to +40 dB
GSM characteristics		
Frequency bands supported		no restrictions
Measurement modes		SCH code power, TCH total in-bandpower, time-slot power, BCH demodulation for all system information types
Measurement speed		350 channels/s with SCH demodulation 500 channels/s without SCH demodulation
Sensitivity		–118 dBm
Measurement accuracy		typ. ±1 dB
BSIC decoding accuracy		98% for C/I > +2 dB
BSIC decoding dynamic range		
Sensitivity for initial BSIC detection		C/I > –18 dB
Sensitivity after successful BSIC detection		C/I > –29 dB
BCCH decoding dynamic range		C/I > 0 dB
WCDMA characteristics		
Frequency bands supported		no restrictions
Number of RF carrier frequencies		max. 12
Measurement speed	high speed/high dynamic range automatic detection of all 512 scrambling codes	100 Hz/12 Hz, with BCH demodulation
Scrambling code detection sensitivity		
Sensitivity for initial SC detection	high speed/high dynamic range	–112 dBm/–121 dBm
Sensitivity after successful SC detection	high speed/high dynamic range	–118 dBm/–123 dBm

Base unit data		
Scrambling code detection accuracy	RSCP	typ. < 1 dB
	E_c/I_0 > –12 dB	typ. < 1.5 dB
Scrambling code false detection (ghost code)		< 10^{-9}
Dynamic range E_c/I_0		–22 dB/–30 dB
Min. BCH demodulation threshold E_c/I_0		> –17 dB
CDMA2000® characteristics		
Supported frequency bands		no restrictions
Number of RF carrier frequencies		max. 18
Measurement speed	automatic detection of all 512 PN	10 Hz
PN detection sensitivity		–119 dBm
Dynamic range	E_c/I_0	29 dB
1xEVDO characteristics		
Frequency bands supported		no restrictions
Number of RF carrier frequencies		max. 18
Measurement speed		10 Hz
PN detection sensitivity		–120 dBm
Dynamic range	E_c/I_0	33 dB
TETRA characteristics		
Supported TETRA bands		no restrictions
Number of RF carrier frequencies		max. 400 within a 10 MHz downlink band
Channel resolution		25 kHz (QPSK)
Measurement speed		max. 8000 channels/s, 20/s for a 10 MHz block
Sensitivity		–120 dBm for RSSI measurements –115 dBm TETRA BSCH decoding BSCH decoding for channels with an SNR > 9.5 dB
I/Q characteristics		
Digital filter bandwidth, burst		800 kHz to 20 MHz
Digital filter bandwidth, streaming	hardware requirements: Gbit LAN link, jumbo frames 8k, transfer rate hard disk 75 Mbyte/s	max. 22 Msample/s
Resampling rate		1 Msample/s to 21.94 Msample/s
Demodulation bandwidth		20 MHz
Data format	14 bit ADC resolution	8 bit, 12 bit, 16 bit or 20 bit
I/Q buffer size		200 Mbyte
Physical characteristics		
RF inputs	SNAP N connector	50 Ω
Data interface	RJ-45	10/100/1000BaseT
External reference input	BNC female	50 Ω
External trigger input/output	BNC female	5 V, TTL
GPS antenna connector	SMA female/active GPS antenna	50 Ω/3 V, max. 100 mA
GPS USB interface (standalone)		type B USB connector
Operating temperature range		+5 °C to +40 °C
Permissible temperature range		0 °C to +50 °C
Storage temperature range	EN 60068-2-1 and EN 60068-2-2	–25 °C to +85 °C
Humidity	EN 60068-2-30	+50 °C at 95 % rel. humidity
EMC		EN 61326-1: 2006 EN 61326-2-1: 2006 EN 55011: 2007 + A2:2007
Safety		in line with IEC 61010–1: 2001 (Ed. 2), EN 61010–1: 2001 (second edition), UL 61010-1 (second edition), CAN/CSA-C22.2 NO. 61010-1
Mechanical resistance		
Vibration	sinusoidal	EN 60068-2-6
	random	EN 60068-2-64
Shock		40 g shock spectrum, in line with MIL-STD-810F, method 516.4, procedure 1

Base unit data		
Dimensions (W × H × D)		180 mm × 130 mm × 270 mm (7.09 in × 5.12 in × 10.63 in)
Weight		5.1 kg (11.24 lb)
Power consumption		typ. 65 W, max. 10 A DC at 9 V
Input voltage		9 V to 18 V DC
Input current		max. 10 A DC
GPS receiver		
Sensitivity		
Acquisition		–148 dBm
Tracking		–158 dBm
Channels		16
Time to first fix (TTFF)		
Cold/warm/hot start	at –125 dBm	41 s/33 s/< 3.5 s
System requirements	R&S®ROMES4 drive test software [1]; controller (Pentium IV, 2 Gbyte RAM, Gigabit Ethernet, USB 1.0, USB required only if GPS is used as standalone application)	

[1] If the R&S®TSMW-K1 Gigabit digital I/Q interface is used, the R&S®ROMES4 drive test software is not required. Instead, MATLAB® or custom-specific software must be installed.

Ordering information

Designation	Type	Order No.
Base unit		
Universal Radio Network Analyzer	R&S®TSMW	1503.3001.02
Hardware options		
LTE Scanner Option (for R&S®ROMES4)	R&S®TSMW-K29	1503.4550.02
WiMAX™ Scanner Option (for R&S®ROMES4)	R&S®TSMW-K28	1503.4543.02
GSM/WCDMA Scanner Option (for R&S®ROMES4)	R&S®TSMW-K21	1503.4514.02
CDMA2000® 1xEVDO Rev. A	R&S®TSMW-K22	1503.4520.02
TETRA	R&S®TSMW-K26	1510.8792.02
Digital I/Q Interface	R&S®TSMW-K1	1503.3960.02
Software options		
R&S® TSMW Scanner Driver for R&S®ROMES4 Drive Test Software	R&S®ROMES4T1W	1117.6885.02
Additional software		
Drive Test Software	R&S®ROMES4	1117.6885.04
System components		
Power Supply	R&S®TSMW-Z1	1503.4608.02
Soft Carrying Bag	R&S®FSH-Z25	1145.5896.02
Rack Adapter	R&S®TSMW-Z2	1503.3901.02
Antenna Magnet Mount without GPS	R&S®TSMW-ZA1	1145.6705.00
Antenna Magnet Mount with GPS	R&S®TSMW-ZA3	1145.6728.00
Antenna 800 MHz to 960 MHz and 1700 MHz to 2500 MHz	R&S®TSMW-ZE1	1145.6740.00
Antenna 400 MHz to 440 MHz	R&S®TSMW-ZE2	1117.8165.00
Antenna 360 MHz to 410 MHz	R&S®TSMW-ZE3	1117.8159.00

Your local Rohde&Schwarz expert will help you determine the optimum solution for your requirements and will be glad to provide you with a customized quotation.
To find your nearest Rohde&Schwarz representative, visit www.sales.rohde-schwarz.com

Service you can rely on

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

About Rohde&Schwarz

Rohde&Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established 75 years ago, Rohde&Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

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