

# R&S®CMW

## Wideband Radio Communication Tester Specifications

R&S®CMW500, R&S®CMW290, R&S®CMW270



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Specifications apply under the following conditions:

Data valid for

- the R&S®CMW500, the R&S®CMW290 and the R&S®CMW270 with 40/80 MHz bandwidth unit (R&S®CMW-H570A/B and R&S®CMW-H100A/D)

and

- the R&S®CMW500 and the R&S®CMW270 with 160 MHz bandwidth unit (R&S®CMW-H570H and R&S®CMW-H100H)

unless otherwise stated.

Data without tolerance limits is not binding. Based on a 24-month calibration interval unless otherwise stated. At least 15 minutes warm-up time at ambient temperature, specified environmental conditions met, calibration cycle adhered to, and all internal automatic adjustments performed. Typical values are designated with the abbreviation "typ.". These values are verified during the final test but are not assured by Rohde & Schwarz. Nominal values are design parameters that are not assured by Rohde & Schwarz. These values are verified during product development but are not specifically tested during production.

In line with the 3GPP/3GPP2 standard, chip rates are specified in Mcps (million chips per second), whereas bit rates and symbol rates are specified in Mbps (million bits per second), kbps (thousand bits per second) or ksps (thousand symbols per second), and sample rates are specified in Msample/s (million samples per second). Mcps, kbps, ksps and Msample/s are not SI units.

During the production process, each instrument is calibrated in line with defined procedures. All measurement results, including measurement uncertainties of the calibration system, have to be within the published specification limits to release the individual instrument. The expanded measurement uncertainties of the calibration system used in the production process are determined with a coverage factor of  $k = 2$  (normally approx. 95 % probability).

Parameters written in italics can be set directly on the tester.

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Data without tolerance limits is not binding.

## General technical specifications

### Possible configurations with two RF paths

Necessary hardware (R&S®CMW-H570, R&S®CMW-H590X):

Selections: R&S®CMW-S590A RF frontend (BASIC) or R&S®CMW-S590D RF frontend (ADV.), and R&S®CMW-S570 RF TRX

Options: R&S®CMW-B590A RF frontend (BASIC) or R&S®CMW-B590D RF frontend (ADV.), and R&S®CMW-B570 RF TRX

#### Configuration with two R&S®CMW-H570 (RF TRX) and two R&S®CMW-H590A (RF frontend (BASIC))

The R&S®CMW-B570 and R&S®CMW-B590A options make the second RF path (RF path 2) available on the front of the instrument at three additional RF connectors, i.e. RF3 COM, RF4 COM and RF3 OUT.

RF3 COM	equivalent to RF1 COM	see general technical specifications
RF4 COM	equivalent to RF2 COM	see general technical specifications
RF3 OUT	equivalent to RF1 OUT	see general technical specifications

#### Configuration with two R&S®CMW-H570 (RF TRX) and one R&S®CMW-H590D (RF frontend (ADV.))

The R&S®CMW-B570 option and R&S®CMW-S590D selection make the second RF path (RF path 2) available on the front of the instrument at connectors RF1 COM, RF2 COM and RF1 OUT.

#### RF path 1 and RF path 2 routed to separate connectors

<b>RF generator 1 and RF generator 2</b>	switchable to RF1 COM, RF2 COM, RF1 OUT	see general technical specifications
<b>RF analyzer 1 and RF analyzer 2</b>	switchable to RF1 COM, RF2 COM	see general technical specifications
Expected nominal power setting range		see general technical specifications, + 3 dB for lower level limit value
Expected nominal power setting for full dynamic range		see general technical specifications, + 3 dB for lower level limit value
Level range		see general technical specifications, + 3 dB (typ. + 2 dB) for lower level limit value

#### RF path 1 and RF path 2 routed to common connector

<b>RF generator 1 and RF generator 2</b>	switchable to RF1 COM, RF2 COM, RF1 OUT	see general technical specifications
Output level range	peak envelope power (PEP)	the specified value is valid for the total power of the two RF generators, see general technical specifications
Output level uncertainty	for each carrier	see general technical specifications, + 0.2 dB
Signal-to-noise ratio	for the carrier with the highest output level (at least 3 dB higher than the other carrier)	see general technical specifications
<b>RF analyzer 1 and RF analyzer 2</b>	switchable to RF1 COM, RF2 COM	see general technical specifications
Level uncertainty	70 MHz to 3300 MHz	see general technical specifications, + 0.2 dB
	3300 MHz to 6000 MHz	see general technical specifications + 0.3 dB
Expected nominal power setting range		see general technical specifications, + 3 dB for lower level limit value
Expected nominal power setting for full dynamic range		see general technical specifications, + 3 dB for lower level limit value
Level range		see general technical specifications, + 3 dB (typ. + 2 dB) for lower level limit value

## Possible configurations with four RF paths <sup>1</sup>

Necessary hardware (R&S<sup>®</sup>CMW-H570, R&S<sup>®</sup>CMW-H590D):

Selections: R&S<sup>®</sup>CMW-S590D RF frontend (ADV.) and R&S<sup>®</sup>CMW-S570 RF TRX

Options: R&S<sup>®</sup>CMW-B590D RF frontend (ADV.) and three R&S<sup>®</sup>CMW-B570 RF TRX

### Configuration with four R&S<sup>®</sup>CMW-H570 (RF TRX) and two R&S<sup>®</sup>CMW-H590D (RF frontend (ADV.))

The three R&S<sup>®</sup>CMW-B570 options and the R&S<sup>®</sup>CMW-B590D option make the four RF paths (RF path 1 RX and TX, RF path 2 RX and TX, RF path 3 RX and TX, RF path 4 RX and TX) available on the front of the instrument at connectors RF1 COM, RF2 COM, RF1 OUT and RF3 COM, RF4 COM, RF3 OUT.

#### RF path 1, 2, 3 and 4 routed to separate connectors

<b>RF generator 1 and RF generator 3</b>	switchable to RF1 COM, RF2 COM, RF1 OUT	see general technical specifications
<b>RF generator 2 and RF generator 4</b>	switchable to RF3 COM, RF4 COM, RF3 OUT	see general technical specifications
<b>RF analyzer 1 and RF analyzer 3</b>	switchable to RF1 COM, RF2 COM	see general technical specifications
Expected nominal power setting range		see general technical specifications, + 3 dB for lower level limit value
Expected nominal power setting for full dynamic range		see general technical specifications, + 3 dB for lower level limit value
Level range		see general technical specifications, + 3 dB (typ. + 2 dB) for lower level limit value
<b>RF analyzer 2 and RF analyzer 4</b>	switchable to RF3 COM, RF4 COM	see general technical specifications
Expected nominal power setting range		see general technical specifications, + 3 dB for lower level limit value
Expected nominal power setting for full dynamic range		see general technical specifications, + 3 dB for lower level limit value
Level range		see general technical specifications, + 3 dB (typ. + 2 dB) for lower level limit value

#### RF path 1, RF path 3 routed to common connector and RF path 2, RF path 4 routed to common connector

<b>RF generator 1 and RF generator 3</b>	switchable to RF1 COM, RF2 COM, RF1 OUT	see general technical specifications
Output level range	peak envelope power (PEP)	the specified value is valid for the total power of the two RF generators, see general technical specifications
Output level uncertainty	for each carrier	see general technical specifications, + 0.2 dB
Signal-to-noise ratio	for the carrier with the highest output level (at least 3 dB higher than the other carrier)	see general technical specifications
<b>RF generator 2 and RF generator 4</b>	switchable to RF3 COM, RF4 COM, RF3 OUT	see general technical specifications
Output level range	peak envelope power (PEP)	the specified value is valid for the total power of the two RF generators, see general technical specifications
Output level uncertainty	for each carrier	see general technical specifications, + 0.2 dB
Signal-to-noise ratio	for the carrier with the highest output level (at least 3 dB higher than the other carrier)	see general technical specifications

<b>RF analyzer 1 and RF analyzer 3</b>	switchable to RF1 COM, RF2 COM	see general technical specifications
Level uncertainty	70 MHz to 3300 MHz	see general technical specifications, + 0.2 dB
	3300 MHz to 6000 MHz	see general technical specifications, + 0.3 dB
Expected nominal power setting range		see general technical specifications, + 3 dB for lower level limit value
Expected nominal power setting for full dynamic range		see general technical specifications, + 3 dB for lower level limit value

<sup>1</sup> R&S<sup>®</sup>CMW500 and R&S<sup>®</sup>CMW270 only.

Level range		see general technical specifications, + 3 dB (typ. + 2 dB) for lower level limit value
<b>RF analyzer 2 and RF analyzer 4</b>	switchable to RF3 COM, RF4 COM	see general technical specifications
Level uncertainty	70 MHz to 3300 MHz	see general technical specifications, + 0.2 dB
	3300 MHz to 6000 MHz	see general technical specifications, + 0.3 dB
Expected nominal power setting range		see general technical specifications, + 3 dB for lower level limit value
Expected nominal power setting for full dynamic range		see general technical specifications, + 3 dB for lower level limit value
Level range		see general technical specifications, + 3 dB (typ. + 2 dB) for lower level limit value

<b>VSWR</b>		
RF1 COM, RF2 COM	70 MHz to 3300 MHz	< 1.2
	3300 MHz to 5000 MHz	< 1.5
	5000 MHz to 6000 MHz	< 1.6
RF1 OUT	70 MHz to 3300 MHz	< 1.5
	3300 MHz to 5000 MHz	< 1.5
	5000 MHz to 6000 MHz	< 1.6

## RF generator with 40/80 MHz bandwidth unit

Frequency range		70 MHz to 3300 MHz, up to 6000 MHz with the R&S®CMW-KB036 option
Frequency resolution		0.1 Hz
Frequency uncertainty		same as timebase + frequency resolution

<b>Output level range</b>			
RF1 COM, RF2 COM	70 MHz to 100 MHz		
	continuous wave (CW)	-130 dBm to -15 dBm	
	peak envelope power (PEP)	up to -15 dBm	
	overranging (PEP)	up to -10 dBm	
	100 MHz to 3300 MHz		
	continuous wave (CW)	-130 dBm to -5 dBm	
	peak envelope power (PEP)	up to -5 dBm	
	overranging (PEP)	up to 0 dBm	
	3300 MHz to 6000 MHz		
	continuous wave (CW)	-120 dBm to -15 dBm	
	peak envelope power (PEP)	up to -15 dBm	
	overranging (PEP)	up to -10 dBm	
	maximum input DC level	0 V DC	
	RF1 OUT	70 MHz to 100 MHz	
		continuous wave (CW)	-120 dBm to -7 dBm
peak envelope power (PEP)		up to -7 dBm	
overranging (PEP)		up to +3 dBm	
100 MHz to 3300 MHz			
continuous wave (CW)		-120 dBm to +3 dBm	
peak envelope power (PEP)		up to +3 dBm	
overranging (PEP)		up to +13 dBm	
3300 MHz to 6000 MHz			
continuous wave (CW)		-112 dBm to -7 dBm	
peak envelope power (PEP)		up to -7 dBm	
overranging (PEP)		up to +3 dBm	
maximum input DC level		0 V DC	



<b>Output level uncertainty</b>	in temperature range +20 °C to +35 °C, no overranging	
RF1 COM, RF2 COM	output level > -120 dBm	
	70 MHz to 100 MHz	< 1.2 dB <sup>2</sup>
	100 MHz to 3300 MHz	< 0.6 dB <sup>2</sup>
RF1 OUT	3300 MHz to 6000 MHz	< 1.2 dB <sup>2</sup>
	output level > -112 dBm	
	70 MHz to 100 MHz	< 1.6 dB <sup>2</sup>
	100 MHz to 3300 MHz	< 0.8 dB <sup>2</sup>
	3300 MHz to 6000 MHz	< 1.6 dB <sup>2</sup>
	<b>Output level uncertainty</b>	in temperature range +5 °C to +45 °C, no overranging
RF1 COM, RF2 COM	output level > -120 dBm	
	70 MHz to 100 MHz	< 2.0 dB <sup>2</sup>
	100 MHz to 3300 MHz	< 1.0 dB <sup>2</sup>
RF1 OUT	3300 MHz to 6000 MHz	< 2.0 dB <sup>2</sup>
	output level > -112 dBm	
	70 MHz to 100 MHz	< 2.0 dB <sup>2</sup>
	100 MHz to 3300 MHz	< 1.0 dB <sup>2</sup>
	3300 MHz to 6000 MHz	< 2.0 dB <sup>2</sup>
	<b>Output level linearity with fixed RF output attenuator setting</b>	in temperature range +20 °C to +35 °C, GPRF generator list mode, level range 0 dB to -30 dB
RF1 COM, RF2 COM	no overranging	< 0.2 dB, typ. < 0.1 dB
<b>Output level resolution</b>		0.01 dB
<b>Output level repeatability</b>	typical values after 1 h warm-up time, always returning to same level and frequency, no temperature change, insignificant time change	
	output level ≥ -80 dBm	< 0.01 dB
	output level < -80 dBm	< 0.05 dB
<b>Attenuation of second harmonic</b>		
RF1 COM, RF2 COM	70 MHz to 6000 MHz, P < -10 dBm	> 30 dB
RF1 OUT	70 MHz to 6000 MHz, P < 0 dBm	> 30 dB
<b>Attenuation of third harmonic</b>		
RF1 COM, RF2 COM	70 MHz to 6000 MHz, P < -10 dBm	> 40 dB
RF1 OUT	70 MHz to 6000 MHz, P < 0 dBm	> 40 dB
<b>Attenuation of nonharmonics</b>	> 5 kHz offset from carrier, for output level > -40 dBm, for full scale CW signal	
	400 MHz to 3300 MHz, except $f_{\text{nonharmonic}} = 3900 \text{ MHz} - f_{\text{carrier}}$ , except $f_{\text{nonharmonic}} = 3900 \text{ MHz}$ , except $f_{\text{carrier}} = (899 \text{ to } 901) \text{ MHz} +$ $n \times 800 \text{ MHz}$ with $n = 1, 2, 3$	> 60 dB
	3300 MHz to 3600 MHz	> 25 dB
	3600 MHz to 6000 MHz, except $f_{\text{nonharmonic}} = 2 \times f_{\text{carrier}} - 6400 \text{ MHz}$	> 40 dB
<b>Phase noise</b>	single sideband, 70 MHz to 3300 MHz	
Carrier offset	≥ 1 MHz	< -120 dBc, 1 Hz
<b>Phase noise</b>	single sideband, 3300 MHz to 6000 MHz	
Carrier offset	≥ 1 MHz	< -117 dBc, 1 Hz
<b>Signal-to-noise ratio</b>	70 MHz to 3300 MHz	
RF1 COM, RF2 COM	5 MHz offset from carrier, for output level > -30 dBm	> 95 dB, typ. > 101 dB, 1 kHz (> 125 dB, typ. > 131 dB, 1 Hz)

<sup>2</sup> Valid for a 12-month calibration interval.

<b>Signal-to-noise ratio</b>	3300 MHz to 6000 MHz	
RF1 COM, RF2 COM	5 MHz offset from carrier, for output level > -30 dBm	> 92 dB, 1 kHz

### Modulation source: arbitrary waveform generator (ARB) (R&S®CMW-B110A/R&S®CMW-B110D option)

<b>Memory size</b>	R&S®CMW-B110A	1.024 Gbyte
	R&S®CMW-B110D	4.096 Gbyte
<b>Word length</b>	I	16 bit
	Q	16 bit
	marker	4 bit
<b>Sample length</b>	with 4-bit marker	up to 227.55 Msample
<b>Sample rate</b>	minimum	400 Hz
	maximum	100 MHz
<b>Maximum possible RF bandwidth</b>	depends on arbitrary waveform file	80 MHz

<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B

### RF analyzer with 40/80 MHz bandwidth unit

<b>Inherent spurious response</b>	without input signal, 70 MHz to 6000 MHz, except 4000 MHz, 4800 MHz, 5162.5 MHz, 5600 MHz, 6000 MHz	
	expected nominal power setting ≤ -10 dBm	< -100 dBm
	expected nominal power setting > -10 dBm	< -90 dB below expected nominal power setting

<b>Spurious response</b>	for full scale single tone input signal	
	70 MHz to 3300 MHz, except $f_{in} = 1962.5$ MHz and 3925 MHz, except $f_{in} = 1962.5$ MHz + $f_{selected}$	< -55 dB
	3300 MHz to 3700 MHz, except $f_{in} = 6400$ MHz - $f_{selected}$ , except $f_{in} = 6400$ MHz - $0.5 \times f_{selected}$	< -40 dB
	3700 MHz to 6000 MHz, except $f_{in} = 6400$ MHz - $0.5 \times f_{selected}$	< -40 dB

<b>Harmonic response</b> RF1 COM, RF2 COM	second harmonic	
	$f_{in} = 70$ MHz to 1650 MHz, $f_{selected} = 140$ MHz to 3300 MHz	< -30 dB
	$f_{in} = 1650$ MHz to 3000 MHz, $f_{selected} = 3300$ MHz to 6000 MHz	< -30 dB

<b>Harmonic response</b> RF1 COM, RF2 COM	third harmonic	
	$f_{in} = 70$ MHz to 900 MHz, $f_{selected} = 210$ MHz to 2700 MHz	< -50 dB
	$f_{in} = 900$ MHz to 1100 MHz, $f_{selected} = 2700$ MHz to 3300 MHz	< -45 dB
	$f_{in} = 1100$ MHz to 2000 MHz, $f_{selected} = 3300$ MHz to 6000 MHz	< -50 dB

<b>Phase noise</b>	single sideband, 70 MHz to 3300 MHz	
Carrier offset	≥ 1 MHz	< -120 dBc, 1 Hz

<b>Phase noise</b>	single sideband, 3300 MHz to 6000 MHz	
Carrier offset	≥ 1 MHz	< -117 dBc, 1 Hz

<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: free run, GPRF: IF power, GPRF: gen, BB signaling

## Power meter

<b>Frequency range</b>		70 MHz to 3300 MHz, up to 6000 MHz with the R&S®CMW-KB036 option
<b>Frequency resolution</b>		0.1 Hz
<b>Resolution bandwidths</b>		Gaussian, 1 kHz to 10 MHz, in 1/3/5 steps, bandpass, 1 kHz to 30 MHz, in 1/3/5 steps, RRC, $\alpha = 0.1$ , 3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter, 1.2288 MHz, CDMA filter
<b>Expected nominal power setting range</b>	for ADC full scale	
RF1 COM, RF2 COM	70 MHz to 100 MHz	-37 dBm to +42 dBm <sup>3</sup>
	100 MHz to 3300 MHz	-47 dBm to +42 dBm <sup>3</sup>
	3300 MHz to 6000 MHz	-37 dBm to +42 dBm <sup>3</sup>

<b>Level range</b>		
RF1 COM, RF2 COM	70 MHz to 100 MHz	
	continuous power (CW)	-74 dBm <sup>4</sup> to +34 dBm
	peak envelope power (PEP)	up to +42 dBm <sup>3</sup>
	100 MHz to 3300 MHz	
	continuous power (CW)	-84 dBm <sup>4</sup> to +34 dBm
	peak envelope power (PEP)	up to +42 dBm <sup>3</sup>
	3300 MHz to 6000 MHz	
	continuous power (CW)	-74 dBm <sup>4</sup> to +34 dBm
	peak envelope power (PEP)	up to +42 dBm <sup>3</sup>
	maximum input DC level	0 V DC

<b>Level uncertainty</b>	in temperature range +20 °C to +35 °C	
RF1 COM, RF2 COM	70 MHz to 100 MHz	< 1.0 dB <sup>5</sup>
	100 MHz to 3300 MHz	< 0.5 dB <sup>5</sup>
	3300 MHz to 6000 MHz	< 1.0 dB <sup>5</sup>

<b>Level uncertainty</b>	in temperature range +5 °C to +45 °C	
RF1 COM, RF2 COM	70 MHz to 100 MHz	< 1.2 dB <sup>5</sup>
	100 MHz to 3300 MHz	< 0.7 dB <sup>5</sup>
	3300 MHz to 6000 MHz	< 1.2 dB <sup>5</sup>

<b>Level linearity with fixed expected nominal power setting</b>	in temperature range +20 °C to +35 °C	
RF1 COM, RF2 COM	level range 0 dB to -40 dB	< 0.15 dB, typ. < 0.1 dB

<b>Level resolution</b>		0.01 dB
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<b>Level repeatability</b>	typical values after 1 h warm-up time, always returning to same level and frequency, no temperature change, insignificant time change	
	input level $\geq -40$ dBm	< 0.01 dB
	input level < -40 dBm	< 0.03 dB

<b>Dynamic range</b>	70 MHz to 3300 MHz, $RBW \rightarrow 1$ kHz, with fixed expected nominal power setting and mixer level offset $\geq +4$ dB	> 100 dB
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<sup>3</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>4</sup>  $RBW \rightarrow 1$  kHz.

<sup>5</sup> Valid for a 12-month calibration interval.

<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		-8 dBm to +42 dBm <sup>6</sup>
<b>Dynamic range</b>	3300 MHz to 6000 MHz, <i>RBW</i> → 1 kHz, with fixed expected nominal power setting and mixer level offset ≥ +4 dB	> 97 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		+2 dBm to +42 dBm <sup>6</sup>

## Spectrum measurements

<b>FFT spectrum analyzer</b>		
Frequency range		70 MHz to 3300 MHz, up to 6000 MHz with the R&S®CMW-KB036 option
Frequency span		1.25 MHz, 2.5 MHz, 5 MHz, 10 MHz, 20 MHz, 40 MHz
FFT length		1k, 2k, 4k, 8k, 16k
Detector		peak, RMS

<b>Dynamic range</b>	70 MHz to 3300 MHz, for <i>FFT length</i> → 16k and <i>span</i> → 5 MHz (equivalent to <i>RBW</i> → 781 Hz), with fixed expected nominal power setting and mixer level offset ≥ +4 dB	> 100 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		-8 dBm to +42 dBm <sup>6</sup>

<b>Dynamic range</b>	3300 MHz to 6000 MHz, for <i>FFT length</i> → 16k and <i>span</i> → 5 MHz (equivalent to <i>RBW</i> → 781 Hz), with fixed expected nominal power setting and mixer level offset ≥ +4 dB	> 97 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		+2 dBm to +42 dBm <sup>6</sup>

<b>RF spectrum analyzer (R&amp;S®CMW-KM010 option)</b>		
Frequency range		70 MHz to 3300 MHz, up to 6000 MHz with the R&S®CMW-KB036 option
Frequency span		0 Hz (zero span), 500 Hz to 3230 MHz, up to 5930 MHz with the R&S®CMW-KB036 option
Resolution bandwidth (RBW)		100 Hz to 10 MHz (additional 40 MHz in zero span)
Video bandwidth (VBW)		10 Hz to 10 MHz
Sweep time	frequency sweep, depends on RBW, VBW and span	500 μs to 2000 s
	zero span, depends on RBW and VBW	80 μs to 2000 s
Detector		average, RMS, sample, min. peak, max. peak, auto peak
Trigger	frequency sweep	free run
	zero span	video, BASE: external TRIG A, B all R&S®CMW internal trigger sources

<b>Dynamic range</b>	70 MHz to 3300 MHz, <i>RBW</i> → 1 kHz, <i>detector</i> → RMS	> 100 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		-8 dBm to +42 dBm <sup>6</sup>

<b>Dynamic range</b>	3300 MHz to 6000 MHz, <i>RBW</i> → 1 kHz, <i>detector</i> → RMS	> 97 dB
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<sup>6</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		+2 dBm to +42 dBm <sup>7</sup>
<b>Level range</b>		see general technical specifications
<b>Level uncertainty</b>	for center frequency and <i>detector</i> → <i>peak</i>	see general technical specifications
<b>Inherent spurious response</b>		see general technical specifications
<b>Spurious response</b>		see general technical specifications
<b>Harmonic response</b>		see general technical specifications
<b>Phase noise</b>		see general technical specifications

## RF generator with 160 MHz bandwidth unit

<b>Frequency range</b>		70 MHz to 3300 MHz, up to 6000 MHz with the R&S®CMW-KB036 option
<b>Frequency resolution</b>		0.1 Hz
<b>Frequency uncertainty</b>		same as timebase + frequency resolution

<b>Output level range</b>		
RF1 COM, RF2 COM	70 MHz to 100 MHz	
	continuous wave (CW)	-130 dBm to -15 dBm
	peak envelope power (PEP)	up to -15 dBm
	overranging (PEP)	up to -10 dBm
	100 MHz to 3300 MHz	
	continuous wave (CW)	-130 dBm to -5 dBm
	peak envelope power (PEP)	up to -5 dBm
	overranging (PEP)	up to 0 dBm
	3300 MHz to 6000 MHz	
	continuous wave (CW)	-120 dBm to -15 dBm
	peak envelope power (PEP)	up to -15 dBm
	overranging (PEP)	up to -10 dBm
	maximum input DC level	0 V DC
RF1 OUT	70 MHz to 100 MHz	
	continuous wave (CW)	-120 dBm to -7 dBm
	peak envelope power (PEP)	up to -7 dBm
	overranging (PEP)	up to +3 dBm
	100 MHz to 3300 MHz	
	continuous wave (CW)	-120 dBm to +3 dBm
	peak envelope power (PEP)	up to +3 dBm
	overranging (PEP)	up to +13 dBm
	3300 MHz to 6000 MHz	
	continuous wave (CW)	-112 dBm to -7 dBm
	peak envelope power (PEP)	up to -7 dBm
	overranging (PEP)	up to +3 dBm
	maximum input DC level	0 V DC

<b>Output level uncertainty</b>		
	in temperature range +20 °C to +35 °C, no overranging	
RF1 COM, RF2 COM	output level > -120 dBm	
	70 MHz to 100 MHz	< 1.2 dB <sup>8</sup>
	100 MHz to 3300 MHz	< 0.6 dB <sup>8</sup>
	3300 MHz to 6000 MHz	< 1.2 dB <sup>8</sup>
RF1 OUT	output level > -112 dBm	
	70 MHz to 100 MHz	< 1.6 dB <sup>8</sup>
	100 MHz to 3300 MHz	< 0.8 dB <sup>8</sup>
	3300 MHz to 6000 MHz	< 1.6 dB <sup>8</sup>

<sup>7</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>8</sup> Valid for a 12-month calibration interval.

<b>Output level uncertainty</b>	in temperature range +5 °C to +45 °C, no overranging	
RF1 COM, RF2 COM	output level > -120 dBm	
	70 MHz to 100 MHz	< 2.0 dB <sup>9</sup>
	100 MHz to 3300 MHz	< 1.0 dB <sup>9</sup>
RF1 OUT	3300 MHz to 6000 MHz	< 2.0 dB <sup>9</sup>
	output level > -112 dBm	
	70 MHz to 100 MHz	< 2.0 dB <sup>9</sup>
	100 MHz to 3300 MHz	< 1.0 dB <sup>9</sup>
	3300 MHz to 6000 MHz	< 2.0 dB <sup>9</sup>
<b>Frequency-dependent attenuation (FDA) setting range</b>		-30 dB to 0 dB
<b>Max. FDA setting range</b>	for specified output level uncertainty	-10 dB to 0 dB
<b>Output level linearity with fixed RF output attenuator setting</b>	in temperature range +20 °C to +35 °C, GPRF generator list mode, level range 0 dB to -30 dB	
RF1 COM, RF2 COM	no overranging	< 0.2 dB, typ. < 0.1 dB
<b>Output level resolution</b>		0.01 dB
<b>Output level settling time</b>	to within 0.1 dB	< 50 µs <sup>10</sup>
<b>Output level repeatability</b>	typical values after 1 h warm-up time, always returning to same level and frequency, no temperature change, insignificant time change	
	output level ≥ -80 dBm	< 0.01 dB
	output level < -80 dBm	< 0.05 dB
<b>Attenuation of second harmonic</b>		
RF1 COM, RF2 COM	70 MHz to 6000 MHz, P < -10 dBm	> 30 dB
RF1 OUT	70 MHz to 6000 MHz, P < 0 dBm	> 30 dB
<b>Attenuation of third harmonic</b>		
RF1 COM, RF2 COM	70 MHz to 6000 MHz, P < -10 dBm	> 40 dB
RF1 OUT	70 MHz to 6000 MHz, P < 0 dBm	> 40 dB
<b>Attenuation of nonharmonics</b>	> 5 kHz offset from carrier, for output level > -40 dBm, for full scale CW signal	
	400 MHz to 3300 MHz, except $f_{\text{nonharmonic}} = 3800 \text{ MHz} - f_{\text{carrier}}$ , except $f_{\text{nonharmonic}} = \text{abs}(3800 \text{ MHz} - 2 \times f_{\text{carrier}})$ , except $f_{\text{carrier}} = (899 \text{ to } 901) \text{ MHz} + n \times 800 \text{ MHz}$ with $n = 1, 2, 3, 4, 5, 6, 7$	> 60 dB
	3300 MHz to 3600 MHz	> 25 dB
	3600 MHz to 6000 MHz, except $f_{\text{nonharmonic}} = 2 \times f_{\text{carrier}} - 6400 \text{ MHz}$	> 40 dB
<b>Phase noise</b>	single sideband, 70 MHz to 3300 MHz	
Carrier offset	≥ 1 MHz	< -120 dBc, 1 Hz
<b>Phase noise</b>	single sideband, 3300 MHz to 6000 MHz	
Carrier offset	≥ 1 MHz	< -117 dBc, 1 Hz
<b>Signal-to-noise ratio</b>	70 MHz to 3300 MHz	
RF1 COM, RF2 COM	5 MHz offset from carrier, for output level > -30 dBm	> 95 dB, typ. > 101 dB, 1 kHz (> 125 dB, typ. > 131 dB, 1 Hz)
<b>Signal-to-noise ratio</b>	3300 MHz to 6000 MHz	
RF1 COM, RF2 COM	5 MHz offset from carrier, for output level > -30 dBm	> 92 dB, 1 kHz

<sup>9</sup> Valid for a 12-month calibration interval.<sup>10</sup> When using list mode.

**Modulation source: arbitrary waveform generator (ARB)  
(included in R&S®CMW-B100H option)**

<b>Memory size</b>	R&S®CMW-H100H	4.096 Gbyte
<b>Word length</b>	I	16 bit
	Q	16 bit
	marker	4 bit
<b>Sample length</b>	with 4-bit marker	up to 800 Msample
<b>Sample rate</b>	minimum	400 Hz
	maximum	200 MHz
<b>Maximum possible RF bandwidth</b>	depends on arbitrary waveform file	160 MHz
<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B

**RF analyzer with 160 MHz bandwidth unit**

<b>Inherent spurious response</b>	without input signal, 150 MHz to 6000 MHz, except $n \times 500$ MHz with $n = 5$ to 12	
	expected nominal power setting $\leq -10$ dBm	$< -100$ dBm
	expected nominal power setting $> -10$ dBm	$< -90$ dB below expected nominal power setting
<b>Spurious response</b>	for full scale single tone input signal 150 MHz to 3800 MHz, except $f_{in} = 2215.5$ MHz and 4425 MHz, except $f_{in} = 2212.5$ MHz + $f_{selected}$	$< -55$ dB
	3800 MHz to 4200 MHz, except $f_{in} = 7200$ MHz - $f_{selected}$ , except $f_{in} = 7200$ MHz - $0.5 \times f_{selected}$	$< -40$ dB
	4200 MHz to 6000 MHz, except $f_{in} = 7200$ MHz - $0.5 \times f_{selected}$	$< -40$ dB
<b>Harmonic response</b>		
RF1 COM, RF2 COM	second harmonic $f_{in} = 150$ MHz to 3000 MHz, $f_{selected} = 300$ MHz to 6000 MHz	$< -30$ dB
<b>Harmonic response</b>		
RF1 COM, RF2 COM	third harmonic $f_{in} = 150$ MHz to 900 MHz, $f_{selected} = 450$ MHz to 2700 MHz	$< -50$ dB
	$f_{in} = 900$ MHz to 1100 MHz, $f_{selected} = 2700$ MHz to 3300 MHz	$< -45$ dB
	$f_{in} = 1100$ MHz to 2000 MHz, $f_{selected} = 3300$ MHz to 6000 MHz	$< -50$ dB
<b>Phase noise</b>		
Carrier offset	single sideband, 150 MHz to 3800 MHz $\geq 1$ MHz	$< -120$ dBc, 1 Hz
<b>Phase noise</b>		
Carrier offset	single sideband, 3800 MHz to 6000 MHz $\geq 1$ MHz	$< -117$ dBc, 1 Hz
<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: free run, GPRF: IF power, GPRF: gen, BB signaling

## Power meter

<b>Frequency range</b>		150 MHz to 3300 MHz, up to 6000 MHz with the R&S®CMW-KB036 option
<b>Frequency resolution</b>		0.1 Hz
<b>Resolution bandwidths</b>		Gaussian, 1 kHz to 10 MHz, in 1/3/5 steps, bandpass, 1 kHz to 30 MHz, in 1/3/5 steps, RRC, $\alpha = 0.1$ , 3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter, 1.2288 MHz, CDMA filter
<b>Expected nominal power setting range</b>	for ADC full scale	
	150 MHz to 3300 MHz	-47 dBm to +42 dBm <sup>11</sup>
	3300 MHz to 6000 MHz	-37 dBm to +42 dBm <sup>11</sup>

<b>Level range</b>		
	150 MHz to 3300 MHz	
	continuous power (CW)	-84 dBm <sup>12</sup> to +34 dBm
	peak envelope power (PEP)	up to +42 dBm <sup>11</sup>
	3300 MHz to 6000 MHz	
	continuous power (CW)	-74 dBm <sup>12</sup> to +34 dBm
	peak envelope power (PEP)	up to +42 dBm <sup>11</sup>
	maximum input DC level	0 V DC

<b>Level uncertainty</b>	in temperature range +20 °C to +35 °C	
	150 MHz to 3300 MHz	< 0.5 dB <sup>13</sup>
	3300 MHz to 6000 MHz	< 1.0 dB <sup>13</sup>

<b>Level uncertainty</b>	in temperature range +5 °C to +45 °C	
	150 MHz to 3300 MHz	< 0.7 dB <sup>13</sup>
	3300 MHz to 6000 MHz	< 1.2 dB <sup>13</sup>

<b>Level linearity with fixed expected nominal power setting</b>	in temperature range +20 °C to +35 °C	
RF1 COM, RF2 COM	level range 0 dB to -40 dB	< 0.15 dB, typ. < 0.1 dB

<b>Level resolution</b>		0.01 dB
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<b>Level repeatability</b>	typical values after 1 h warm-up time, always returning to same level and frequency, no temperature change, insignificant time change	
	input level $\geq -40$ dBm	< 0.01 dB
	input level < -40 dBm	< 0.03 dB

<b>Port switching time</b>	to within 0.1 dB	< 50 $\mu$ s <sup>14</sup>
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<b>Dynamic range</b>	150 MHz to 3800 MHz, <i>RBW</i> $\rightarrow$ 1 kHz, with fixed expected nominal power setting and mixer level offset $\geq +4$ dB	> 100 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		-8 dBm to +42 dBm <sup>11</sup>

<b>Dynamic range</b>	3800 MHz to 6000 MHz, <i>RBW</i> $\rightarrow$ 1 kHz, with fixed expected nominal power setting and mixer level offset $\geq +4$ dB	> 97 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		+2 dBm to +42 dBm <sup>11</sup>

<sup>11</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>12</sup> *RBW*  $\rightarrow$  1 kHz.

<sup>13</sup> Valid for a 12-month calibration interval.

<sup>14</sup> When using list mode.



## Spectrum measurements

<b>FFT spectrum analyzer</b>		
Frequency range		150 MHz to 3300 MHz, up to 6000 MHz with the R&S®CMW-KB036 option
Frequency span		1.25 MHz, 2.5 MHz, 5 MHz, 10 MHz, 20 MHz, 40 MHz, 80 MHz, 160 MHz
FFT length		1k, 2k, 4k, 8k, 16k
Detector		peak, RMS
<b>Dynamic range</b>	150 MHz to 3800 MHz, <i>for FFT length → 16k and span → 5 MHz</i> (equivalent to RBW → 781 Hz), with fixed expected nominal power setting and mixer level offset ≥ +4 dB	> 100 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		-8 dBm to +42 dBm <sup>15</sup>
<b>Dynamic range</b>	3800 MHz to 6000 MHz, <i>for FFT length → 16k and span → 5 MHz</i> (equivalent to RBW → 781 Hz), with fixed expected nominal power setting and mixer level offset ≥ +4 dB	> 97 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		+2 dBm to +42 dBm <sup>15</sup>
<b>RF spectrum analyzer (R&amp;S®CMW-KM010 option)</b>		
Frequency range		150 MHz to 3300 MHz, up to 6000 MHz with the R&S®CMW-KB036 option
Frequency span		0 Hz (zero span), 500 Hz to 3230 MHz, up to 5930 MHz with the R&S®CMW-KB036 option
Resolution bandwidth (RBW)		100 Hz to 10 MHz (additional 40 MHz in zero span)
Video bandwidth (VBW)		10 Hz to 10 MHz
Sweep time	frequency sweep, depends on RBW, VBW and span zero span, depends on RBW and VBW	500 μs to 2000 s 80 μs to 2000 s
Detector		average, RMS, sample, min. peak, max. peak, auto peak
Trigger	frequency sweep zero span	free run video, BASE: external TRIG A, B all R&S®CMW internal trigger sources
<b>Dynamic range</b>	150 MHz to 3800 MHz, <i>RBW → 1 kHz,</i> <i>detector → RMS</i> mixer level offset ≥ +4 dB	> 100 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		-8 dBm to +42 dBm <sup>15</sup>
<b>Dynamic range</b>	3800 MHz to 6000 MHz, <i>RBW → 1 kHz,</i> <i>detector → RMS</i> mixer level offset ≥ +4 dB	> 97 dB
<b>Expected nominal power setting for full dynamic range</b>		
RF1 COM, RF2 COM		+2 dBm to +42 dBm <sup>15</sup>
<b>Level range</b>		see general technical specifications
<b>Level uncertainty</b>	for center frequency and <i>detector → peak</i>	see general technical specifications

<sup>15</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

Inherent spurious response		see general technical specifications
Spurious response		see general technical specifications
Harmonic response		see general technical specifications
Phase noise		see general technical specifications

## Timebase

### Timebase, TCXO

Max. frequency drift	in temperature range +5 °C to +45 °C	$\pm 1 \times 10^{-6}$
Max. aging	at +25 °C, after 14 days of continuous operation	$\pm 1 \times 10^{-6}$ /year

### Timebase, basic OCXO (R&S®CMW-B690A option)

Max. frequency drift	in temperature range +5 °C to +45 °C	$\pm 5 \times 10^{-8}$
Retrace	at +25 °C, after 24 hours power off / 2 hours power on / 1 hour power on	$\pm 2 \times 10^{-8}$
Max. aging	at +25 °C, after 10 days of continuous operation	$\pm 1 \times 10^{-7}$ /year, $\pm 1 \times 10^{-9}$ /day
Warm-up time	at +25 °C, the frequency is in the range that is 10 times the frequency drift ( $\pm 5 \times 10^{-7}$ )	approx. 10 min

### Timebase, highly stable OCXO (R&S®CMW-B690B option)

Max. frequency drift	in temperature range +5 °C to +45 °C, referred to +25 °C	$\pm 5 \times 10^{-9}$
	with instrument orientation	$\pm 1 \times 10^{-9}$
Retrace	at +25 °C, after 24 hours power on / 2 hours power off / 1 hour power on	$\pm 5 \times 10^{-9}$
Max. aging	at +25 °C, after 10 days of continuous operation	$\pm 3 \times 10^{-8}$ /year, $\pm 5 \times 10^{-10}$ /day
Warm-up time	at +25 °C, the frequency is in the range that is 10 times the frequency drift ( $\pm 5 \times 10^{-8}$ )	approx. 10 min

## Reference frequency inputs/outputs

<b>Synchronization input</b>		BNC connector REF IN, rear panel
Frequency	sine wave	10 MHz to 80 MHz, step: 1 Hz
	square wave (TTL level)	1 MHz to 80 MHz, step: 1 Hz
Max. frequency variation		$\pm 10 \times 10^{-6}$
Input voltage range		0.5 V to 2 V, RMS
Impedance		50 $\Omega$
<b>Synchronization output 1</b>		BNC connector REF OUT 1, rear panel
Frequency		10 MHz from internal reference or frequency at synchronization input
Output voltage		> 1.4 V, peak-to-peak
Impedance		50 $\Omega$

# Audio specifications (prerequisite: R&S®CMW-B400B)

## Audio analyzer

### Statistics

Statistical count		1 to 1000
Values		current, average, extremum, standard deviation

### Audio filter, weighting

Lowpass		off, 3 kHz, 4 kHz, 15 kHz
Highpass		off, 6 Hz, 50 Hz, 300 Hz
Weighting filter		off, A-weighting, CCITT, C-message

### Connectors AF 1 IN / AF 2 IN

Input impedance		100 k $\Omega$   15 pF
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### AF voltmeter

Frequency range		50 Hz to 21 kHz
Level range		50 $\mu$ V to 30 V
Level resolution	at level < 1 mV	1 $\mu$ V
	at level $\geq$ 1 mV	0.1 %
Level uncertainty	at 1 mV $\leq$ level < 20 mV	< 1.3% + resolution
	at 20 mV $\leq$ level $\leq$ 20 V	< 1.0 % + resolution

### THD+N and THD meter

Measurement bandwidth		21 kHz
Frequency range		100 Hz to 10.5 kHz
Level range		10 mV to 30 V
Resolution		0.01 %
Inherent distortion THD+N	at 100 mV $\leq$ level $\leq$ 20 V	< 0.05 %
Inherent distortion THD	at 100 mV $\leq$ level $\leq$ 20 V	< 0.025 %
Uncertainty	at 100 mV $\leq$ level $\leq$ 2 V	< 1 % + inherent distortion
	at 2 V $\leq$ level $\leq$ 20 V	< 2 % + inherent distortion

## Audio generator

### Connectors AF 1 OUT / AF 2 OUT

Output impedance		< 4 $\Omega$
Maximum output current		20 mA

### AF sine generator

Frequency range		20 Hz to 21 kHz
Frequency uncertainty		same as timebase, see base unit specifications
Frequency resolution		1 Hz
Level range		10 $\mu$ V to 5 V
Level resolution	at level < 10 mV	10 $\mu$ V
	at level $\geq$ 10 mV	0.1 %
Level uncertainty	at level $\geq$ 1 mV and frequency $\leq$ 10 kHz	$\leq$ 1.5 % + resolution
THD+N	at level $\geq$ 100 mV, into load $\geq$ 600 $\Omega$ , measurement bandwidth: 21.9 kHz	$\leq$ 0.05 %
THD	at level $\geq$ 100 mV, into load $\geq$ 600 $\Omega$ , measurement bandwidth: 21.9 kHz	$\leq$ 0.025 %

## Digital interface unbalanced

### BNC rear panel connectors

<b>Connector SPDIF IN</b>		
Input impedance		75 Ω

<b>Connector SPDIF OUT</b>		
Output impedance		75 Ω

<b>Max. sample rate</b>		48 kHz
<b>Max. resolution</b>		24 bit PCM
<b>Output level</b>		0.5 V, peak-to-peak
<b>Max. output</b>		0.6 V, peak-to-peak
<b>Max. current</b>		8 mA
<b>Min input</b>		0.2 V, peak-to-peak
<b>Modulation</b>		biphase mark code
<b>Usage</b>		audio analysis, digital audio tape (DAT)

## GSM specifications – mobile station test <sup>16</sup>

### GSM RF generator

(prerequisite: R&S®CMW-B110A/R&S®CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

<b>Frequency range</b>	GSM450 band	460 MHz to 468 MHz
	GSM480 band	488 MHz to 496 MHz
	GSM750 band	747 MHz to 762 MHz
	GSM850 band	869 MHz to 894 MHz
	GSM900 band	921 MHz to 960 MHz
	GSM1800 band	1805 MHz to 1880 MHz
	GSM1900 band	1930 MHz to 1990 MHz

### GSM GEN (R&S®CMW-KG200 option)

<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>		see general technical specifications
<b>Output level resolution</b>		see general technical specifications

<b>Signal quality</b>		
Phase error	GMSK	< 1°, RMS < 4°, peak
Error vector magnitude (EVM)	8PSK	< 2 %, RMS

### GSM WinIQSIM2™ (R&S®CMW-KW200 option), GSM EDGE Evolution WinIQSIM2™ (R&S®CMW-KW201 option)

<b>Arbitrary waveform files</b>	GMSK, B × T = 0.3, with the R&S®CMW-KW200 option	GSM_GMSK.WV (PAR = 0 dB), GMSKDIGMOD.WV (PAR = 0 dB)
	8PSK, with the R&S®CMW-KW200 option	GSM_EDGE.WV (PAR = 3.23 dB), EDGEDIGMOD.WV (PAR = 3.22 dB)
<b>Arbitrary waveform files</b>	16QAM, with the R&S®CMW-KW200 and R&S®CMW-KW201 options	EDGE_EVO_16QAM_A.WV (PAR = 4.70 dB)
	32QAM, with the R&S®CMW-KW200 and R&S®CMW-KW201 options	EDGE_EVO_32QAM_B.WV (PAR = 5.37 dB)

<sup>16</sup> R&S®CMW500 and R&S®CMW290 only.

<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>	with the R&S®CMW-KW200 option, waveform files used: GMSKDIGMOD.WV or EDGEDIGMOD.WV	see general technical specifications
	with the R&S®CMW-KW200 and R&S®CMW-KW201 options, waveform files used: EDGE_EVO_16QAM_A.WV, EDGE_EVO_32QAM_B.WV	see general technical specifications
<b>Output level resolution</b>		see general technical specifications

<b>Signal quality</b>		
Phase error	GMSK with the R&S®CMW-KW200 option, waveform file used: GSM_GMSK.WV	< 1°, RMS
		< 4°, peak
Error vector magnitude (EVM)	8PSK with the R&S®CMW-KW200 option, waveform file used: GSM_EDGE.WV	< 2 %, RMS
	16QAM / 32QAM level A with the R&S®CMW-KW200 and R&S®CMW-KW201 options, waveform file used: EDGE_EVO_16QAM_A.WV	< 2 %, RMS
	QPSK / 16QAM / 32QAM level B with the R&S®CMW-KW200 and R&S®CMW-KW201 options, waveform file used: EDGE_EVO_32QAM_B.WV	< 2 %, RMS

## GSM RF analyzer (R&S®CMW-KM200 option) and GSM EDGE Evolution A analyzer (R&S®CMW-KM201 option)

<b>Frequency range</b>	GSM450 band	450 MHz to 458 MHz
	GSM480 band	478 MHz to 486 MHz
	GSM750 band	777 MHz to 792 MHz
	GSM850 band	824 MHz to 849 MHz
	GSM900 band	876 MHz to 915 MHz
	GSM1800 band	1710 MHz to 1785 MHz
	GSM1900 band	1850 MHz to 1910 MHz

<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, GSM: free run, GSM: IF power, GSM: acquisition

## Modulation analysis

<b>Level range</b>		-28 dBm to +42 dBm <sup>17</sup>
<b>Analysis mode</b>	with the R&S®CMW-KM200 option	GMSK, 8PSK
	with the R&S®CMW-KM200 and R&S®CMW-KM201 options	GMSK, 8PSK, 16QAM (level A)
<b>Inherent phase error</b>	GMSK	< 0.6°, RMS
		< 2°, peak
<b>Inherent error vector magnitude (inherent EVM)</b>	8PSK, 16QAM (level A)	< 0.8 %, RMS
<b>Frequency measurement uncertainty</b>		< 20 Hz + drift of timebase, see general technical specifications

<sup>17</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

Inherent I/Q offset		< -50 dB
Filter	GMSK	bandpass, 900 kHz, RRC filter, $\alpha = 0.16$
	8PSK, 16QAM (level A)	windowed, raised cosine filter in line with 3GPP TS 45.005

<b>Burst power measurement</b>		
Level uncertainty	bandpass, 900 kHz, RRC filter, $\alpha = 0.16$	see general technical specifications

### Power versus time measurement

Filter	selectable	Gaussian, 500 kHz or 1 MHz
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Dynamic range	<i>filter</i> → 500 kHz, Gaussian, with fixed expected nominal power setting	
	GMSK	> 72 dB, RMS
	8PSK, 16QAM (level A)	> 69 dB, RMS
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	-8 dBm to +42 dBm <sup>18</sup>

Relative measurement uncertainty	result > -40 dB	typ. < 0.1 dB
	-60 dB ≤ result ≤ -40 dB	typ. < 0.5 dB

<b>Burst power measurement</b>		
Level range		-50 dBm to +42 dBm <sup>18</sup>
Level uncertainty	<i>filter</i> → 500 kHz or 1 MHz, Gaussian	see general technical specifications

### Spectrum due to modulation measurement

Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	-8 dBm to +42 dBm <sup>18</sup>
Test method		relative measurement, averaging
Filter		Gaussian, 30 kHz, 5 pole
Measurement	at an offset of ±	100/200/250/400/600/800/1000/1200/1400/1600/1800 kHz

Dynamic range	offset ≥ 1200 kHz	
	GMSK	> 74 dB
	8PSK, 16QAM (level A)	> 70 dB

### Spectrum due to switching measurement

Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	-8 dBm to +42 dBm <sup>18</sup>
Test method		absolute measurement, max. hold
Filter		Gaussian, 30 kHz, 5 pole
Measurement	at an offset of ±	400/600/1200/1800 kHz

Dynamic range	offset ≥ 1200 kHz	
	GMSK	> 72 dB
	8PSK, 16QAM (level A)	> 68 dB

## GSM signaling (prerequisite: R&S®CMW-KS200, R&S®CMW-KS201, R&S®CMW-KS203, R&S®CMW-KS210, R&S®CMW-KS211 options; either R&S®CMW-B200A and R&S®CMW-B210A options or R&S®CMW-B500I option)

<b>Frequency range</b>		
GSM850 band, GSM900 band, GSM1800 band, GSM1900 band	DL	see GSM RF generator specifications
	UL	see GSM RF analyzer specifications

<b>Frequency setting</b>		channel number
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<sup>18</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Output level range</b>	depends on PAR and additional 6 dB level margin	see general technical specifications
	with DLDC: depends on PAR and additional 9.3 dB level margin	see general technical specifications
<b>Output level resolution</b>		see general technical specifications
<b>Output level uncertainty</b>		see general technical specifications
<b>Modulation</b>		
Inherent phase error	GMSK	< 1°, RMS
		< 4°, peak

## GSM specifications – small cell test <sup>19</sup>

### GSM RF analyzer (R&S®CMW-KN200 option)

<b>Frequency range</b>	GSM450 band	460 MHz to 468 MHz
	GSM480 band	488 MHz to 496 MHz
	GSM750 band	747 MHz to 762 MHz
	GSM850 band	869 MHz to 894 MHz
	GSM900 band	921 MHz to 960 MHz
	GSM1800 band	1805 MHz to 1880 MHz
	GSM1900 band	1930 MHz to 1990 MHz

<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, GSM: free run, GSM: IF power, GSM: acquisition

### Modulation analysis

<b>Level range</b>		-28 dBm to +42 dBm <sup>20</sup>
<b>Analysis mode</b>	with the R&S®CMW-KN200 option	GMSK, 8PSK
<b>Inherent phase error</b>	GMSK	< 0.6°, RMS
		< 2°, peak
<b>Inherent error vector magnitude (inherent EVM)</b>	8PSK	< 0.8 %, RMS
<b>Frequency measurement uncertainty</b>		< 20 Hz + drift of timebase, see general technical specifications
<b>Inherent I/Q offset</b>		< -50 dB
<b>Filter</b>	GMSK	bandpass, 900 kHz, RRC filter, $\alpha = 0.16$
	8PSK	windowed, raised cosine filter in line with 3GPP TS 45.005

<b>Burst power measurement</b>		
Level uncertainty	bandpass, 900 kHz, RRC filter, $\alpha = 0.16$	see general technical specifications

### Power versus time measurement

<b>Filter</b>	selectable	Gaussian, 500 kHz or 1 MHz
<b>Dynamic range</b>	<i>filter</i> → 500 kHz, Gaussian, with fixed expected nominal power setting	
	GMSK	> 72 dB, RMS
	8PSK	> 69 dB, RMS
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	-8 dBm to +42 dBm <sup>20</sup>

<sup>19</sup> R&S®CMW500 only.

<sup>20</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Relative measurement uncertainty</b>	result > -40 dB	typ. < 0.1 dB
	-60 dB ≤ result ≤ -40 dB	typ. < 0.5 dB
<b>Burst power measurement</b>		
Level range		-50 dBm to +42 dBm <sup>21</sup>
Level uncertainty	<i>filter</i> → 500 kHz or 1 MHz, Gaussian	see general technical specifications

### Spectrum due to modulation measurement

Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	-8 dBm to +42 dBm <sup>21</sup>
Test method		relative measurement, averaging
Filter		Gaussian, 30 kHz, 5 pole
Measurement	at an offset of ±	100/200/250/400/600/800/1000/1200/ 1400/1600/1800 kHz
Dynamic range	offset ≥ 1200 kHz	
	GMSK	> 74 dB
	8PSK	> 70 dB

### Spectrum due to switching measurement

Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	-8 dBm to +42 dBm <sup>21</sup>
Test method		absolute measurement, max. hold
Filter		Gaussian, 30 kHz, 5 pole
Measurement	at an offset of ±	400/600/1200/1800 kHz
Dynamic range	offset ≥ 1200 kHz	
	GMSK	> 72 dB
	8PSK	> 68 dB

## NB-IoT specifications – mobile station test <sup>22</sup>

Standard		3GPP NB-IoT HD-FDD
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### NB-IoT RF generator (prerequisite: R&S®CMW-B110A/R&S®CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

Frequency range	NB-IoT operates in the E-UTRA bands 1, 2, 3, 5, 8, 11, 12, 13, 17, 18, 19, 20, 21, 25, 26, 28, 31, 66	see LTE FDD RF generator specifications
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### NB-IoT WiniQSIM2™ (R&S®CMW-KW300 option)

Arbitrary waveform file	NB-IoT HD-FDD	KW300_NB_IOT_64frames_DCI_160ms. wv (PAR = 8.64 dB)
Output level range	depends on PAR	see general technical specifications
Output level uncertainty	waveform file used: KW300_NB_IOT_64frames_DCI_160ms. wv	see general technical specifications
Output level resolution		see general technical specifications

<sup>21</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>22</sup> R&S®CMW500 and R&S®CMW290 only.



<b>Signal quality</b>		
Error vector magnitude (EVM)	EVM NPDSCH QPSK, bandwidth = 200 kHz waveform file used: KW300_NB_IOT_64frames_DCI_160ms. ww	< 2 %, RMS

## NB-IoT HD-FDD RF analyzer (R&S®CMW-KM300 option)

<b>Bandwidth</b>		200 kHz
<b>Frequency range</b>	NB-IoT operates in the E-UTRA bands 1, 2, 3, 5, 8, 11, 12, 13, 17, 18, 19, 20, 21, 25, 26, 28, 31, 66	see LTE FDD RF analyzer specifications
<b>Level setting</b>		manual mode
<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation
<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, NB-IoT: free run, NB-IoT: IF power

## Power measurement

<b>Slot power</b>	RMS detector	
Level range		-50 dBm to +30 dBm, RMS
Level uncertainty		see general technical specifications

## Modulation analysis

<b>Measured parameters</b>	numeric results	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, TX power, peak power, subcarrier power (SC power)
	graphical	EVM versus SC-FDMA symbol, ME versus SC-FDMA symbol, PE versus SC-FDMA symbol, in-band emissions, I/Q constellation

<b>Error vector magnitude (EVM)</b>		
Inherent EVM	-38 dBm ≤ input level < +30 dBm, RMS	< 1 %, RMS

<b>Frequency error</b>		
Measurement range	subcarrier spacing = 3.75 kHz	±1.8 kHz
	subcarrier spacing = 15 kHz	±7.0 kHz
Frequency measurement uncertainty		< 20 Hz <sup>23</sup> + drift of timebase, see general technical specifications

<b>I/Q origin offset</b>		
Inherent I/Q offset	for average ≥ 10 measurements	< -45 dB

<sup>23</sup> For frequency error measurements relative to the downlink signal of the same R&S®CMW100, the uncertainty is in line with 3GPP TS 36.521 V14.3.0.

<b>In-band emissions</b>		
Dynamic range		> 45 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

### Spectrum measurements

<b>Adjacent channel leakage ratio</b>		
Filter	NB-IoT, GSM UTRA	rectangle 180 kHz 3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range		> 50 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Spectrum emission mask (SEM)</b>		
Frequency span		4 MHz < -45 dBm

### NB-IoT signaling (prerequisite: R&S®CMW-KS300 option, R&S®CMW-B500I option)

<b>Channels</b>		
Physical channels and signals	DL	NPSS, NSSS, NRS, NPBCH, NPDCCH, NPDSCH
	UL	NPRACH, NPUSCH, demodulation RS
Bandwidth		200 kHz
Modulation schemes	DL NPDSCH	QPSK
	UL NPUSCH	BPSK, QPSK

<b>Frequency range</b>	NB-IoT operates in the E-UTRA bands 1, 2, 3, 5, 8, 11, 12, 13, 17, 18, 19, 20, 21, 25, 26, 28, 31, 66	see LTE FDD RF generator specifications and LTE FDD RF analyzer specifications
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<b>Frequency setting</b>		channel number
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### DL signal

<b>Output level range</b>	due to PAR	15 dB below max. output level of RF generator, see general technical specification
<b>Output level uncertainty</b>		see general technical specification
<b>Output level setting</b>		NRS energy per resource element (EPRE) [dBm/15 kHz]

<b>Signal quality</b>		
Error vector magnitude (EVM)		< 2 %, RMS

## WCDMA specifications – mobile station (UE) test <sup>24</sup>

Standard		3GPP FDD
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### WCDMA RF generator

(prerequisite: R&S®CMW-B110A/R&S®CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

Frequency range	WCDMA band 1	2112.4 MHz to 2167.6 MHz
	WCDMA band 2	1932.4 MHz to 1987.6 MHz
	WCDMA band 3	1807.4 MHz to 1877.6 MHz
	WCDMA band 4	2112.4 MHz to 2152.6 MHz
	WCDMA band 5	871.4 MHz to 891.6 MHz
	WCDMA band 6	877.4 MHz to 882.6 MHz
	WCDMA band 7	2622.4 MHz to 2687.6 MHz
	WCDMA band 8	927.4 MHz to 957.6 MHz
	WCDMA band 9	1847.4 MHz to 1877.4 MHz
	WCDMA band 10	2112.4 MHz to 2167.6 MHz
	WCDMA band 11	1478.4 MHz to 1498.4 MHz
	WCDMA band 12	730.4 MHz to 743.6 MHz
	WCDMA band 13	748.4 MHz to 753.6 MHz
	WCDMA band 14	760.4 MHz to 765.6 MHz
	WCDMA band S	2182.4 MHz to 2197.6 MHz
WCDMA band S170	2180 MHz to 2190 MHz	
WCDMA band S190	2190 MHz to 2200 MHz	

### WCDMA GEN (R&S®CMW-KG400 option), WCDMA HSPA GEN (R&S®CMW-KG401 option)

Output level range	depends on PAR	see general technical specifications
Output level uncertainty		see general technical specifications
Output level resolution		see general technical specifications

Signal quality		
Error vector magnitude (EVM)	composite EVM	< 2 %, RMS

### WCDMA WinIQSIM2™ (R&S®CMW-KW400 option), WCDMA HSDPA WinIQSIM2™ (R&S®CMW-KW401 option), WCDMA HSUPA WinIQSIM2™ (R&S®CMW-KW402 option), WCDMA HSPA+ WinIQSIM2™ (R&S®CMW-KW403 option)

Arbitrary waveform files	with the R&S®CMW-KW400 option	TM4CPICH.WV (PAR = 8.34 dB), 3GPPDEFAULT.WV (PAR = 10.65 dB)
	with the R&S®CMW-KW400 and R&S®CMW-KW401 options	WCDMA_DL_HSDPA.WV (PAR = 10.08 dB)
	with the R&S®CMW-KW400 and R&S®CMW-KW401 and R&S®CMW-KW402 options	WCDMA_DL_HSUPA.WV (PAR = 10.12 dB)

Output level range	depends on PAR	see general technical specifications
Output level uncertainty	with the R&S®CMW-KW400 option, waveform file used: 3GPPDEFAULT.WV	see general technical specifications
	with the R&S®CMW-KW401 option, waveform file used: WCDMA_DL_HSDPA.WV	see general technical specifications
	with the R&S®CMW-KW402 option, waveform file used: WCDMA_DL_HSUPA.WV	see general technical specifications
	with the R&S®CMW-KW400 and R&S®CMW-KW401 and R&S®CMW-KW402 and R&S®CMW-KW403 options	see general technical specifications
Output level resolution		see general technical specifications

<sup>24</sup> R&S®CMW500 and R&S®CMW290 only.

<b>Signal quality</b>		
Error vector magnitude (EVM)	composite EVM, with the R&S®CMW-KW400 option, waveform file used: TM4CPICH.WV	< 2 %, RMS
	composite EVM, with the R&S®CMW-KW401 option, waveform file used: WCDMA_DL_HSDPA.WV	< 2 %, RMS
	composite EVM, with the R&S®CMW-KW402 option, waveform file used: WCDMA_DL_HSUPA.WV	< 2 %, RMS
	with the R&S®CMW-KW400 and R&S®CMW-KW401 and R&S®CMW-KW402 and R&S®CMW-KW403 options	< 2 %, RMS

## WCDMA RF analyzer (R&S®CMW-KM400, R&S®CMW-KM401, R&S®CMW-KM403 options)

Frequency range		
	WCDMA band 1	1922.4 MHz to 1977.6 MHz
	WCDMA band 2	1852.4 MHz to 1907.6 MHz
	WCDMA band 3	1712.4 MHz to 1782.6 MHz
	WCDMA band 4	1712.4 MHz to 1752.6 MHz
	WCDMA band 5	826.4 MHz to 846.6 MHz
	WCDMA band 6	832.4 MHz to 837.6 MHz
	WCDMA band 7	2502.4 MHz to 2567.6 MHz
	WCDMA band 8	882.4 MHz to 912.6 MHz
	WCDMA band 9	1752.4 MHz to 1782.4 MHz
	WCDMA band 10	1712.4 MHz to 1767.6 MHz
	WCDMA band 11	1430.4 MHz to 1450.4 MHz
	WCDMA band 12	700.4 MHz to 713.6 MHz
	WCDMA band 13	779.4 MHz to 784.6 MHz
	WCDMA band 14	790.4 MHz to 795.6 MHz
	WCDMA band S	2002.4 MHz to 2017.6 MHz
	WCDMA band S170	2010 MHz to 2020 MHz
	WCDMA band S190	2000 MHz to 2010 MHz

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, WCDMA: free run, WCDMA: free run (fast sync), WCDMA: IF power, WCDMA: DCCH TTI trigger, WCDMA: frame trigger, WCDMA: HS-DPCCH trigger, WCDMA: slot trigger

## Modulation analysis

Filter		3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Level range		-28 dBm to +42 dBm <sup>25</sup>

<sup>25</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Analysis modes</b>	with the R&S®CMW-KM400 option	QPSK, WCDMA
	with the R&S®CMW-KM400 and R&S®CMW-KM401 options	WCDMA + HSDPA, WCDMA + HSUPA, WCDMA + HSPA
	with the R&S®CMW-KM400 and R&S®CMW-KM401 and R&S®CMW-KM403 options	WCDMA + HSPA+
<b>Measured parameters</b>	numeric results and standard deviation	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, I/Q imbalance, UE power, power steps, phase discontinuity, CDP, CDE
	graphical	EVM versus time, EVM versus chip, ME versus time, ME versus chip, PE versus time, PE versus chip, FE versus time, UE versus time, PS versus slot, PD versus slot, CDP versus slot, CDE versus slot, CD monitor

<b>Error vector magnitude (EVM)</b>		
Measurement range		up to 25 %, RMS
Inherent EVM		< 2.5 %, RMS
Measurement length		half-slot, 1 slot, multislot (1 to 120)

<b>Frequency error</b>		
Measurement range		±3 kHz
Frequency measurement uncertainty		< 20 Hz + drift of timebase, see general technical specifications

<b>I/Q origin offset</b>		
Inherent I/Q offset	for average ≥ 10 measurements	< -55 dB

<b>I/Q imbalance</b>		
Inherent I/Q imbalance		< -50 dB

## Spectrum measurements

<b>Adjacent channel leakage ratio</b>		
Filter	RMS detector	3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range	first adjacent channel at ±5 MHz	> 54 dB
	second adjacent channel at ±10 MHz	> 57 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	-4 dBm to +42 dBm <sup>26</sup>
Uncertainty	for -33 dBc first adjacent channel level	< 0.5 dB
	for -43 dBc second adjacent channel level	< 0.5 dB
Measurement length		1 slot (2560 chip)

## Power meter

<b>UE power measurement</b>		
Filter	RMS detector	bandpass, 6.3 MHz, RRC, $\alpha = 0.22$
Level range		-55 dBm to +42 dBm <sup>26</sup>
Level uncertainty		see general technical specifications
Measurement length		half-slot, 1 slot

<sup>26</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Off power measurement</b>	RMS detector	
Filter		3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Noise floor		-72 dBm
Level uncertainty		see general technical specifications + uncertainty due to noise floor

### 3G WCDMA signaling (prerequisite: R&S®CMW-KS400, R&S®CMW-KS410, R&S®CMW-KS425 options, R&S®CMW-B300A or R&S®CMW-B300B or R&S®CMW-B500I option)

<b>Standard</b>		3GPP FDD
<b>Symbol rate</b>		3.84 MHz

<b>Channels</b>		
Physical channels	DL	P-CPICH, P-SCH, S-SCH, P-CCPCH, S-CCPCH, AICH, PICH
	DL OCNS R99	16-channel orthogonal channel noise
	UL	DPCCH, DPDCH, PRACH
Radio bearer	DPCH signaling radio bearer (SRB)	
	DL	1.7 kbps, 2.5 kbps, 3.4 kbps, 13.6 kbps
	UL	1.7 kbps, 2.5 kbps, 3.4 kbps, 13.6 kbps
	DPCH reference measurement channels (RMC) in line with 3GPP TS 34.121	
	DL	12.2 kbps, 64 kbps, 144 kbps, 384 kbps
	UL	12.2 kbps, 64 kbps, 144 kbps, 384 kbps
	DPCH voice echo NB-AMR	
	with the R&S®CMW-KS400 option	12.2 kbps
	with the R&S®CMW-KS400 and R&S®CMW-KS410 options	4.75 kbps, 5.15 kbps, 5.9 kbps, 6.7 kbps, 7.4 kbps, 7.95 kbps, 10.2 kbps, 12.2 kbps
	DPCH voice echo WB-AMR	
with the R&S®CMW-KS400 and R&S®CMW-KS410 options	6.6 kbps, 8.85 kbps, 12.65 kbps, 14.25 kbps, 15.85 kbps, 18.25 kbps, 19.85 kbps, 23.05 kbps, 23.85 kbps	
DPCH video echo	64 kbps	

<b>Frequency range</b>		
Bands 1 to 14	with the R&S®CMW-KS400 option	
	DL	see WCDMA RF generator specifications
	UL	see WCDMA RF analyzer specifications
Band S, band S170, band S190	with the R&S®CMW-KS400 and R&S®CMW-KS425 options	
	DL	see WCDMA RF generator specifications
	UL	see WCDMA RF analyzer specifications

<b>Frequency setting</b>		channel number
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<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>		see general technical specifications
<b>Output level resolution</b>		see general technical specifications
<b>Output level setting</b>		total output power

<b>Channel levels</b>	P-CPICH, P-SCH, S-SCH, P-CCPCH, PICH, DPCH, OCNS	-30 dB to +0 dB relative to total power
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<b>Signal quality</b>		
Error vector magnitude (EVM)	global EVM for DL RMC in line with 3GPP TS 34.121 C3.1 to C3.4 with DPCH/CPICH = 0 dB	< 2 %, RMS

## WCDMA specifications – small cell test <sup>27</sup>

### WCDMA RF analyzer (R&S®CMW-KN400)

<b>Frequency range</b>	WCDMA band 1	2112.4 MHz to 2167.6 MHz
	WCDMA band 2	1932.4 MHz to 1987.6 MHz
	WCDMA band 3	1807.4 MHz to 1877.6 MHz
	WCDMA band 4	2112.4 MHz to 2152.6 MHz
	WCDMA band 5	871.4 MHz to 891.6 MHz
	WCDMA band 6	877.4 MHz to 882.6 MHz
	WCDMA band 7	2622.4 MHz to 2687.6 MHz
	WCDMA band 8	927.4 MHz to 957.6 MHz
	WCDMA band 9	1847.4 MHz to 1877.4 MHz
	WCDMA band 10	2112.4 MHz to 2167.6 MHz
	WCDMA band 11	1478.4 MHz to 1498.4 MHz
	WCDMA band 12	730.4 MHz to 743.6 MHz
	WCDMA band 13	748.4 MHz to 753.6 MHz
	WCDMA band 14	760.4 MHz to 765.6 MHz
	WCDMA band S	2182.4 MHz to 2197.6 MHz
WCDMA band S170	2180 MHz to 2190 MHz	
WCDMA band S190	2190 MHz to 2200 MHz	

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, WCDMA: free run, WCDMA: free run (fast sync), WCDMA: IF power, WCDMA: DCCH TTI trigger, WCDMA: frame trigger, WCDMA: HS-DPCCH trigger, WCDMA: slot trigger

### Modulation analysis

<b>Filter</b>		3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
<b>Level range</b>		-28 dBm to +42 dBm <sup>28</sup>

<b>Analysis modes</b>	with the R&S®CMW-KM400 option	QPSK, WCDMA
<b>Measured parameters</b>	numeric results and standard deviation	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, I/Q imbalance, UE power, power steps, phase discontinuity, CDP, CDE

<sup>27</sup> R&S®CMW500 only.

<sup>28</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

	graphical	EVM versus time, EVM versus chip, ME versus time, ME versus chip, PE versus time, PE versus chip, FE versus time, UE versus time, PS versus slot, PD versus slot, CDP versus slot, CDE versus slot, CD monitor
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<b>Error vector magnitude (EVM)</b>		
Measurement range		up to 25 %, RMS
Inherent EVM		< 2.5 %, RMS
Measurement length		half-slot, 1 slot, multislot (1 to 120)

<b>Frequency error</b>		
Measurement range		±3 kHz
Frequency measurement uncertainty		< 20 Hz + drift of timebase, see general technical specifications

<b>I/Q origin offset</b>		
Inherent I/Q offset	for average ≥ 10 measurements	< -52 dB

<b>I/Q imbalance</b>		
Inherent I/Q imbalance		< -50 dB

### Spectrum measurements

<b>Adjacent channel leakage ratio</b>		
Filter	RMS detector	
Dynamic range	first adjacent channel at ±5 MHz	3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
	second adjacent channel at ±10 MHz	> 52 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	> 52 dB
Uncertainty	for -33 dBc first adjacent channel level	-4 dBm to +42 dBm <sup>29</sup>
	for -43 dBc second adjacent channel level	< 0.5 dB
Measurement length		< 0.5 dB
		1 slot (2560 chip)

### Power meter

<b>UE power measurement</b>		
Filter	RMS detector	
Level range		bandpass, 6.3 MHz, RRC, $\alpha = 0.22$
Level uncertainty		-55 dBm to +42 dBm <sup>29</sup>
Measurement length		see general technical specifications
		half-slot, 1 slot

<b>Off power measurement</b>		
Filter	RMS detector	
Noise floor		3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Level uncertainty		-72 dBm
		see general technical specifications + uncertainty due to noise floor

<sup>29</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.



## LTE specifications – mobile station test with 40/80 MHz bandwidth unit <sup>30</sup>

Standard	LTE FDD and TDD
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### LTE RF generator (prerequisite: R&S®CMW-B110A or R&S®CMW-B110D option)

Frequency range	E-UTRA band 1, FDD	2110 MHz to 2170 MHz
	E-UTRA band 2, FDD	1930 MHz to 1990 MHz
	E-UTRA band 3, FDD	1805 MHz to 1880 MHz
	E-UTRA band 4, FDD	2110 MHz to 2155 MHz
	E-UTRA band 5, FDD	869 MHz to 894 MHz
	E-UTRA band 6, FDD	875 MHz to 885 MHz
	E-UTRA band 7, FDD	2620 MHz to 2690 MHz
	E-UTRA band 8, FDD	925 MHz to 960 MHz
	E-UTRA band 9, FDD	1844.9 MHz to 1879.9 MHz
	E-UTRA band 10, FDD	2110 MHz to 2170 MHz
	E-UTRA band 11, FDD	1475.9 MHz to 1495.9 MHz
	E-UTRA band 12, FDD	729 MHz to 746 MHz
	E-UTRA band 13, FDD	746 MHz to 756 MHz
	E-UTRA band 14, FDD	758 MHz to 768 MHz
	E-UTRA band 15, FDD	2600 MHz to 2620 MHz
	E-UTRA band 16, FDD	2585 MHz to 2600 MHz
	E-UTRA band 17, FDD	734 MHz to 746 MHz
	E-UTRA band 18, FDD	860 MHz to 875 MHz
	E-UTRA band 19, FDD	875 MHz to 890 MHz
	E-UTRA band 20, FDD	791 MHz to 821 MHz
	E-UTRA band 21, FDD	1495.9 MHz to 1510.9 MHz
	E-UTRA band 22, FDD, prerequisite: R&S®CMW-KB036 option	3510 MHz to 3590 MHz
	E-UTRA band 23, FDD	2180 MHz to 2200 MHz
	E-UTRA band 24, FDD	1525 MHz to 1559 MHz
	E-UTRA band 25, FDD	1930 MHz to 1995 MHz
	E-UTRA band 26, FDD	859 MHz to 894 MHz
	E-UTRA band 27, FDD	852 MHz to 869 MHz
	E-UTRA band 28, FDD	758 MHz to 803 MHz
	E-UTRA band 29, FDD	717 MHz to 728 MHz
	E-UTRA band 30, FDD	2350 MHz to 2360 MHz
	E-UTRA band 31, FDD	462.5 MHz to 467.5 MHz
	E-UTRA band 33, TDD	1900 MHz to 1920 MHz
	E-UTRA band 34, TDD	2010 MHz to 2025 MHz
	E-UTRA band 35, TDD	1850 MHz to 1910 MHz
	E-UTRA band 36, TDD	1930 MHz to 1990 MHz
	E-UTRA band 37, TDD	1910 MHz to 1930 MHz
	E-UTRA band 38, TDD	2570 MHz to 2620 MHz
	E-UTRA band 39, TDD	1880 MHz to 1920 MHz
	E-UTRA band 40, TDD	2300 MHz to 2400 MHz
	E-UTRA band 41, TDD	2496 MHz to 2690 MHz
	E-UTRA band 42, TDD, prerequisite: R&S®CMW-KB036 option	3400 MHz to 3600 MHz
	E-UTRA band 43, TDD, prerequisite: R&S®CMW-KB036 option	3600 MHz to 3800 MHz
	E-UTRA band 44, TDD	703 MHz to 803 MHz

### LTE WiniQSIM2™ (R&S®CMW-KW500 option)

Arbitrary waveform file	LTE FDD	LTE_FDD_QPSK_10MHZ.WV (PAR = 11.15 dB)
	LTE TDD	LTE_TDD_64QAM_20MHZ.WV (PAR = 11.10 dB)

<sup>30</sup> R&S®CMW500 and R&S®CMW290 only.

<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>	waveform file used: LTE_FDD_QPSK_10MHZ.WV	see general technical specifications
	waveform file used: LTE_TDD_64QAM_20MHZ.WV	see general technical specifications
<b>Output level resolution</b>		see general technical specifications
<b>Signal quality</b>		
Error vector magnitude (EVM)	EVM PDSCH QPSK, bandwidth = 10 MHz, 50 resource blocks, PRB symbol offset = 3, 10 subframes, PCFICH present, waveform file used: LTE_FDD_QPSK_10MHZ.WV	< 2 %, RMS
	EVM PDSCH 64QAM, bandwidth = 20 MHz, 100 resource blocks, PRB symbol offset = 2, uplink/downlink configuration 1, special subframe configuration 7, waveform file used: LTE_TDD_64QAM_20MHZ.WV	< 2 %, RMS

### LTE FDD RF analyzer (R&S®CMW-KM500 option)

<b>Bandwidth</b>		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
<b>Frequency range</b>	E-UTRA band 1, FDD	1920 MHz to 1980 MHz
	E-UTRA band 2, FDD	1850 MHz to 1910 MHz
	E-UTRA band 3, FDD	1710 MHz to 1785 MHz
	E-UTRA band 4, FDD	1710 MHz to 1755 MHz
	E-UTRA band 5, FDD	824 MHz to 849 MHz
	E-UTRA band 6, FDD	830 MHz to 840 MHz
	E-UTRA band 7, FDD	2500 MHz to 2570 MHz
	E-UTRA band 8, FDD	880 MHz to 915 MHz
	E-UTRA band 9, FDD	1749.9 MHz to 1784.9 MHz
	E-UTRA band 10, FDD	1710 MHz to 1770 MHz
	E-UTRA band 11, FDD	1427.9 MHz to 1447.9 MHz
	E-UTRA band 12, FDD	699 MHz to 716 MHz
	E-UTRA band 13, FDD	777 MHz to 787 MHz
	E-UTRA band 14, FDD	788 MHz to 798 MHz
	E-UTRA band 15, FDD	1900 MHz to 1920 MHz
	E-UTRA band 16, FDD	2010 MHz to 2025 MHz
	E-UTRA band 17, FDD	704 MHz to 716 MHz
	E-UTRA band 18, FDD	815 MHz to 830 MHz
	E-UTRA band 19, FDD	830 MHz to 845 MHz
	E-UTRA band 20, FDD	832 MHz to 862 MHz
	E-UTRA band 21, FDD	1447.9 MHz to 1462.9 MHz
	E-UTRA band 22, FDD, prerequisite: R&S®CMW-KB036 option	3410 MHz to 3490 MHz
	E-UTRA band 23, FDD	2000 MHz to 2020 MHz
	E-UTRA band 24, FDD	1625.5 MHz to 1660.5 MHz
	E-UTRA band 25, FDD	1850 MHz to 1915 MHz
	E-UTRA band 26, FDD	814 MHz to 849 MHz
	E-UTRA band 27, FDD	807 MHz to 824 MHz
	E-UTRA band 28, FDD	703 MHz to 748 MHz
	E-UTRA band 30, FDD	2305 MHz to 2315 MHz
	E-UTRA band 31, FDD	452.5 MHz to 457.5 MHz
	<b>Level setting</b>	
<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger source		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, LTE: free run (fast sync), LTE: IF power

## Power measurement

<b>Slot power</b>	RMS detector	
Level range		-50 dBm to +30 dBm, RMS
Level uncertainty		see general technical specifications

## Modulation analysis

<b>Measured parameters</b>	numeric results	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, TX power, peak power, resource block power (RB power)
	graphical	EVM versus SC-FDMA symbol, ME versus SC-FDMA symbol, PE versus SC-FDMA symbol, EVM versus subcarrier, in-band emissions, spectrum flatness, I/Q constellation

<b>Error vector magnitude (EVM)</b>		
Inherent EVM	allocated resource blocks $\leq 15$	
	-34 dBm $\leq$ input level $<$ +30 dBm, RMS	$< 1 \%$ , RMS
	-38 dBm $\leq$ input level $<$ -34 dBm, RMS	$< 1.5 \%$ , RMS
	allocated resource blocks $\leq 50$	
	-30 dBm $\leq$ input level $\leq$ +30 dBm, RMS	$< 1 \%$ , RMS
	-38 dBm $\leq$ input level $<$ -30 dBm, RMS	$< 2 \%$ , RMS

	allocated resource blocks $\leq 100$	
	-28 dBm $\leq$ input level $\leq$ +30 dBm, RMS	$< 1 \%$ , RMS
	-38 dBm $\leq$ input level $<$ -28 dBm, RMS	$< 2.5 \%$ , RMS

<b>Frequency error</b>		
Measurement range		$\pm 80$ kHz
Frequency measurement uncertainty		$< 20$ Hz <sup>31</sup> + drift of timebase, see general technical specifications

<b>I/Q origin offset</b>		
Inherent I/Q offset	for average $\geq 10$ measurements	$< -50$ dB

<b>In-band emissions</b>		
Dynamic range	allocated resource blocks $\leq 50$ , $f_{RF} < 3300$ MHz	$> 50$ dB
	allocated resource blocks $\leq 50$ , $f_{RF} > 3300$ MHz	$> 47$ dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Equalizer spectrum flatness</b>	allocated resource blocks $\leq 50$	
Level uncertainty		$< 0.5$ dB

<sup>31</sup> For frequency error measurements relative to the downlink signal of the same R&S®CMW500, the uncertainty is in line with 3GPP TS 36.521-1 V9.3.0.

**Spectrum measurements**

<b>Adjacent channel leakage ratio</b>		
Filter	E-UTRA	rectangle 1.08 MHz, 2.7 MHz, 4.5 MHz, 9 MHz, 13.5 MHz, 18 MHz
	UTRA	3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range	E-UTRA, $f_{RF} < 3300$ MHz	> 45 dB
	E-UTRA, $f_{RF} > 3300$ MHz	> 42 dB
	UTRA, $f_{RF} < 3300$ MHz	> 52 dB
	UTRA, $f_{RF} > 3300$ MHz	> 49 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Spectrum emission mask (SEM)</b>		
Frequency span		70 MHz
Noise floor	<i>RBW</i> → 1 MHz, $f_{RF} < 3300$ MHz	< -35 dBm
	<i>RBW</i> → 1 MHz, $f_{RF} > 3300$ MHz	< -32 dBm
	<i>RBW</i> → 100 kHz, $f_{RF} < 3300$ MHz	< -40 dBm
	<i>RBW</i> → 100 kHz, $f_{RF} > 3300$ MHz	< -37 dBm
	<i>RBW</i> → 30 kHz, $f_{RF} < 3300$ MHz	< -45 dBm
	<i>RBW</i> → 30 kHz, $f_{RF} > 3300$ MHz	< -42 dBm

### LTE FDD signaling (prerequisite: R&S®CMW-KS500 option, R&S®CMW-B300A or R&S®CMW-B300B or R&S®CMW-B500I option)

<b>Standard</b>		3GPP E-UTRA FDD
<b>Channels</b>		
Physical channels and signals	DL	RS (cell-specific RS), PSS, SSS, PBCH, PCFICH, PHICH, PDCCH, PDSCH
	UL	RS (demodulation RS), PRACH, PUCCH, PUSCH
Bandwidth		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
Modulation schemes	DL PDSCH	QPSK, 16QAM, 64QAM
	UL PUSCH	QPSK, 16QAM
Reference measurement channels	RMCs in line with 3GPP TS 36.521 Annex A.2 (UL) and Annex A.3 (DL)	RMCs for FDD, full and partial RB allocation, modulation: QPSK, 16QAM, 64QAM (DL only)
<b>Frequency range</b>		
Bands 1 to 31	with the R&S®CMW-KS500 option	
	DL	see LTE FDD RF generator specifications
	UL	see LTE FDD RF analyzer specifications
<b>Frequency setting</b>		channel number

**DL signal**

<b>Output level range</b>	due to PAR	15 dB below max. output level of RF generator, see general technical specifications
<b>Output level uncertainty</b>		see general technical specifications
<b>Output level resolution</b>		0.1 dB
<b>Output level setting</b>	in line with 3GPP TS 36.521 Annex C.0	RS energy per resource element (EPRE) [dBm/15 kHz]
<b>Channel levels</b>	PSS, SSS, PBCH, PCFICH, PHICH, PDCCH, PDSCH	-30 dB to +0 dB relative to RS EPRE
	PHICH	-30 dB to -12 dB relative to RS EPRE
<b>Signal quality</b>		
Error vector magnitude (EVM)	global EVM for cell with bandwidth = 20 MHz	< 2 %, RMS

## LTE TDD RF analyzer (R&S®CMW-KM550 option)

<b>Bandwidth</b>		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
<b>Frequency range</b>	E-UTRA band 33, TDD	1900 MHz to 1920 MHz
	E-UTRA band 34, TDD	2010 MHz to 2025 MHz
	E-UTRA band 35, TDD	1850 MHz to 1910 MHz
	E-UTRA band 36, TDD	1930 MHz to 1990 MHz
	E-UTRA band 37, TDD	1910 MHz to 1930 MHz
	E-UTRA band 38, TDD	2570 MHz to 2620 MHz
	E-UTRA band 39, TDD	1880 MHz to 1920 MHz
	E-UTRA band 40, TDD	2300 MHz to 2400 MHz
	E-UTRA band 41, TDD	2496 MHz to 2690 MHz
	E-UTRA band 42, TDD, prerequisite: R&S®CMW-KB036 option	3400 MHz to 3600 MHz
E-UTRA band 43, TDD, prerequisite: R&S®CMW-KB036 option	3600 MHz to 3800 MHz	
E-UTRA band 44, TDD	703 MHz to 803 MHz	
<b>Level setting</b>		manual mode
<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation
<b>Trigger</b>		
Trigger source		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, LTE: free run (fast sync), LTE: IF power

### Power measurement

<b>Slot power</b>	RMS detector	
Level range		-50 dBm to +30 dBm, RMS
Level uncertainty		see general technical specifications

### Modulation analysis

<b>Measured parameters</b>	numeric results	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, TX power, peak power, resource block power (RB power)
	graphical	EVM versus SC-FDMA symbol, ME versus SC-FDMA symbol, PE versus SC-FDMA symbol, EVM versus subcarrier, in-band emissions, spectrum flatness, I/Q constellation

<b>Error vector magnitude (EVM)</b>		
Inherent EVM	allocated resource blocks $\leq 15$	
	-34 dBm $\leq$ input level $<$ +30 dBm, RMS	$<$ 1 %, RMS
	-38 dBm $\leq$ input level $<$ -34 dBm, RMS	$<$ 1.5 %, RMS
	allocated resource blocks $\leq 50$	
	-30 dBm $\leq$ input level $\leq$ +30 dBm, RMS	$<$ 1 %, RMS
	-38 dBm $\leq$ input level $<$ -30 dBm, RMS	$<$ 2 %, RMS
	allocated resource blocks $\leq 100$	
	-28 dBm $\leq$ input level $\leq$ +30 dBm, RMS	$<$ 1 %, RMS
-38 dBm $\leq$ input level $<$ -28 dBm, RMS	$<$ 2.5 %, RMS	

<b>Frequency error</b>		
Measurement range		±80 kHz
Frequency measurement uncertainty		< 20 Hz <sup>32</sup> + drift of timebase, see general technical specifications

<b>I/Q origin offset</b>		
Inherent I/Q offset		< -50 dB

<b>In-band emissions</b>		
Dynamic range	allocated resource blocks ≤ 50, $f_{RF} < 3300$ MHz	> 50 dB
	allocated resource blocks ≤ 50, $f_{RF} > 3300$ MHz	> 47 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Equalizer spectrum flatness</b>		
Level uncertainty	allocated resource blocks ≤ 50	< 0.5 dB

## Spectrum measurements

<b>Adjacent channel leakage ratio</b>		
Filter	E-UTRA	rectangle 1.08 MHz, 2.7 MHz, 4.5 MHz, 9 MHz, 13.5 MHz, 18 MHz
	UTRA	1.28 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range	E-UTRA, $f_{RF} < 3300$ MHz	> 45 dB
	E-UTRA, $f_{RF} > 3300$ MHz	> 42 dB
	UTRA, $f_{RF} < 3300$ MHz	> 56 dB
	UTRA, $f_{RF} > 3300$ MHz	> 53 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Spectrum emission mask (SEM)</b>		
Frequency span		70 MHz
Noise floor	<i>RBW</i> → 1 MHz, $f_{RF} < 3300$ MHz	< -35 dBm
	<i>RBW</i> → 1 MHz, $f_{RF} > 3300$ MHz	< -32 dBm
	<i>RBW</i> → 100 kHz, $f_{RF} < 3300$ MHz	< -40 dBm
	<i>RBW</i> → 100 kHz, $f_{RF} > 3300$ MHz	< -37 dBm
	<i>RBW</i> → 30 kHz, $f_{RF} < 3300$ MHz	< -45 dBm
	<i>RBW</i> → 30 kHz, $f_{RF} > 3300$ MHz	< -42 dBm

## LTE specifications – small cell test with 40/80 MHz bandwidth unit <sup>33</sup>

Standard		LTE FDD and TDD
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### LTE FDD eNodeB RF analyzer (R&S<sup>®</sup>CMW-KN500 option)

Bandwidth		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
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Frequency range	E-UTRA band 1, FDD	2110 MHz to 2170 MHz
	E-UTRA band 2, FDD	1930 MHz to 1990 MHz
	E-UTRA band 3, FDD	1805 MHz to 1880 MHz
	E-UTRA band 4, FDD	2110 MHz to 2155 MHz
	E-UTRA band 5, FDD	869 MHz to 894 MHz
	E-UTRA band 6, FDD	875 MHz to 885 MHz
	E-UTRA band 7, FDD	2620 MHz to 2690 MHz
	E-UTRA band 8, FDD	925 MHz to 960 MHz

<sup>32</sup> For frequency error measurements relative to the downlink signal of the same R&S<sup>®</sup>CMW500, the uncertainty is in line with 3GPP TS 36.521-1 V9.3.0.

<sup>33</sup> R&S<sup>®</sup>CMW500 only.

	E-UTRA band 9, FDD	1844.9 MHz to 1879.9 MHz
	E-UTRA band 10, FDD	2110 MHz to 2170 MHz
	E-UTRA band 11, FDD	1475.9 MHz to 1495.9 MHz
	E-UTRA band 12, FDD	729 MHz to 746 MHz
	E-UTRA band 13, FDD	746 MHz to 756 MHz
	E-UTRA band 14, FDD	758 MHz to 768 MHz
	E-UTRA band 15, FDD	2600 MHz to 2620 MHz
	E-UTRA band 16, FDD	2585 MHz to 2600 MHz
	E-UTRA band 17, FDD	734 MHz to 746 MHz
	E-UTRA band 18, FDD	860 MHz to 875 MHz
	E-UTRA band 19, FDD	875 MHz to 890 MHz
	E-UTRA band 20, FDD	791 MHz to 821 MHz
	E-UTRA band 21, FDD	1495.9 MHz to 1510.9 MHz
	E-UTRA band 22, FDD, prerequisite: R&S®CMW-KB036 option	3510 MHz to 3590 MHz
	E-UTRA band 23, FDD	2180 MHz to 2200 MHz
	E-UTRA band 24, FDD	1525 MHz to 1559 MHz
	E-UTRA band 25, FDD	1930 MHz to 1995 MHz
	E-UTRA band 26, FDD	859 MHz to 894 MHz
	E-UTRA band 27, FDD	852 MHz to 869 MHz
	E-UTRA band 28, FDD	758 MHz to 803 MHz
	E-UTRA band 29, FDD	717 MHz to 728 MHz
	E-UTRA band 30, FDD	2350 MHz to 2360 MHz
	E-UTRA band 31, FDD	462.5 MHz to 467.5 MHz
<b>Level setting</b>		manual mode

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger source		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, LTE: free run (fast sync), LTE: IF power

## Power measurement

<b>Slot power</b>	RMS detector	
Level range		-50 dBm to +30 dBm, RMS
Level uncertainty		see general technical specifications

## Modulation analysis

<b>Measured parameters</b>	numeric results	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, TX power, peak power, reference symbol power, OFDM symbol power
	graphical	EVM versus OFDMA symbol, ME versus OFDMA symbol, PE versus OFDMA symbol, OFDM symbol power spectrum flatness, spectrum ACLR I/Q constellation

<b>Error vector magnitude (EVM)</b>		
Inherent EVM	for average $\geq 10$ subframes -20 dBm $\leq$ input level < +30 dBm, RMS	< 1.5 %, RMS

<b>Frequency error</b>		
Measurement range		±80 kHz
Frequency measurement uncertainty		< 20 Hz <sup>34</sup> + drift of timebase, see general technical specifications

### Spectrum measurements

<b>Adjacent channel leakage ratio</b>		
Filter	E-UTRA	rectangle 1.08 MHz, 2.7 MHz, 4.5 MHz, 9 MHz, 13.5 MHz, 18 MHz
	UTRA	1.28 MHz, RRC, $\alpha = 0.22$ , WCDMA filter 3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter 7.68 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range	E-UTRA, $f_{RF} < 3300$ MHz	> 50 dB
	E-UTRA, $f_{RF} > 3300$ MHz	> 48 dB
	UTRA384, $f_{RF} < 3300$ MHz	> 52 dB
	UTRA384, $f_{RF} > 3300$ MHz	> 52 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Spectrum emission mask (SEM)</b>		
Frequency span		70 MHz
Noise floor	$RBW \rightarrow \leq 1$ MHz, expected nominal power < 12 dBm, $f_{RF} < 3300$ MHz	< -58 dBm
	$RBW \rightarrow \leq 1$ MHz, expected nominal power < 12 dBm, $f_{RF} > 3300$ MHz	< -55 dBm

### LTE TDD eNodeB RF analyzer (R&S®CMW-KN550 option)

<b>Bandwidth</b>		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
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<b>Frequency range</b>	E-UTRA band 33, TDD	1900 MHz to 1920 MHz
	E-UTRA band 34, TDD	2010 MHz to 2025 MHz
	E-UTRA band 35, TDD	1850 MHz to 1910 MHz
	E-UTRA band 36, TDD	1930 MHz to 1990 MHz
	E-UTRA band 37, TDD	1910 MHz to 1930 MHz
	E-UTRA band 38, TDD	2570 MHz to 2620 MHz
	E-UTRA band 39, TDD	1880 MHz to 1920 MHz
	E-UTRA band 40, TDD	2300 MHz to 2400 MHz
	E-UTRA band 41, TDD	2496 MHz to 2690 MHz
	E-UTRA band 42, TDD, prerequisite: R&S®CMW-KB036 option	3400 MHz to 3600 MHz
	E-UTRA band 43, TDD, prerequisite: R&S®CMW-KB036 option	3600 MHz to 3800 MHz
E-UTRA band 44, TDD	703 MHz to 803 MHz	
<b>Level setting</b>		manual mode

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger source		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, LTE: free run (fast sync), LTE: IF power

### Power measurement

<b>Slot power</b>	RMS detector	
Level range		-50 dBm to +30 dBm, RMS
Level uncertainty		see general technical specifications

<sup>34</sup> For frequency error measurements relative to the downlink signal of the same R&S®CMW500, the uncertainty is in line with 3GPP TS 36.521-1 V9.3.0.



## Modulation analysis

<b>Measured parameters</b>	numeric results	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, TX power, peak power, reference symbol power, OFDM symbol power
	graphical	EVM versus OFDMA symbol, ME versus OFDMA symbol, PE versus OFDMA symbol, OFDM symbol power spectrum flatness, spectrum ACLR, I/Q constellation

<b>Error vector magnitude (EVM)</b>		
Inherent EVM	for average $\geq 10$ subframes -20 dBm $\leq$ input level < +30 dBm, RMS	< 1.5 %, RMS

<b>Frequency error</b>		
Measurement range		$\pm 80$ kHz
Frequency measurement uncertainty		< 20 Hz <sup>35</sup> + drift of timebase, see general technical specifications

## Spectrum measurements

<b>Adjacent channel leakage ratio</b>		
Filter	E-UTRA	rectangle 1.08 MHz, 2.7 MHz, 4.5 MHz, 9 MHz, 13.5 MHz, 18 MHz
	UTRA	1.28 MHz, RRC, $\alpha = 0.22$ , WCDMA filter 3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter 7.68 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range	E-UTRA, $f_{RF} < 3300$ MHz	> 50 dB
	E-UTRA, $f_{RF} > 3300$ MHz	> 47 dB
	UTRA128, $f_{RF} < 3300$ MHz	> 52 dB
	UTRA384, $f_{RF} < 3300$ MHz	> 52 dB
	UTRA768, $f_{RF} < 3300$ MHz	> 49 dB
	UTRA128, $f_{RF} > 3300$ MHz	> 52 dB
	UTRA384_1, $f_{RF} > 3300$ MHz	> 50 dB
	UTRA384_2, $f_{RF} > 3300$ MHz	> 52 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Spectrum emission mask (SEM)</b>		
Frequency span		70 MHz
Noise floor	$RBW \rightarrow \leq 1$ MHz, expected nominal power < 12 dBm, $f_{RF} < 3300$ MHz	< -58 dBm
	$RBW \rightarrow \leq 1$ MHz, expected nominal power < 12 dBm, $f_{RF} > 3300$ MHz	< -55 dBm

<sup>35</sup> For frequency error measurements relative to the downlink signal of the same R&S®CMW500, the uncertainty is in line with 3GPP TS 36.521-1 V9.3.0.

## LTE specifications – mobile station test with 160 MHz bandwidth unit <sup>36</sup>

Standard	LTE FDD and TDD
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### LTE RF generator

Frequency range		
	E-UTRA band 1, FDD	2110 MHz to 2170 MHz
	E-UTRA band 2, FDD	1930 MHz to 1990 MHz
	E-UTRA band 3, FDD	1805 MHz to 1880 MHz
	E-UTRA band 4, FDD	2110 MHz to 2155 MHz
	E-UTRA band 5, FDD	869 MHz to 894 MHz
	E-UTRA band 6, FDD	875 MHz to 885 MHz
	E-UTRA band 7, FDD	2620 MHz to 2690 MHz
	E-UTRA band 8, FDD	925 MHz to 960 MHz
	E-UTRA band 9, FDD	1844.9 MHz to 1879.9 MHz
	E-UTRA band 10, FDD	2110 MHz to 2170 MHz
	E-UTRA band 11, FDD	1475.9 MHz to 1495.9 MHz
	E-UTRA band 12, FDD	729 MHz to 746 MHz
	E-UTRA band 13, FDD	746 MHz to 756 MHz
	E-UTRA band 14, FDD	758 MHz to 768 MHz
	E-UTRA band 15, FDD	2600 MHz to 2620 MHz
	E-UTRA band 16, FDD	2585 MHz to 2600 MHz
	E-UTRA band 17, FDD	734 MHz to 746 MHz
	E-UTRA band 18, FDD	860 MHz to 875 MHz
	E-UTRA band 19, FDD	875 MHz to 890 MHz
	E-UTRA band 20, FDD	791 MHz to 821 MHz
	E-UTRA band 21, FDD	1495.9 MHz to 1510.9 MHz
	E-UTRA band 22, FDD, prerequisite: R&S <sup>®</sup> CMW-KB036 option	3510 MHz to 3590 MHz
	E-UTRA band 23, FDD	2180 MHz to 2200 MHz
	E-UTRA band 24, FDD	1525 MHz to 1559 MHz
	E-UTRA band 25, FDD	1930 MHz to 1995 MHz
	E-UTRA band 26, FDD	859 MHz to 894 MHz
	E-UTRA band 27, FDD	852 MHz to 869 MHz
	E-UTRA band 28, FDD	758 MHz to 803 MHz
	E-UTRA band 29, FDD	717 MHz to 728 MHz
	E-UTRA band 30, FDD	2350 MHz to 2360 MHz
	E-UTRA band 31, FDD	462.5 MHz to 467.5 MHz
	E-UTRA band 33, TDD	1900 MHz to 1920 MHz
	E-UTRA band 34, TDD	2010 MHz to 2025 MHz
	E-UTRA band 35, TDD	1850 MHz to 1910 MHz
	E-UTRA band 36, TDD	1930 MHz to 1990 MHz
	E-UTRA band 37, TDD	1910 MHz to 1930 MHz
	E-UTRA band 38, TDD	2570 MHz to 2620 MHz
	E-UTRA band 39, TDD	1880 MHz to 1920 MHz
	E-UTRA band 40, TDD	2300 MHz to 2400 MHz
	E-UTRA band 41, TDD	2496 MHz to 2690 MHz
	E-UTRA band 42, TDD, prerequisite: R&S <sup>®</sup> CMW-KB036 option	3400 MHz to 3600 MHz
	E-UTRA band 43, TDD, prerequisite: R&S <sup>®</sup> CMW-KB036 option	3600 MHz to 3800 MHz
	E-UTRA band 44, TDD	703 MHz to 803 MHz

### LTE WiniQSIM2™ (R&S<sup>®</sup>CMW-KW500 option)

Arbitrary waveform file		
	LTE FDD	LTE_FDD_QPSK_10MHZ.WV (PAR = 11.15 dB)
	LTE TDD	LTE_TDD_64QAM_20MHZ.WV (PAR = 11.10 dB)

<sup>36</sup> R&S<sup>®</sup>CMW500 and R&S<sup>®</sup>CMW290 only.

<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>	waveform file used: LTE_FDD_QPSK_10MHZ.WV	see general technical specifications
	waveform file used: LTE_TDD_64QAM_20MHZ.WV	see general technical specifications
<b>Output level resolution</b>		see general technical specifications
<b>Signal quality</b>		
Error vector magnitude (EVM)	EVM PDSCH QPSK, bandwidth = 10 MHz, 50 resource blocks, PRB symbol offset = 3, 10 subframes, PCFICH present, waveform file used: LTE_FDD_QPSK_10MHZ.WV	< 2 %, RMS
	EVM PDSCH 64QAM, bandwidth = 20 MHz, 100 resource blocks, PRB symbol offset = 2, uplink/downlink configuration 1, special subframe configuration 7, waveform file used: LTE_TDD_64QAM_20MHZ.WV	< 2 %, RMS

### LTE FDD RF analyzer (R&S®CMW-KM500 option)

<b>Bandwidth</b>		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
<b>Frequency range</b>	E-UTRA band 1, FDD	1920 MHz to 1980 MHz
	E-UTRA band 2, FDD	1850 MHz to 1910 MHz
	E-UTRA band 3, FDD	1710 MHz to 1785 MHz
	E-UTRA band 4, FDD	1710 MHz to 1755 MHz
	E-UTRA band 5, FDD	824 MHz to 849 MHz
	E-UTRA band 6, FDD	830 MHz to 840 MHz
	E-UTRA band 7, FDD	2500 MHz to 2570 MHz
	E-UTRA band 8, FDD	880 MHz to 915 MHz
	E-UTRA band 9, FDD	1749.9 MHz to 1784.9 MHz
	E-UTRA band 10, FDD	1710 MHz to 1770 MHz
	E-UTRA band 11, FDD	1427.9 MHz to 1447.9 MHz
	E-UTRA band 12, FDD	699 MHz to 716 MHz
	E-UTRA band 13, FDD	777 MHz to 787 MHz
	E-UTRA band 14, FDD	788 MHz to 798 MHz
	E-UTRA band 15, FDD	1900 MHz to 1920 MHz
	E-UTRA band 16, FDD	2010 MHz to 2025 MHz
	E-UTRA band 17, FDD	704 MHz to 716 MHz
	E-UTRA band 18, FDD	815 MHz to 830 MHz
	E-UTRA band 19, FDD	830 MHz to 845 MHz
	E-UTRA band 20, FDD	832 MHz to 862 MHz
	E-UTRA band 21, FDD	1447.9 MHz to 1462.9 MHz
	E-UTRA band 22, FDD, prerequisite: R&S®CMW-KB036 option	3410 MHz to 3490 MHz
	E-UTRA band 23, FDD	2000 MHz to 2020 MHz
	E-UTRA band 24, FDD	1625.5 MHz to 1660.5 MHz
	E-UTRA band 25, FDD	1850 MHz to 1915 MHz
	E-UTRA band 26, FDD	814 MHz to 849 MHz
	E-UTRA band 27, FDD	807 MHz to 824 MHz
	E-UTRA band 28, FDD	703 MHz to 748 MHz
	E-UTRA band 30, FDD	2305 MHz to 2315 MHz
	E-UTRA band 31, FDD	452.5 MHz to 457.5 MHz
	<b>Level setting</b>	
<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger source		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, LTE: free run (fast sync), LTE: IF power

## Power measurement

<b>Slot power</b>	RMS detector	
Level range		-50 dBm to +30 dBm, RMS
Level uncertainty		see general technical specifications

## Modulation analysis

<b>Measured parameters</b>	numeric results	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, TX power, peak power, resource block power (RB power)
	graphical	EVM versus SC-FDMA symbol, ME versus SC-FDMA symbol, PE versus SC-FDMA symbol, EVM versus subcarrier, in-band emissions, spectrum flatness, I/Q constellation

<b>Error vector magnitude (EVM)</b>		
Inherent EVM	allocated resource blocks $\leq 15$	
	$-34 \text{ dBm} \leq \text{input level} < +30 \text{ dBm}$ , RMS	< 1 %, RMS
	$-38 \text{ dBm} \leq \text{input level} < -34 \text{ dBm}$ , RMS	< 1.5 %, RMS

	allocated resource blocks $\leq 50$	
	$-30 \text{ dBm} \leq \text{input level} \leq +30 \text{ dBm}$ , RMS	< 1 %, RMS
	$-38 \text{ dBm} \leq \text{input level} < -30 \text{ dBm}$ , RMS	< 2 %, RMS
	allocated resource blocks $\leq 100$	
	$-28 \text{ dBm} \leq \text{input level} \leq +30 \text{ dBm}$ , RMS	< 1 %, RMS
	$-38 \text{ dBm} \leq \text{input level} < -28 \text{ dBm}$ , RMS	< 2.5 %, RMS

<b>Frequency error</b>		
Measurement range		$\pm 80 \text{ kHz}$
Frequency measurement uncertainty		< $20 \text{ Hz}^{37}$ + drift of timebase, see general technical specifications

<b>I/Q origin offset</b>		
Inherent I/Q offset	for average $\geq 10$ measurements	< -50 dB

<b>In-band emissions</b>		
Dynamic range	allocated resource blocks $\leq 50$	> 50 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Equalizer spectrum flatness</b>	allocated resource blocks $\leq 50$	
Level uncertainty		< 0.5 dB

<sup>37</sup> For frequency error measurements relative to the downlink signal of the same R&S®CMW500, the uncertainty is in line with 3GPP TS 36.521-1 V9.3.0.

**Spectrum measurements**

<b>Adjacent channel leakage ratio</b>		
Filter	E-UTRA	rectangle 1.08 MHz, 2.7 MHz, 4.5 MHz, 9 MHz, 13.5 MHz, 18 MHz
	UTRA	3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range	E-UTRA	> 45 dB
	UTRA	> 52 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Spectrum emission mask (SEM)</b>		
Frequency span		70 MHz
Noise floor	<i>RBW</i> → 1 MHz	< -35 dBm
	<i>RBW</i> → 100 kHz	< -40 dBm
	<i>RBW</i> → 30 kHz	< -45 dBm

### LTE FDD signaling (prerequisite: R&S®CMW-KS500 option, R&S®CMW-B300A or R&S®CMW-B300B or R&S®CMW-B500I option)

<b>Standard</b>		3GPP E-UTRA FDD
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<b>Channels</b>		
Physical channels and signals	DL	RS (cell-specific RS), PSS, SSS, PBCH, PCFICH, PHICH, PDCCH, PDSCH
	UL	RS (demodulation RS), PRACH, PUCCH, PUSCH
Bandwidth		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
Modulation schemes	DL PDSCH	QPSK, 16QAM, 64QAM
	UL PUSCH	QPSK, 16QAM

Reference measurement channels	RMCs in line with 3GPP TS 36.521 Annex A.2 (UL) and Annex A.3 (DL)	RMCs for FDD, full and partial RB allocation, modulation: QPSK, 16QAM, 64QAM (DL only)
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<b>Frequency range</b>		
Bands 1 to 31	with the R&S®CMW-KS500 option	
	DL	see LTE FDD RF generator specifications
	UL	see LTE FDD RF analyzer specifications

<b>Frequency setting</b>		channel number
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**DL signal**

<b>Output level range</b>	due to PAR	15 dB below max. output level of RF generator, see general technical specifications
<b>Output level uncertainty</b>		see general technical specifications
<b>Output level resolution</b>		0.1 dB
<b>Output level setting</b>	in line with 3GPP TS 36.521 Annex C.0	RS energy per resource element (EPRE) [dBm/15 kHz]

<b>Channel levels</b>	PSS, SSS, PBCH, PCFICH, PHICH, PDCCH, PDSCH	-30 dB to +0 dB relative to RS EPRE
	PHICH	-30 dB to -12 dB relative to RS EPRE

<b>Signal quality</b>		
Error vector magnitude (EVM)	global EVM for cell with bandwidth = 20 MHz	< 2 %, RMS

## LTE TDD RF analyzer (R&S®CMW-KM550 option)

<b>Bandwidth</b>		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
<b>Frequency range</b>	E-UTRA band 33, TDD	1900 MHz to 1920 MHz
	E-UTRA band 34, TDD	2010 MHz to 2025 MHz
	E-UTRA band 35, TDD	1850 MHz to 1910 MHz
	E-UTRA band 36, TDD	1930 MHz to 1990 MHz
	E-UTRA band 37, TDD	1910 MHz to 1930 MHz
	E-UTRA band 38, TDD	2570 MHz to 2620 MHz
	E-UTRA band 39, TDD	1880 MHz to 1920 MHz
	E-UTRA band 40, TDD	2300 MHz to 2400 MHz
	E-UTRA band 41, TDD	2496 MHz to 2690 MHz
	E-UTRA band 42, TDD, prerequisite: R&S®CMW-KB036 option	3400 MHz to 3600 MHz
E-UTRA band 43, TDD, prerequisite: R&S®CMW-KB036 option	3600 MHz to 3800 MHz	
E-UTRA band 44, TDD	703 MHz to 803 MHz	
<b>Level setting</b>		manual mode
<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation
<b>Trigger</b>		
Trigger source		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, LTE: free run (fast sync), LTE: IF power

### Power measurement

<b>Slot power</b>	RMS detector	
Level range		-50 dBm to +30 dBm, RMS
Level uncertainty		see general technical specifications

### Modulation analysis

<b>Measured parameters</b>	numeric results	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, TX power, peak power, resource block power (RB power)
	graphical	EVM versus SC-FDMA symbol, ME versus SC-FDMA symbol, PE versus SC-FDMA symbol, EVM versus subcarrier, in-band emissions, spectrum flatness, I/Q constellation
<b>Error vector magnitude (EVM)</b>		
Inherent EVM	allocated resource blocks ≤ 15	
	-34 dBm ≤ input level < +30 dBm, RMS	< 1 %, RMS
	-38 dBm ≤ input level < -34 dBm, RMS	< 1.5 %, RMS
	allocated resource blocks ≤ 50	
	-30 dBm ≤ input level ≤ +30 dBm, RMS	< 1 %, RMS
	-38 dBm ≤ input level < -30 dBm, RMS	< 2 %, RMS
	allocated resource blocks ≤ 100	
	-28 dBm ≤ input level ≤ +30 dBm, RMS	< 1 %, RMS
-38 dBm ≤ input level < -28 dBm, RMS	< 2.5 %, RMS	

<b>Frequency error</b>		
Measurement range		±80 kHz
Frequency measurement uncertainty		< 20 Hz <sup>38</sup> + drift of timebase, see general technical specifications

<b>I/Q origin offset</b>		
Inherent I/Q offset		< -50 dB

<b>In-band emissions</b>		
Dynamic range	allocated resource blocks ≤ 50	> 50 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Equalizer spectrum flatness</b>		
Level uncertainty	allocated resource blocks ≤ 50	< 0.5 dB

## Spectrum measurements

<b>Adjacent channel leakage ratio</b>		
Filter	E-UTRA	rectangle 1.08 MHz, 2.7 MHz, 4.5 MHz, 9 MHz, 13.5 MHz, 18 MHz
	UTRA	1.28 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range	E-UTRA	> 45 dB
	UTRA	> 56 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Spectrum emission mask (SEM)</b>		
Frequency span		70 MHz
Noise floor	<i>RBW</i> → 1 MHz	< -35 dBm
	<i>RBW</i> → 100 kHz	< -40 dBm
	<i>RBW</i> → 30 kHz	< -45 dBm

## LTE specifications – small cell test with 160 MHz bandwidth unit<sup>39</sup>

Standard		LTE FDD and TDD
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### LTE FDD eNodeB RF analyzer (R&S®CMW-KN500 option)

Bandwidth		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
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Frequency range	E-UTRA band 1, FDD	2110 MHz to 2170 MHz
	E-UTRA band 2, FDD	1930 MHz to 1990 MHz
	E-UTRA band 3, FDD	1805 MHz to 1880 MHz
	E-UTRA band 4, FDD	2110 MHz to 2155 MHz
	E-UTRA band 5, FDD	869 MHz to 894 MHz
	E-UTRA band 6, FDD	875 MHz to 885 MHz
	E-UTRA band 7, FDD	2620 MHz to 2690 MHz
	E-UTRA band 8, FDD	925 MHz to 960 MHz
	E-UTRA band 9, FDD	1844.9 MHz to 1879.9 MHz
	E-UTRA band 10, FDD	2110 MHz to 2170 MHz
	E-UTRA band 11, FDD	1475.9 MHz to 1495.9 MHz
	E-UTRA band 12, FDD	729 MHz to 746 MHz
	E-UTRA band 13, FDD	746 MHz to 756 MHz
	E-UTRA band 14, FDD	758 MHz to 768 MHz
	E-UTRA band 15, FDD	2600 MHz to 2620 MHz
	E-UTRA band 16, FDD	2585 MHz to 2600 MHz
	E-UTRA band 17, FDD	734 MHz to 746 MHz
	E-UTRA band 18, FDD	860 MHz to 875 MHz

<sup>38</sup> For frequency error measurements relative to the downlink signal of the same R&S®CMW500, the uncertainty is in line with 3GPP TS 36.521-1 V9.3.0.

<sup>39</sup> R&S®CMW500 only.

	E-UTRA band 19, FDD	875 MHz to 890 MHz
	E-UTRA band 20, FDD	791 MHz to 821 MHz
	E-UTRA band 21, FDD	1495.9 MHz to 1510.9 MHz
	E-UTRA band 22, FDD, prerequisite: R&S®CMW-KB036 option	3510 MHz to 3590 MHz
	E-UTRA band 23, FDD	2180 MHz to 2200 MHz
	E-UTRA band 24, FDD	1525 MHz to 1559 MHz
	E-UTRA band 25, FDD	1930 MHz to 1995 MHz
	E-UTRA band 26, FDD	859 MHz to 894 MHz
	E-UTRA band 27, FDD	852 MHz to 869 MHz
	E-UTRA band 28, FDD	758 MHz to 803 MHz
	E-UTRA band 29, FDD	717 MHz to 728 MHz
	E-UTRA band 30, FDD	2350 MHz to 2360 MHz
	E-UTRA band 31, FDD	462.5 MHz to 467.5 MHz
<b>Level setting</b>		manual mode

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger source		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, LTE: free run (fast sync), LTE: IF power

### Power measurement

<b>Slot power</b>	RMS detector	
Level range		-50 dBm to +30 dBm, RMS
Level uncertainty		see general technical specifications

### Modulation analysis

<b>Measured parameters</b>	numeric results	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, TX power, peak power, reference symbol power, OFDM symbol power
	graphical	EVM versus OFDMA symbol, ME versus OFDMA symbol, PE versus OFDMA symbol, OFDM symbol power spectrum flatness, spectrum ACLR I/Q constellation

<b>Error vector magnitude (EVM)</b>		
Inherent EVM	for average $\geq 10$ subframes -20 dBm $\leq$ input level < +30 dBm, RMS	< 1.5 %, RMS

<b>Frequency error</b>		
Measurement range		$\pm 80$ kHz
Frequency measurement uncertainty		< 20 Hz <sup>40</sup> + drift of timebase, see general technical specifications

<sup>40</sup> For frequency error measurements relative to the downlink signal of the same R&S®CMW500, the uncertainty is in line with 3GPP TS 36.521-1 V9.3.0.



**Spectrum measurements**

<b>Adjacent channel leakage ratio</b>		
Filter	E-UTRA	rectangle 1.08 MHz, 2.7 MHz, 4.5 MHz, 9 MHz, 13.5 MHz, 18 MHz
	UTRA	1.28 MHz, RRC, $\alpha = 0.22$ , WCDMA filter 3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter 7.68 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range	E-UTRA	> 50 dB
	UTRA384	> 52 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Spectrum emission mask (SEM)</b>		
Frequency span		70 MHz
Noise floor	$RBW \rightarrow \leq 1$ MHz, expected nominal power < 12 dBm	< -58 dBm

**LTE TDD eNodeB RF analyzer (R&S®CMW-KN550 option)**

<b>Bandwidth</b>		1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
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<b>Frequency range</b>	E-UTRA band 33, TDD	1900 MHz to 1920 MHz
	E-UTRA band 34, TDD	2010 MHz to 2025 MHz
	E-UTRA band 35, TDD	1850 MHz to 1910 MHz
	E-UTRA band 36, TDD	1930 MHz to 1990 MHz
	E-UTRA band 37, TDD	1910 MHz to 1930 MHz
	E-UTRA band 38, TDD	2570 MHz to 2620 MHz
	E-UTRA band 39, TDD	1880 MHz to 1920 MHz
	E-UTRA band 40, TDD	2300 MHz to 2400 MHz
	E-UTRA band 41, TDD	2496 MHz to 2690 MHz
	E-UTRA band 42, TDD, prerequisite: R&S®CMW-KB036 option	3400 MHz to 3600 MHz

	E-UTRA band 43, TDD, prerequisite: R&S®CMW-KB036 option	3600 MHz to 3800 MHz
	E-UTRA band 44, TDD	703 MHz to 803 MHz
<b>Level setting</b>		manual mode

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger source		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, LTE: free run (fast sync), LTE: IF power

**Power measurement**

<b>Slot power</b>	RMS detector	
Level range		-50 dBm to +30 dBm, RMS
Level uncertainty		see general technical specifications

**Modulation analysis**

<b>Measured parameters</b>	numeric results	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, TX power, peak power, reference symbol power, OFDM symbol power
	graphical	EVM versus OFDMA symbol, ME versus OFDMA symbol, PE versus OFDMA symbol, OFDM symbol power spectrum flatness, spectrum ACLR, I/Q constellation

<b>Error vector magnitude (EVM)</b>		
Inherent EVM	for average $\geq 10$ subframes -20 dBm $\leq$ input level < +30 dBm, RMS	< 1.5 %, RMS

<b>Frequency error</b>		
Measurement range		$\pm 80$ kHz
Frequency measurement uncertainty		< 20 Hz <sup>41</sup> + drift of timebase, see general technical specifications

**Spectrum measurements**

<b>Adjacent channel leakage ratio</b>		
Filter	E-UTRA	rectangle 1.08 MHz, 2.7 MHz, 4.5 MHz, 9 MHz, 13.5 MHz, 18 MHz
	UTRA	1.28 MHz, RRC, $\alpha = 0.22$ , WCDMA filter 3.84 MHz, RRC, $\alpha = 0.22$ , WCDMA filter 7.68 MHz, RRC, $\alpha = 0.22$ , WCDMA filter
Dynamic range	E-UTRA	> 50 dB
	UTRA128	> 52 dB
	UTRA384	> 52 dB
	UTRA768	> 49 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	see general technical specifications

<b>Spectrum emission mask (SEM)</b>		
Frequency span		70 MHz
Noise floor	$RBW \rightarrow \leq 1$ MHz, expected nominal power < 12 dBm	< -58 dBm

<sup>41</sup> For frequency error measurements relative to the downlink signal of the same R&S®CMW500, the uncertainty is in line with 3GPP TS 36.521-1 V9.3.0.

## Bluetooth® specifications

Standard	standard	Bluetooth® Core Specification Version 5.0
	test standard	Bluetooth® RF Test Specification RF.TS.5.0.0, Bluetooth® Low Energy RF PHY Test Specification, RF-PHY.TS.5.0.0

### Bluetooth® RF generator (prerequisite: R&S®CMW-B110A/R&S®CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

Frequency range	Bluetooth®	2402 MHz to 2480 MHz
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### Bluetooth® WinIQSIM2™ (R&S®CMW-KW610 option)

Arbitrary waveform file	basic rate	BLUETOOTH_11110000_DH5.WV LAP: 123456, (PAR = 0.00 dB)
	enhanced data rate (EDR)	BLUETOOTH_PRBS9_3-DH5.WV LAP: 123456, (PAR = 3.20 dB)

Output level range RF1 COM, RF2 COM	depends on PAR	
	peak envelope power (PEP) overranging (PEP)	up to -5 dBm up to 0 dBm
RF1 OUT	peak envelope power (PEP) overranging (PEP)	up to +3 dBm up to +8 dBm
	Output level uncertainty	including overranging, waveform files used: BLUETOOTH_11110000_DH5.WV, BLUETOOTH_PRBS9_3-DH5.WV
Output level resolution		see general technical specifications

<b>Signal quality</b>		
Modulation index uncertainty	basic rate, frequency deviation $\Delta f_1$ max. = 160 kHz, waveform file used: BLUETOOTH_11110000_DH5.WV	< 1 %
Differential error vector magnitude (DEV M)	enhanced data rate, waveform file used: BLUETOOTH_PRBS9_3-DH5.WV	< 1.5 %, RMS

### Bluetooth® RF analyzer (R&S®CMW-KM610 option)

Frequency range	Bluetooth®	2402 MHz to 2480 MHz
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<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, minimum, standard deviation

<b>Trigger</b>		
Trigger sources		Bluetooth®: IF power

### Modulation analysis

Filter	<i>filter bandwidth</i> → wide	bandpass 2.0 MHz
	<i>filter bandwidth</i> → narrow	bandpass 1.3 MHz
Level range		-35 dBm to +42 dBm <sup>42</sup>
Supported packet types	basic rate	DH1, DH3, DH5
	enhanced data rate (EDR)	2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5

<sup>42</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Measured parameters</b>	basic rate, numeric results and standard deviation	$\Delta f_2$ 99.9 %, frequency accuracy, frequency drift, maximum drift rate, frequency deviation $\Delta f_1$ average, frequency deviation $\Delta f_1$ minimum, frequency deviation $\Delta f_1$ maximum, frequency deviation $\Delta f_2$ average, frequency deviation $\Delta f_2$ minimum, frequency deviation $\Delta f_2$ maximum, nominal power
	enhanced data rate (EDR), numeric results and standard deviation	99 % DEVM, frequency stability $\omega_i$ , frequency stability $(\omega_o + \omega_i)_{max}$ , frequency stability $\omega_o_{max}$ , RMS DEVM, peak RMS, nominal power
<b>Total measurement range for frequency accuracy, frequency deviation and frequency drift</b>	basic rate	$\pm 250$ kHz
<b>Frequency accuracy</b>	basic rate	
Measurement range	for nominal deviation of 160 kHz	$\pm 100$ kHz
Uncertainty	for deviation $\leq 160$ kHz	$< 2$ kHz
<b>Frequency deviation</b>	basic rate	
Measurement range	without frequency offset	$\leq 210$ kHz
Uncertainty	for modulation index 0.22 to 0.42	$< 1$ %
<b>Frequency drift</b>	basic rate	
Measurement range		$\pm 50$ kHz
Uncertainty	measured in burst relative to frequency offset in preamble, with 10101010 pattern referenced to measured frequency offset in preamble (relative frequency drift)	$< 2$ kHz $\leq 1$ kHz
<b>Frequency stability <math>\omega_i</math></b>	enhanced data rate	
Measurement range		$\pm 100$ kHz
Uncertainty	for $\omega_i \leq 75$ kHz, for deviation $\leq 160$ kHz	$< 2$ kHz
<b>Frequency stability <math>\omega_o_{max}</math></b>	enhanced data rate	
Measurement range		$\pm 15$ kHz
Uncertainty	for $\omega_o \leq 10$ kHz	$< 1$ kHz
<b>Differential error vector magnitude (DEV M)</b>	enhanced data rate	
Inherent DEV M	for PRBS pattern	$< 1.5$ %, RMS $< 3.0$ %, peak

## Bluetooth® RF analyzer (R&S®CMW-KM611 option)

<b>Frequency range</b>	Bluetooth®	2402 MHz to 2480 MHz
<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, minimum, standard deviation
<b>Trigger</b>		
Trigger sources		Bluetooth®: IF power

## Modulation analysis

<b>Filter</b>	filter bandwidth: wide	2.0 MHz bandpass
	filter bandwidth: narrow	1.3 MHz bandpass
<b>Level range</b>		-35 dBm to +42 dBm <sup>43</sup>
<b>Supported packet types</b>		RF PHY Test Reference Packets

<b>Measured parameters</b>	numeric results and standard deviation	$\Delta f_2$ 99.9%, frequency accuracy, frequency offset, initial frequency drift, frequency drift, max drift rate, frequency deviation $\Delta f_1$ average, frequency deviation $\Delta f_1$ minimum, frequency deviation $\Delta f_1$ maximum, frequency deviation $\Delta f_2$ average, frequency deviation $\Delta f_2$ minimum, frequency deviation $\Delta f_2$ maximum, nominal power
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<b>Total measurement range for frequency accuracy, offset, deviation and drift measurements</b>		$\pm 350$ kHz
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<b>Frequency accuracy (using preamble)</b>		
Measurement range	for nominal deviation of 250 kHz	$\pm 175$ kHz
Uncertainty	for deviation $\leq 250$ kHz	< 2 kHz

<b>Frequency offset</b>		
Measurement range	for nominal deviation of 250 kHz	$\pm 175$ kHz
Uncertainty	for deviation $\leq 250$ kHz	< 2 kHz

<b>Frequency deviation</b>		
Measurement range	without frequency offset	$\leq 350$ kHz
Uncertainty	for modulation index 0.40 to 0.60	< 1.0 %

<b>Frequency drift</b>		
Measurement range		$\pm 75$ kHz
Uncertainty	measured in burst relative to frequency offset in preamble, with 10101010 pattern	< 2 kHz
	referenced to measured frequency offset in preamble (relative frequency drift)	$\leq 1$ kHz

## Bluetooth® RF analyzer (R&S®CMW-KM721 option)

<b>Frequency range</b>	Bluetooth®	2402 MHz to 2480 MHz
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<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, minimum, standard deviation

<b>Trigger</b>		
Trigger source		Bluetooth®: IF power

## Modulation analysis

<b>Filter</b>	filter bandwidth: wide (LE 2 Msymbol/s)	4.0 MHz bandpass
	filter bandwidth: wide (LE long range)	2.0 MHz bandpass
	filter bandwidth: narrow (LE 2 Msymbol/s)	2.6 MHz bandpass
	filter bandwidth: narrow (LE long range)	1.3 MHz bandpass
<b>Level range</b>		-35 dBm to +42 dBm <sup>43</sup>
<b>Supported packet types</b>		RF PHY Test Reference Packets

<sup>43</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Measured parameters</b>	numeric results and standard deviation (common)	frequency accuracy, frequency offset, initial frequency drift, frequency drift, max drift rate, frequency deviation $\Delta f_1$ average, frequency deviation $\Delta f_1$ minimum, frequency deviation $\Delta f_1$ maximum, nominal power
	numeric results and standard deviation (LE 2 Msymbol/s)	$\Delta f_2$ 99.9 % frequency deviation $\Delta f_2$ average, frequency deviation $\Delta f_2$ minimum, frequency deviation $\Delta f_2$ maximum,
	numeric results and standard deviation (LE long range)	$\Delta f_1$ 99.9 %

<b>Total measurement range for frequency accuracy, offset, deviation and drift measurements</b>	LE 2 Msymbol/s	$\pm 700$ kHz
	LE long range	$\pm 350$ kHz

<b>Frequency accuracy (using preamble)</b>		
Measurement range	for nominal deviation of 500 kHz (LE 2 Msymbol/s)	$\pm 175$ kHz
	for nominal deviation of 250 kHz (LE long range)	
Uncertainty	for deviation $\leq 500$ kHz (LE 2 Msymbol/s)	$< 2$ kHz
	for deviation $\leq 250$ kHz (LE long range)	

<b>Frequency offset</b>		
Measurement range	for nominal deviation of 500 kHz (LE 2 Msymbol/s)	$\pm 175$ kHz
	for nominal deviation of 250 kHz (LE long range)	
Uncertainty	for deviation $\leq 500$ kHz (LE 2 Msymbol/s)	$< 2$ kHz
	for deviation $\leq 250$ kHz (LE long range)	

<b>Frequency deviation</b>		
Measurement range	without frequency offset (LE 2 Msymbol/s)	$\leq 700$ kHz
	without frequency offset (LE long range)	$\leq 350$ kHz
Uncertainty	for modulation index 0.40 to 0.60	$< 0.5$ %

<b>Frequency drift</b>		
Measurement range		$\pm 75$ kHz
Uncertainty	measured in burst referenced to frequency offset in preamble	$< 2$ kHz
	referenced to measured frequency offset value in preamble (relative frequency drift)	$\leq 1$ kHz

**Bluetooth® signaling (prerequisite: R&S®CMW-KS600, R&S®CMW-KS610 options; prerequisite: R&S®CMW-KS611, R&S®CMW-KS721 options; prerequisite: R&S®CMW-KS601 option; prerequisite: R&S®CMW-B200A or R&S®CMW-B500I option)**

<b>Standard</b>		Bluetooth® Core Specification Version 5.0
<b>Frequency range</b>	channels 0 to 78 (basic rate, enhanced data rate)	2402 MHz to 2480 MHz
	channels 0 to 39 (low energy)	
<b>Output level range</b>	depends on PAR	
RF1 COM, RF2 COM	peak envelope power (PEP)	up to -5 dBm
	overranging (PEP)	up to 0 dBm
RF1 OUT	peak envelope power (PEP)	up to +3 dBm
	overranging (PEP)	up to +8 dBm
<b>Output level uncertainty</b>	including overranging	see general technical specifications
<b>Output level resolution</b>		see general technical specifications
<b>GFSK modulation</b>		
Modulation index uncertainty	basic rate, 11110000 pattern, 160 kHz frequency deviation	< 1 %
	low energy (1 Msymbol/s and long range), 11110000 pattern, 250 kHz frequency deviation	< 1 %
	low energy (2 Msymbol/s), 11110000 pattern, 500 kHz frequency deviation	< 1 %
<b>DPSK modulation</b>		
Modulation uncertainty (DEVM)	enhanced data rate	< 1.5 %, RMS
<b>Dirty TX</b>		
Drift uncertainty	prerequisites: R&S®CMW-KS610 or R&S®CMW-KS611	
	basic rate	< 0.5 kHz
	enhanced data rate	< 0.5 kHz
Symbol time error uncertainty	low energy	< 0.5 kHz
		same as timebase, see general technical specifications
<b>Input level range</b>	basic rate, enhanced data rate, low energy	-60 dBm to +42 dBm <sup>44</sup>

<sup>44</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

## GPS specifications

Standard		GPS
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### GPS RF generator (prerequisite: R&S®CMW-B110A/R&S®CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

Frequency range	GPS band	
	L1	1575.42 MHz
	L2	1227.6 MHz

### GPS WinIQSIM2™ (R&S®CMW-KW620 option)

Arbitrary waveform file		GPS_DEFAULT.WV (PAR = 3.66 dB)
Output level range	depends on PAR	see general technical specifications
Output level uncertainty	waveform file used: GPS_DEFAULT.WV	see general technical specifications
Output level resolution		see general technical specifications

## DVB specifications

Standard		DVB-T
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### DVB RF generator (prerequisite: R&S®CMW-B110A/R&S®CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

Frequency range	VHF band III	
	channels 5 to 12	174 MHz to 230 MHz
	UHF band IV	
	channels 21 to 34	470 MHz to 582 MHz
UHF band V		
	channels 35 to 69	582 MHz to 862 MHz

### DVB WinIQSIM2™ (R&S®CMW-KW630 option)

Arbitrary waveform file		DVB-T_SCRAMBLED_16QAM_3SEC_TESTFILE.WV (PAR = 13.23 dB)
Output level range	depends on PAR	see general technical specifications
Output level uncertainty	waveform file used: DVB-T_SCRAMBLED_16QAM_3SEC_TESTFILE.WV	see general technical specifications
Output level resolution		see general technical specifications



## FM STEREO RADIO specifications

Standard		FM STEREO RADIO
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### FM STEREO RADIO generator

(prerequisite: R&S®CMW-B110A/R&S®CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

Frequency range	FM	70 MHz to 110 MHz
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### FM STEREO RADIO waveforms (R&S®CMW-KV645 option)

Arbitrary waveform file		FM_M_M1K0_D75K0.WV (PAR = 0.00 dB)
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Output level range	depends on PAR	see general technical specifications
Output level uncertainty	waveform file used: FM_M_M1K0_D75K0.WV	see general technical specifications
Output level resolution		see general technical specifications

Signal quality	RMS detector *SQRT(2)	
Deviation error	waveform file used: FM_M_M1K0_D75K0.WV	< 1 %

## WLAN specifications with 40/80 MHz bandwidth unit

Standard		IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, IEEE 802.11n, IEEE 802.11ac
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### WLAN RF generator

(prerequisite: R&S®CMW-B110A or R&S®CMW-B110D option)

Frequency range	WLAN IEEE 802.11b/g/n (2.4 GHz band)	2412 MHz to 2484 MHz
	WLAN IEEE 802.11a/n (5 GHz band), prerequisite: R&S®CMW-KB036 option	5000 MHz to 6000 MHz

### WLAN ABG WinIQSIM2™ (R&S®CMW-KW650 option)

Arbitrary waveform files	in line with IEEE 802.11a/g OFDM 64QAM	WLAN_A_G_OFDM_64QAM.WV (PAR = 10.01 dB)
	in line with IEEE 802.11b CCK DQPSK	WLAN_B_CCK_DQPSK.WV (PAR = 1.48 dB)
	in line with IEEE 802.11n 64QAM, code rate 5/6	WLAN_N_64QAM_5_6.WV (PAR = 10.01 dB)

Output level range	depends on PAR	see general technical specifications
Output level uncertainty	waveform files used: WLAN_A_G_OFDM_64QAM.WV, WLAN_B_CCK_DQPSK.WV WLAN_N_64QAM_5_6.WV	see general technical specifications
Output level resolution		see general technical specifications

<b>Signal quality</b>		
Error vector magnitude (EVM)	IEEE 802.11b, EVM, waveform file used: WLAN_B_CCK_DQPSK.WV	< 4 %, peak
	IEEE 802.11a/g, EVM all carriers, waveform file used: WLAN_A_G_OFDM_64QAM.WV	< -40 dB, RMS
	IEEE 802.11n, EVM all carriers, waveform file used: WLAN_N_64QAM_5_6.WV	< -40 dB, RMS

### WLAN AC WinIQSIM2™ (R&S®CMW-KW656 option)

Arbitrary waveform files	in line with IEEE 802.11ac 256QAM, 20 MHz, code rate 3/4	WLAN_VHT_BW20_MCS8_LEN4096.WV (PAR = 9.57 dB)
	in line with IEEE 802.11ac 256QAM, 40 MHz, code rate 3/4	WLAN_VHT_BW40_MCS8_LEN4096.WV (PAR = 11.22534 dB)
	in line with IEEE 802.11ac 256QAM, 80 MHz, code rate 3/4	WLAN_VHT_BW80_MCS8_LEN4096.WV (PAR = 10.23565 dB)

Output level range	depends on PAR	see general technical specifications
Output level uncertainty	waveform files used: WLAN_VHT_BW20_MCS8_LEN4096.WV WLAN_VHT_BW40_MCS8_LEN4096.WV WLAN_VHT_BW80_MCS8_LEN4096.WV	see general technical specifications
Output level resolution		see general technical specifications

<b>Signal quality</b>		
Error vector magnitude (EVM)	IEEE 802.11ac, EVM all carriers, waveform file used: WLAN_VHT_BW20_MCS8_LEN4096.WV	< -40 dB, RMS
	WLAN_VHT_BW40_MCS8_LEN4096.WV	< -40 dB, RMS
	WLAN_VHT_BW80_MCS8_LEN4096.WV	< -37 dB, RMS

### WLAN ABG RF analyzer (R&S®CMW-KM650 option)

Frequency range	WLAN IEEE 802.11b/g	2412 MHz to 2484 MHz
	WLAN IEEE 802.11a, prerequisite: R&S®CMW-KB036 option	5000 MHz to 6000 MHz, for frequency exceptions for inherent spurious response, see general technical specifications

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, standard deviation

<b>Trigger</b>		
Trigger sources		WLAN: free run, WLAN: IF power

### Modulation analysis

Filter		20 MHz
Level range		-28 dBm to +42 dBm <sup>45</sup>
Payload length		≥ 16 symbol
Analysis modes	DSSS	1 Mbps DBPSK, 2 Mbps DQPSK, 5.5 Mbps CCK, 11 Mbps CCK

<sup>45</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

	OFDM	6 Mbps BPSK, 9 Mbps BPSK, 12 Mbps QPSK, 18 Mbps QPSK, 24 Mbps 16QAM, 36 Mbps 16QAM, 48 Mbps 64QAM, 54 Mbps 64QAM
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<b>Measured parameters</b>	DSSS, numeric results and standard deviation	burst power, error vector magnitude (EVM) peak, error vector magnitude (EVM) RMS, center frequency error, chip clock error, I/Q offset, gain imbalance, quadrature error
	DSSS, graphical	EVM versus chip, I/Q constellation
	OFDM, numeric results and standard deviation	burst power, EVM all carriers, EVM data carriers, EVM pilot carriers, center frequency error, symbol clock error, I/Q offset, gain imbalance, quadrature error
	OFDM, graphical	EVM versus symbol, EVM versus carrier, I/Q constellation, spectrum flatness

<b>Error vector magnitude (EVM)</b>		
Inherent EVM <sup>46</sup>	DSSS, IEEE 802.11b/g	< 5 %, peak < 2 %, RMS
	OFDM, IEEE 802.11g	< -40 dB, RMS
	OFDM, IEEE 802.11a	< -40 dB, RMS <sup>48</sup>
	-18 dBm ≤ input level ≤ +42 dBm <sup>47</sup> , RMS	< -40 dB, RMS <sup>48</sup>
Measurement length	DSSS	1000 samples
	OFDM	entire PPDU

<b>Center frequency error</b>		
Frequency measurement uncertainty	DSSS, IEEE 802.11b/g	< 20 Hz + drift of timebase, see general technical specifications
	OFDM, IEEE 802.11g, for ≥ 100 symbol (400 μs)	< 20 Hz + drift of timebase, see general technical specifications
	OFDM, IEEE 802.11a, for ≥ 100 symbol (400 μs)	< 35 Hz + drift of timebase, see general technical specifications

<b>Chip clock error</b>	DSSS	
Uncertainty		< 1 ppm

<b>Symbol clock error</b>	OFDM	
Uncertainty		< 1 ppm

<b>I/Q offset</b>		
Inherent I/Q offset	DSSS, for average ≥ 10 measurements	< -50 dB
	OFDM, for average ≥ 10 measurements	< -45 dB

<sup>46</sup> Measured with channel estimation based on payload.

<sup>47</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>48</sup> 3 dB less with R&S®CMW-H590D RF frontend (ADV.).

<b>Spectrum flatness</b>		
Level uncertainty	OFDM, IEEE 802.11g (2.4 GHz band)	< 0.5 dB
	OFDM, IEEE 802.11a (5 GHz band)	< 0.8 dB

## Spectrum measurements

<b>Transmit spectrum mask</b>		
Frequency span		80 MHz
Dynamic range	DSSS	in line with IEEE 802.11b
	OFDM	in line with IEEE 802.11a/g
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	
	IEEE 802.11g (2.4 GHz band)	+2 dBm to +42 dBm <sup>49</sup>
	IEEE 802.11a (5 GHz band)	+12 dBm to +42 dBm <sup>49</sup>

## WLAN N RF analyzer (R&S®CMW-KM651 option)

<b>Frequency range</b>	WLAN IEEE 802.11n (2.4 GHz band)	2412 MHz to 2484 MHz
	WLAN IEEE 802.11n (5 GHz band), prerequisite: R&S®CMW-KB036 option	5000 MHz to 6000 MHz, for frequency exceptions for inherent spurious response, see general technical specifications

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, standard deviation

<b>Trigger</b>		
Trigger sources		WLAN: free run, WLAN: IF power

<b>High throughput (HT)</b>		
PPDU format		legacy mode, mixed mode, greenfield mode

## Modulation analysis

<b>Bandwidth</b>		20 MHz, 40 MHz
<b>Level range</b>		-28 dBm to +42 dBm <sup>49</sup>
<b>Payload length</b>		≥ 16 symbol
<b>Analysis modes</b>		BPSK code rate 1/2 (MCS0), BPSK code rate 3/4, QPSK code rate 1/2 (MCS1), QPSK code rate 3/4 (MCS2), 16QAM code rate 1/2 (MCS3), 16QAM code rate 3/4 (MCS4), 64QAM code rate 1/2, 64QAM code rate 2/3 (MCS5), 64QAM code rate 3/4 (MCS6), 64QAM code rate 5/6 (MCS7)
	for optional 40 MHz MCS format	BPSK code rate 1/2 (MCS32)

<b>Measured parameters</b>	numeric results and standard deviation	burst power, EVM all carriers, EVM data carriers, EVM pilot carriers, center frequency error, symbol clock error, I/Q offset, gain imbalance, quadrature error
	graphical	EVM versus symbol, EVM versus carrier, spectrum flatness

<sup>49</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Error vector magnitude (EVM)</b>		
Inherent EVM <sup>50</sup>	IEEE 802.11n (2.4 GHz band)	
	-28 dBm ≤ input level ≤ +42 dBm <sup>51</sup> , RMS	< -40 dB, RMS <sup>52</sup>
	IEEE 802.11n (5 GHz band)	
	-18 dBm ≤ input level ≤ +42 dBm <sup>51</sup> , RMS	< -40 dB, RMS <sup>52</sup>
Measurement length		entire PPDU
<b>Center frequency error</b>		
Frequency measurement uncertainty	IEEE 802.11n (2.4 GHz band), for ≥ 100 symbol (400 μs)	< 20 Hz + drift of timebase, see general technical specifications
	IEEE 802.11n (5 GHz band), for ≥ 100 symbol (400 μs)	< 35 Hz + drift of timebase, see general technical specifications
<b>Symbol clock error</b>		
Uncertainty		< 1 ppm
<b>I/Q offset</b>		
Inherent I/Q offset	for average ≥ 10 measurements	< -45 dB
<b>Spectrum flatness</b>		
Level uncertainty	IEEE 802.11n (2.4 GHz band)	
	bandwidth 20 MHz	< 0.5 dB
	bandwidth 40 MHz	< 0.8 dB
	IEEE 802.11n (5 GHz band)	
	bandwidth 20 MHz	< 0.8 dB
	bandwidth 40 MHz	< 1.0 dB

## Spectrum measurements

<b>Transmit spectrum mask</b>		
Frequency span		up to 160 MHz
Dynamic range		in line with IEEE 802.11n
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	
	IEEE 802.11n (2.4 GHz band)	+2 dBm to +42 dBm <sup>51</sup>
	IEEE 802.11n (5 GHz band)	+12 dBm to +42 dBm <sup>51</sup>

## WLAN N MISO RF analyzer (R&S®CMW-KM652 option)

<b>Frequency range</b>	WLAN IEEE 802.11n (2.4 GHz band) WLAN IEEE 802.11n (5 GHz band), prerequisite: R&S®CMW-KB036 option	2412 MHz to 2484 MHz 5000 MHz to 6000 MHz, for frequency exceptions for inherent spurious response, see general technical specifications
<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, standard deviation
<b>Trigger</b>		
Trigger sources		WLAN: IF power
<b>High throughput</b>		
PPDU format		mixed mode, greenfield mode

<sup>50</sup> Measured with channel estimation based on payload.

<sup>51</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>52</sup> 3 dB less with R&S®CMW-H590D RF frontend (ADV.).

**Modulation analysis**

<b>Bandwidth</b>		20 MHz, 40MHz
<b>Level range</b>		-28 dBm to +42 dBm <sup>53</sup>
<b>Payload length</b>		≥ 16 symbol (max. 1024)
<b>Analysis modes</b> <sup>54</sup>		MCS0 to MCS7: data and pilot, MCS8 to MCS31: pilot only, MCS33 to MCS76: pilot only
<b>Measured parameters</b>	numeric results and standard deviation	total power, STS1 to STS4 power, EVM all carriers, EVM data carriers, EVM pilot carriers, center frequency error

<b>Error vector magnitude (EVM)</b>		
Inherent EVM <sup>55</sup>	IEEE 802.11n (2.4 GHz band) -28 dBm ≤ input level ≤ +42 dBm <sup>53</sup> , RMS	< -40 dB, RMS <sup>56</sup>
	IEEE 802.11n (5 GHz band) -18 dBm ≤ input level ≤ +42 dBm <sup>53</sup> , RMS	< -40 dB, RMS <sup>56</sup>
Measurement length		entire PPDU

<b>Center frequency error</b>		
Frequency measurement uncertainty	IEEE 802.11n (2.4 GHz band), for ≥ 100 symbol (400 μs)	< 20 Hz + drift of timebase, see general technical specifications
	IEEE 802.11n (5 GHz band), for ≥ 100 symbol (400 μs)	< 35 Hz + drift of timebase, see general technical specifications

**WLAN N switched MIMO RF analyzer (R&S<sup>®</sup>CMW-KM653 option)**

<b>Frequency range</b>	WLAN IEEE 802.11n (2.4 GHz band)	2412 MHz to 2484 MHz
	WLAN IEEE 802.11n (5 GHz band), prerequisite: R&S <sup>®</sup> CMW-KB036 option	5000 MHz to 6000 MHz, for frequency exceptions for inherent spurious response, see general technical specifications

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, standard deviation

<b>Trigger</b>		
Trigger sources		WLAN: IF power

<b>High throughput (HT)</b>		
PPDU format		mixed mode, greenfield mode

**Modulation analysis**

<b>Bandwidth</b>		20 MHz, 40 MHz
<b>Level range</b>		-28 dBm to +42 dBm <sup>53</sup>
<b>Payload length</b>		≥ 16 symbol

<sup>53</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>54</sup> Modulation analysis on data possible after initial acquisition of training data.

<sup>55</sup> Measured with channel estimation based on payload.

<sup>56</sup> 3 dB less with R&S<sup>®</sup>CMW-H590D RF frontend (ADV.).

<b>Analysis modes</b>		BPSK code rate 1/2 (MCS0), BPSK code rate 3/4, QPSK code rate 1/2 (MCS1), QPSK code rate 3/4 (MCS2), 16QAM code rate 1/2 (MCS3), 16QAM code rate 3/4 (MCS4), 64QAM code rate 1/2, 64QAM code rate 2/3 (MCS5), 64QAM code rate 3/4 (MCS6), 64QAM code rate 5/6 (MCS7)
	for optional 40 MHz MCS format	BPSK code rate 1/2 (MCS32)
<b>Measured parameters</b>	numeric results and standard deviation	total power, EVM all carriers, EVM data carriers, EVM pilot carriers, center frequency error, symbol clock error,
	numeric results for each spatial stream	EVM all carriers, EVM data carriers, EVM pilot carriers power I/Q offset

## WLAN P RF analyzer (R&S®CMW-KM655 option)

<b>Frequency range</b>	WLAN IEEE 802.11p, prerequisite: R&S®CMW-KB036 option	5000 MHz to 6000 MHz, for frequency exceptions for inherent spurious response, see general technical specifications
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<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, standard deviation

<b>Trigger</b>		
Trigger sources		WLAN: IF power

## Modulation analysis

<b>Filter</b>		5 MHz, 10 MHz, 20 MHz
<b>Level range</b>		-28 dBm to +42 dBm <sup>57</sup>
<b>Payload length</b>		≥ 16 symbol
<b>Analysis modes</b>	OFDM 5 MHz channel spacing	1.5 Mbps BPSK, 2.25 Mbps BPSK, 3 Mbps QPSK, 4.5 Mbps QPSK, 6 Mbps 16QAM, 9 Mbps 16QAM, 12 Mbps 64QAM, 13.5 Mbps 64QAM
	OFDM 10 MHz channel spacing	3 Mbps BPSK, 4.5 Mbps BPSK, 6 Mbps QPSK, 9 Mbps QPSK, 12 Mbps 16QAM, 18 Mbps 16QAM, 24 Mbps 64QAM, 27 Mbps 64QAM

<sup>57</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

	OFDM 20 MHz channel spacing	6 Mbps BPSK, 9 Mbps BPSK, 12 Mbps QPSK, 18 Mbps QPSK, 24 Mbps 16QAM, 36 Mbps 16QAM, 48 Mbps 64QAM, 54 Mbps 64QAM
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<b>Measured parameters</b>	OFDM, numeric results and standard deviation	burst power, EVM all carriers, EVM data carriers, EVM pilot carriers, center frequency error, symbol clock error, I/Q offset, gain imbalance, quadrature error
	OFDM, graphical	EVM versus symbol, EVM versus carrier, I/Q constellation, spectrum flatness

<b>Error vector magnitude (EVM)</b>		
Inherent EVM <sup>58</sup>	-18 dBm ≤ input level ≤ +42 dBm <sup>59</sup> , RMS	< -40 dB, RMS <sup>60</sup>
Measurement length		entire PPDU

<b>Center frequency error</b>		
Frequency measurement uncertainty	for ≥ 100 symbol (400 μs)	< 35 Hz + drift of timebase, see general technical specifications

<b>Symbol clock error</b>		
Uncertainty		< 1 ppm

<b>I/Q offset</b>		
Inherent I/Q offset	for average ≥ 10 measurements	< -45 dB

<b>Spectrum flatness</b>		
Level uncertainty		< 0.8 dB

## Spectrum measurements

<b>Transmit spectrum mask</b>		
Frequency span		up to 80 MHz
Dynamic range		in line with IEEE 802.11p up to class B
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	+12 dBm to +42 dBm <sup>59</sup>

## WLAN AC RF analyzer (R&S®CMW-KM656 option)

<b>Frequency range</b>	WLAN IEEE 802.11ac (5 GHz band), prerequisite: R&S®CMW-KB036 option	5000 MHz to 6000 MHz, for frequency exceptions for inherent spurious response, see general technical specifications
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<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, standard deviation

<b>Trigger</b>		
Trigger sources		WLAN: IF power

<sup>58</sup> Measured with channel estimation based on payload.

<sup>59</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>60</sup> 3 dB less with R&S®CMW-H590D RF frontend (ADV.).



<b>High throughput (HT)</b>		
PPDU format		mixed mode

## Modulation analysis

<b>Bandwidth</b>		20 MHz, 40 MHz, 80 MHz, 80+80 MHz, 160 MHz
<b>Level range</b>		-28 dBm to +42 dBm <sup>61</sup>
<b>Payload length</b>		≥ 1 symbol
<b>Analysis modes</b>		BPSK code rate 1/2 (MCS0), BPSK code rate 3/4, QPSK code rate 1/2 (MCS1), QPSK code rate 3/4 (MCS2), 16QAM code rate 1/2 (MCS3), 16QAM code rate 3/4 (MCS4), 64QAM code rate 1/2, 64QAM code rate 2/3 (MCS5), 64QAM code rate 3/4 (MCS6), 64QAM code rate 5/6 (MCS7) 256QAM code rate 3/4 (MCS8) 256QAM code rate 5/6 (MCS9)

<b>Measured parameters</b>	numeric results and standard deviation	burst power, EVM all carriers, EVM data carriers, EVM pilot carriers, center frequency error, symbol clock error, I/Q offset
	graphical	EVM versus symbol, spectrum flatness, I/Q constellation, transmit spectrum mask

<b>Error vector magnitude (EVM)</b>		
Inherent EVM <sup>62</sup>	bandwidth 20 MHz, 40 MHz, 80 MHz -18 dBm ≤ input level ≤ +42 dBm <sup>61</sup> , RMS	< -38 dB, RMS <sup>63</sup>
	bandwidth 160 MHz -15 dBm ≤ input level ≤ +42 dBm <sup>61</sup> , RMS	typ. < -38 dB, RMS <sup>63</sup>
	Measurement length	entire PPDU

<b>Center frequency error</b>		
Frequency measurement uncertainty	for ≥ 100 symbol (400 μs)	< 35 Hz + drift of timebase, see general technical specifications

<b>Symbol clock error</b>		
Uncertainty	for ≥ 100 symbol (400 μs)	< 1 ppm

<b>I/Q offset</b>		
Inherent I/Q offset	for average ≥ 10 measurements	< -45 dB

<b>Spectrum flatness</b>		
Level uncertainty	bandwidth 20 MHz	< 0.8 dB
	bandwidth 40 MHz	< 1.0 dB
	bandwidth 80 MHz	< 1.5 dB
	bandwidth 160 MHz	typ. < 1.5 dB

<sup>61</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>62</sup> Measured with channel estimation based on payload.

<sup>63</sup> 3 dB less with R&S®CMW-H590D RF frontend (ADV.).

**Spectrum measurements**

<b>Transmit spectrum mask</b>		
Frequency span		up to 640 MHz
Dynamic range		in line with IEEE 802.11ac
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	+12 dBm to +42 dBm <sup>64</sup>

**WLAN signaling access point emulator**  
**(prerequisite: R&S®CMW-KS650, R&S®CMW-KS651, R&S®CMW-B200A options, R&S®CMW-B270A or R&S®CMW-B500I option)**

<b>Standard</b>		IEEE 802.11a, g (OFDM), n
<b>Physical layer mode</b>		OFDM

<b>Frequency range</b>	WLAN IEEE 802.11n (2.4 GHz band), WLAN IEEE 802.11g (OFDM), (2.4 GHz band)	2412 MHz to 2484 MHz
	WLAN IEEE 802.11a (5 GHz band), WLAN IEEE 802.11n (5 GHz band), prerequisite: R&S®CMW-KB036 option	5180 MHz to 5825 MHz

<b>Output level range</b>		
RF1 COM, RF2 COM	2.4 GHz band	burst power (RMS) up to -16 dBm
	5 GHz band	burst power (RMS) up to -26 dBm burst power (RMS) up to -16 dBm (overranging)
RF1 OUT	2.4 GHz band	burst power (RMS) up to -3 dBm
	5 GHz band	burst power (RMS) up to -13 dBm burst power (RMS) up to -3 dBm (overranging)
<b>Output level uncertainty</b>		see general technical specifications
<b>Output level resolution</b>		see general technical specifications

<b>Modulation accuracy (EVM)</b>	2.4 GHz band	< -38 dB
	5 GHz band	< -38 dB
<b>Minimum input level</b>	RF1 COM, RF2 COM	down to -40 dBm

**Physical layer OFDM**

<b>FFT size</b>		64
<b>Bandwidth</b>		20 MHz
<b>Cyclic prefix</b>		800 ns
<b>Physical layer mode</b>		SISO
<b>Modulation</b>	IEEE 802.11a, g (OFDM)	BPSK, QPSK, 16QAM, 64QAM (bit rate: 6/9/12/18/24/36/48/54 Mbps)
	IEEE 802.11n	MCS 0 to 7
<b>Channel coding</b>		BCC

**Measurements**

<b>PER</b>		
Measurement range	graphically displayed, stop on limit fail	0 % to 100 %
Payload mode		data interval, payload size
Acknowledge type		ACK
Data	DL	all 0s, all 1s, bit pattern: 0101, bit pattern: 1010, pseudorandom, PN9 to PN32
<b>Mobile capabilities</b>		MAC address, MAC version

<sup>64</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

## Features

<b>Connection status</b>	status indication	signal on, associated, authenticated, probed, deauthenticated
<b>Trigger output</b>	WLAN signaling: frame trigger	adjustable pulse width, invertible
	WLAN signaling: RX trigger	invertible

## WLAN specifications with 160 MHz bandwidth unit

### WLAN RF generator

<b>Standards</b>	IEEE 802.11a/g/p/n OFDM	R&S®CMW-KW650 option
	IEEE 802.11b/g DSSS	R&S®CMW-KW650 option
	IEEE 802.11ac	R&S®CMW-KW656 option
	IEEE 802.11ax	R&S®CMW-KW657 option

<b>Bandwidth</b>		up to 160 MHz
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<b>Frequency range</b>	2.4 GHz band, IEEE 802.11b/g/p/n	2412 MHz to 2484 MHz
	5 GHz band, IEEE 802.11a/n/ac/ax, prerequisite: R&S®CMW-KB036 option	5000 MHz to 6000 MHz

<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>		see general technical specifications
<b>Output level resolution</b>		see general technical specifications

<b>Signal quality</b>		
<b>Error vector magnitude (EVM)</b>	IEEE 802.11 a/g/p/n/ac	
	bandwidth: 5 MHz	< -42 dB RMS
	bandwidth: 10 MHz, 20 MHz, 40 MHz	< -44 dB RMS
	bandwidth: 80 MHz, 80+80 MHz	< -42 dB RMS
	bandwidth: 160 MHz	< -40 dB RMS
	IEEE 802.11 ax	
	bandwidth: 20 MHz, 40 MHz	< -42 dB RMS
	bandwidth: 80 MHz, 80+80 MHz	< -40 dB RMS
	bandwidth: 160 MHz	< -38 dB RMS
	IEEE 802.11 b/g DSSS	< 4 %, peak
<b>Prerequisites</b>	channel estimation (OFDM)	based on payload

<b>Arbitrary waveform files</b>	IEEE 802.11a/g OFDM	WLAN_A_G_OFDM_64QAM.WV (PAR = 10.01 dB)
	IEEE 802.11b DSSS	WLAN_B_CCK_DQPSK.WV (PAR = 1.48 dB)
	IEEE 802.11n	WLAN_N_64QAM_5_6.WV (PAR = 10.01 dB)
	IEEE 802.11ac 20 MHz	WLAN_VHT_BW20_MCS8_LEN4096.WV (PAR = 9.57 dB)
	IEEE 802.11ac 40 MHz	WLAN_VHT_BW40_MCS8_LEN4096.WV (PAR = 11.23 dB)
	IEEE 802.11ac 80 MHz	WLAN_VHT_BW80_MCS8_LEN4096.WV (PAR = 10.24 dB)
	IEEE 802.11ac 160 MHz	WLAN_VHT_BW160_MCS9_SYM20.WV (PAR = 10.45 dB)
	IEEE 802.11ax 20 MHz	WLAN_HE_SU_BW20_4xLTF_GI32_ MCS11_SYM16.WV (PAR = 9.59 dB)

	IEEE 802.11ax 40 MHz	WLAN_HE_SU_BW40_4xLTF_GI32_MCS11_SYM16.WV (PAR = 9.89 dB)
	IEEE 802.11ax 80 MHz	WLAN_HE_SU_BW80_4xLTF_GI32_MCS11_SYM16.WV (PAR = 9.88 dB)
	IEEE 802.11ax 160 MHz	WLAN_HE_SU_BW160_4xLTF_GI32_MCS11_SYM16.WV (PAR = 11.03 dB)

## WLAN OFDM RF analyzer

<b>Standards</b>	IEEE 802.11a/g	R&S®CMW-KM650 option
	IEEE 802.11n	R&S®CMW-KM651 option
	IEEE 802.11p	R&S®CMW-KM655 option
	IEEE 802.11ac	R&S®CMW-KM656 option
	IEEE 802.11ax	R&S®CMW-KM657 option

<b>Receive modes</b>	SISO	requires above options for standards
	composite MIMO	R&S®CMW-KM652 option

<b>Bandwidth</b>	IEEE 802.11a/g	20 MHz
	IEEE 802.11n	20 MHz, 40 MHz
	IEEE 802.11p	5 MHz, 10 MHz, 20 MHz
	IEEE 802.11ac	20 MHz, 40 MHz, 80 MHz, 80+80 MHz, 160 MHz
	IEEE 802.11ax	20 MHz, 40 MHz, 80 MHz, 160 MHz
		80+80 MHz can be measured simultaneously on same or on separate antenna ports with any channel spacing

<b>Frequency range</b>	2.4 GHz band, IEEE 802.11g/p/n	2412 MHz to 2484 MHz
	5 GHz band, IEEE 802.11a/n/ac/ax, prerequisite: R&S®CMW-KB036 option	5000 MHz to 6000 MHz, for frequency exceptions for inherent spurious response, see general technical specifications

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, minimum, standard deviation

<b>Trigger</b>		
Trigger sources		WLAN: IF power, BASE: external TRIG A, BASE: external TRIG B, GPRF: gen

## Modulation analysis

<b>Level range</b>		-28 dBm to +42 dBm <sup>65</sup>
<b>Payload length</b>		1 to 1377 data symbols
<b>Modulations</b>		BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM
<b>Burst types</b>	IEEE 802.11a/g/p	non HT
	IEEE 802.11n	HT mixed-format, HT Greenfield
	IEEE 802.11ac	VHT mixed-format
	IEEE 802.11ax	HE single user (HE_SU), HE trigger-based (HE_TRIG) HE multiuser (HE_MU)
<b>MIMO</b>	switched and composite	up to 8 x 8

<sup>65</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Measured results</b>	scalar SISO results	burst and signal field information, burst power, peak power, crest factor, EVM all carriers, EVM data carriers, EVM pilot carriers, center frequency error, symbol clock error, I/Q offset, DC power, gain imbalance, quadrature error timing error
	graphical SISO results	EVM versus symbol, EVM versus carrier, I/Q constellation, spectrum flatness, power versus time
	composite MIMO results	EVM all carriers, EVM data carriers, EVM pilot carriers, total power, total peak power, power per space time stream, center frequency error symbol clock error

<b>Error vector magnitude (EVM)</b>		
Inherent EVM (RMS)	IEEE 802.11 a/g/p/n/ac	
	bandwidth: 5 MHz	< -44 dB
	bandwidth: 10 MHz, 20 MHz, 40 MHz	< -46 dB
	bandwidth: 80 MHz, 80+80 MHz	< -44 dB
	bandwidth: 160 MHz	< -42 dB

	IEEE 802.11 ax	
	bandwidth: 20 MHz, 40 MHz	< -44 dB
	bandwidth: 80 MHz, 80+80 MHz	< -42 dB
	bandwidth: 160 MHz	< -40 dB
Prerequisites	expected nominal power setting	≥ -8 dBm for 2.4 GHz band ≥ +2 dBm for 5 GHz band
	channel estimation	based on payload
	burst length	> 16 symbols
	average	> 20 packets

<b>Center frequency error</b>		
Frequency measurement uncertainty	2.4 GHz band	< 20 Hz + drift of timebase, see general technical specifications
	5 GHz band	< 35 Hz + drift of timebase, see general technical specifications
Prerequisites	measurement length	≥ 100 symbols

<b>Symbol clock error</b>		
Uncertainty		< 1 ppm

<b>I/Q offset</b>		
Inherent I/Q offset	for average ≥ 10 measurements	< -45 dB

<b>Spectrum flatness</b>		
Level uncertainty	bandwidth: 5 MHz, 10 MHz, 20 MHz	≤ 0.8 dB
	bandwidth: 40 MHz, 80 MHz, 160 MHz	≤ 1.0 dB

**Spectrum measurements**

<b>Transmit spectrum mask</b>		
Frequency span	4 x of used WLAN bandwidth	40 MHz to 640 MHz
Limit masks		IEEE, ETSI, ARIB
Resolution bandwidth	IEEE, ARIB	100 kHz
	ETSI	1 MHz
Dynamic range		in line with IEEE standard
Expected nominal power setting for full dynamic range	2.4 GHz band	+2 dBm to +42 dBm <sup>66</sup>
	5 GHz band	+12 dBm to +42 dBm <sup>66</sup>

**WLAN DSSS RF analyzer**

<b>Standards</b>	IEEE 802.11b/g	R&S®CMW-KM650 option
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<b>Frequency range</b>	2.4 GHz band	2412 MHz to 2484 MHz
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<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, maximum, standard deviation

<b>Trigger</b>		
Trigger sources		WLAN: IF power, BASE: external TRIG A, BASE: external TRIG B, GPRF: gen

**Modulation analysis**

<b>Level range</b>		-28 dBm to +42 dBm <sup>66</sup>
<b>Payload length</b>		1000 to 362472 chips
<b>Modulations</b>		1 Mbps DBPSK, 2 Mbps DQPSK, 5.5 Mbps CCK, 11 Mbps CCK

<b>Measured parameters</b>	scalar results	burst and signal field information, burst power, EVM peak, EVM RMS, center frequency error, chip clock error, I/Q offset, gain imbalance, quadrature error, rise/fall time
	graphical results	EVM versus chip, I/Q constellation, power versus time

<b>Error vector magnitude (EVM)</b>		
Inherent EVM		< 5 %, peak
		< 2 %, RMS
Prerequisites	input level	-18 dBm ≤ input level ≤ +42 dBm <sup>66</sup> , RMS
	measurement length	1000 chips

<b>Center frequency error</b>		
Frequency measurement uncertainty		< 20 Hz + drift of timebase, see general technical specifications

<b>Chip clock error</b>		
Uncertainty		< 1 ppm

<sup>66</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>I/Q offset</b>		
Inherent I/Q offset	OFDM, for average $\geq 10$ measurements	$< -45$ dB

### Spectrum measurements

<b>Transmit spectrum mask</b>		
Frequency span		80 MHz
Resolution bandwidth	IEEE	100 kHz
Dynamic range		in line with IEEE standard
Limit masks		IEEE
Expected nominal power setting for full dynamic range		+2 dBm to +42 dBm <sup>67</sup>

### WLAN signaling access point emulator / station emulator (prerequisite: R&S®CMW-B500I option)

<b>Standard</b>	WLAN IEEE 802.11a, b, g	R&S®CMW-KS650 option
	WLAN IEEE 802.11n	R&S®CMW-KS651 option
	WLAN IEEE 802.11ac	R&S®CMW-KS656 option
	WLAN IEEE 802.11ax (AP emulator only)	Option: R&S®CMW-KS657
<b>Physical layer mode</b>		DSS, OFDM, OFDMA

<b>Frequency range</b>	WLAN IEEE 802.11b, g, WLAN IEEE 802.11n (mixed format only)	2412 MHz to 2484 MHz
	WLAN IEEE 802.11a, WLAN IEEE 802.11n (mixed format only), WLAN IEEE 802.11ac, WLAN IEEE 802.11ax, prerequisite: R&S®CMW-KB036 option	5180 MHz to 5825 MHz

<b>Output level range</b>		
RF1 COM, RF2 COM	2.4 GHz band	burst power (RMS) up to $-16$ dBm
	5 GHz band, prerequisite: R&S®CMW-KB036 option	burst power (RMS) up to $-26$ dBm burst power (RMS) up to $-16$ dBm (overranging)
RF1 OUT	2.4 GHz band	burst power (RMS) up to $-3$ dBm
	5 GHz band, prerequisite: R&S®CMW-KB036 option	burst power (RMS) up to $-13$ dBm burst power (RMS) up to $-3$ dBm (overranging)
<b>Output level uncertainty</b>		see general technical specifications
<b>Output level resolution</b>		see general technical specifications
<b>Modulation accuracy (EVM)</b>	IEEE 802.11 ac, 80 MHz bandwidth	$< -38$ dB
<b>Minimum input level</b>	RF1 COM, RF2 COM	down to $-40$ dBm

### Physical layer OFDM

<b>Bandwidth</b>	WLAN IEEE 802.11a	20 MHz
	WLAN IEEE 802.11n (mixed format only)	20 MHz, 40 MHz
	WLAN IEEE 802.11ac	20 MHz, 40 MHz, 80 MHz, 160 MHz <sup>68</sup>
	WLAN IEEE 802.11ax	20 MHz, 40 MHz, 80 MHz
<b>Physical layer mode</b>		SISO
<b>Modulation</b>	IEEE 802.11a, g (OFDM)	BPSK, QPSK, 16QAM, 64QAM (bit rate: 6/9/12/18/24/36/48/54 Mbps)
	IEEE 802.11n (mixed format only)	MCS 0 to 7
	IEEE 802.11ac	MCS 0 to 9
	IEEE 802.11ax	MCS 0 to 11
<b>Channel coding</b>		BCC, LDPC for IEEE 802.11ax

### Measurements

<b>PER</b>		
Measurement range	graphically displayed, stop on limit fail	0 % to 100 %
Payload mode		data interval, payload size

<sup>67</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>68</sup> The signal phase of the two 80 MHz frequency segments shall be correlated.

Acknowledge type		ACK
Data	DL	all 0s, all 1s, bit pattern: 0101, bit pattern: 1010, pseudorandom, PN9 to PN32

## Features

Connection status	status indication	signal on, associated, authenticated, probed, deauthenticated
Trigger output	WLAN signaling: frame trigger	adjustable pulse width, invertible
	WLAN signaling: RX trigger	invertible

## LR-WPAN specifications

Standard	low-rate wireless personal area networks	IEEE 802.15.4™ - 2011
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## LR-WPAN RF generator

Frequency range	2450 MHz O-QPSK PHY	2405 MHz to 2480 MHz
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### LR-WPAN waveforms (R&S®CMW-KV680 option)

Arbitrary waveform file	2450 MHz O-QPSK PHY	LRWPAN_2450MHz_OQPSK_127Bytes_PRBS9.WV (PAR = 0.06 dB)
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Output level range	depending on PAR	see general technical specifications
Output level uncertainty	waveform file used: LRWPAN_2450MHz_OQPSK_127Bytes_PRBS9.WV	see general technical specifications
Output level resolution		see general technical specifications

Signal quality		
Offset error vector magnitude	measured over the PHY service data unit (PSDU), waveform files used: LRWPAN_2450MHz_OQPSK_127Bytes_PRBS9.WV	< 2 %, RMS

### LR-WPAN RF analyzer (R&S®CMW-KM680 option)

Frequency range	2450 MHz O-QPSK PHY	2405 MHz to 2480 MHz
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Statistics		
Statistical count		1 to 1000
Values		current, average, maximum, minimum, standard deviation

Trigger		
Trigger sources		LRWPAN: IF power



**Modulation analysis**

<b>Level range</b>		-35 dBm to +42 dBm <sup>69</sup>
<b>Supported PHYs</b>		2450 MHz O-QPSK PHY
<b>Measured parameters</b>	2450 MHz O-QPSK PHY	frequency accuracy, symbol rate error, offset RMS EVM PSDU, offset peak EVM PSDU
<b>Frequency accuracy</b>	2450 MHz O-QPSK PHY	
<b>Measurement range</b>		±800 kHz
<b>Uncertainty</b>		< 20 Hz + drift of timebase, see general technical specifications
<b>Offset EVM PSDU</b>	2450 MHz O-QPSK PHY	
<b>Inherent EVM</b>	for PRBS pattern	< 2 %, RMS

**TD-SCDMA specifications – mobile station (UE) test <sup>70</sup>**

<b>Standard</b>		TD-SCDMA CWTS
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**TD-SCDMA RF generator**

(prerequisite: R&S<sup>®</sup>CMW-B110A/R&S<sup>®</sup>CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

<b>Frequency range <sup>71</sup></b>	TD-SCDMA band A channels 10054 to 10121	2010.8 MHz to 2024.2 MHz
	TD-SCDMA band E channels 11504 to 11996	2300.8 MHz to 2399.2 MHz
	TD-SCDMA band F channels 9404 to 9596	1880.8 MHz to 1919.2 MHz

**TD-SCDMA WinIQSIM2™ (R&S<sup>®</sup>CMW-KW750 option) and TD-SCDMA ENH. WinIQSIM2™ (R&S<sup>®</sup>CMW-KW751 option)**

<b>Arbitrary waveform files</b>	with the R&S <sup>®</sup> CMW-KW750 option	TD-SCDMA_DEFAULT.WV (PAR = 3.14 dB), TD-SCDMA_PTWLOW.WV (PAR = 2.67 dB)
	with the R&S <sup>®</sup> CMW-KW750 and R&S <sup>®</sup> CMW-KW751 options	TD-SCDMA-DL_12K2.WV (PAR = 5.41 dB)

<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>	waveform file used: TD-SCDMA_PTWLOW.WV	see general technical specifications
<b>Output level resolution</b>		see general technical specifications

<b>Signal quality</b>		
Error vector magnitude (EVM)	composite EVM, waveform file used: TD-SCDMA_DEFAULT.WV	< 4 %, RMS

**TD-SCDMA RF analyzer (R&S<sup>®</sup>CMW-KM750 option)**

<b>Frequency range <sup>71</sup></b>	TD-SCDMA band A channels 10054 to 10121	2010.8 MHz to 2024.2 MHz
	TD-SCDMA band E channels 11504 to 11996	2300.8 MHz to 2399.2 MHz
	TD-SCDMA band F channels 9404 to 9596	1880.8 MHz to 1919.2 MHz

<sup>69</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<sup>70</sup> R&S<sup>®</sup>CMW500 and R&S<sup>®</sup>CMW290 only.

<sup>71</sup> Bands A, E, F in line with the CCSA standard.

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, TD-SCDMA: free run, TD-SCDMA: IF power

## Modulation analysis

<b>Filter</b>		1.28 MHz, RRC, $\alpha = 0.22$ , TD-SCDMA filter
<b>Level range</b>		-28 dBm to +42 dBm <sup>72</sup>
<b>Analysis modes</b>	TD-SCDMA uplink	QPSK, DPCH, QPSK, DPCH + HSDPA, 16QAM, DPCH + HSUPA
<b>Measured parameters</b>	numeric results and standard deviation	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, I/Q origin offset, I/Q imbalance, UE power
	graphical	EVM versus time, ME versus time, PE versus time

<b>Error vector magnitude (EVM)</b>		
Measurement range		up to 25 %, RMS
Inherent EVM		< 2.5 %, RMS
Measurement length		1 slot, multislot (1 to 112)

<b>Frequency error</b>		
Measurement range		$\pm 3$ kHz
Frequency measurement uncertainty		< 20 Hz + drift of timebase, see general technical specifications

<b>I/Q origin offset</b>		
Inherent I/Q offset	for average $\geq 10$ measurements	< -55 dB

<b>I/Q imbalance</b>		
Inherent I/Q imbalance		< -50 dB

## Code domain

<b>Filter</b>		1.28 MHz, RRC, $\alpha = 0.22$ , TD-SCDMA filter
<b>Level range</b>		-28 dBm to +42 dBm <sup>72</sup>
<b>Analysis modes</b>	TD-SCDMA uplink	QPSK, DPCH, QPSK, DPCH + HSDPA, 16QAM, DPCH + HSUPA
<b>Measured parameters</b>	numeric results and standard deviation	code domain error (CDE)
	graphical	code domain power versus code

<b>Code domain power versus code</b>		
Uncertainty		< 0.4 dB
Measurement length		1 slot

<b>Code domain error (CDE)</b>		
Uncertainty		< 0.4 dB
Measurement length		1 slot

<sup>72</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

**Spectrum measurements**

<b>Adjacent channel leakage ratio</b>	RMS detector	
Filter		1.28 MHz, RRC, $\alpha = 0.22$ , TD-SCDMA filter
Dynamic range	first adjacent channel at $\pm 1.6$ MHz	> 53 dB
	second adjacent channel at $\pm 3.2$ MHz	> 61 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	-3 dBm to +42 dBm <sup>73</sup>
Uncertainty	for -33 dBc first adjacent channel level	< 0.5 dB
	for -43 dBc second adjacent channel level	< 0.5 dB
Measurement length		1 slot

**Power meter**

<b>Measured parameters</b>	numeric current RMS values	UE power
<b>UE power</b>	RMS detector	
Filter		bandpass, 2.1 MHz, RRC, $\alpha = 0.22$
Level range		-55 dBm to +42 dBm <sup>73</sup>
Level uncertainty		see general technical specifications
Measurement length		1 slot

**TD-SCDMA signaling (prerequisite: R&S®CMW-KS750 option, R&S®CMW-B300A or R&S®CMW-B300B option)**

<b>Standard</b>		3GPP TDD
<b>Symbol rate</b>		1.28 MHz
<b>Channels</b>		
Physical channels	DL	P-CCPCH, S-CCPCH, DwPCH, FPACH, PICH, DPCH
	UL	UpPCH, PRACH, DPCH
Radio bearer	DPCH signaling radio bearer (SRB)	
	DL	2.5 kbps, 3.4 kbps
	UL	2.5 kbps, 3.4 kbps
	DPCH reference measurement channels (RMC) in line with 3GPP TS 34.122	
	DL	12.2 kbps
	UL	12.2 kbps
	DPCH voice echo	12.2 kbps
	DPCH voice echo NB-AMR	4.75 kbps, 5.15 kbps, 5.9 kbps, 6.7 kbps, 7.4 kbps, 7.95 kbps 10.2 kbps, 12.2 kbps
	DPCH video echo	64 kbps
<b>Frequency range</b>		
Bands A, E, F	with the R&S®CMW-KS750 option	
	DL	see TD-SCDMA RF generator specifications
	UL	see TD-SCDMA RF analyzer specifications
<b>Frequency setting</b>		channel number
<b>Output level range</b>	P-CCPCH, depends on PAR	see general technical specifications
<b>Output level uncertainty</b>	P-CCPCH	see general technical specifications
<b>Output level resolution</b>	P-CCPCH	see general technical specifications
<b>Output level setting</b>	P-CCPCH	total output power
<b>Channel levels</b>	S-CCPCH, DwPCH, FPACH, PICH, DPCH	-30 dB to +0 dB relative to total power

<sup>73</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

<b>Signal quality</b>		
Error vector magnitude (EVM)	global EVM for DL RMC in line with 3GPP TS 34.122 C3.1 to C3.4	< 2 %, RMS

## CDMA2000<sup>®</sup> 1xRTT specifications – mobile station test <sup>74</sup>

<b>Standard</b>	CDMA2000 <sup>®</sup> standards	TIA/EIA IS-2000 Rev. 0
	CDMA2000 <sup>®</sup> test standards	TIA/EIA IS-98-F
<b>Symbol rate</b>		1.2288 Mcps

### CDMA2000<sup>®</sup> 1xRTT RF generator

(prerequisite: R&S<sup>®</sup>CMW-B110A/R&S<sup>®</sup>CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

<b>Frequency range</b>	band class 0	860.025 MHz to 893.985 MHz
	band class 1	1930.000 MHz to 1990.000 MHz
	band class 2	917.0125 MHz to 959.9875 MHz
	band class 3	832.0125 MHz to 869.9875 MHz
	band class 4	1840.000 MHz to 1870.000 MHz
	band class 5	421.675 MHz to 493.480 MHz
	band class 6	2110.000 MHz to 2169.950 MHz
	band class 7	746.000 MHz to 764.000 MHz
	band class 8	1805.000 MHz to 1879.950 MHz
	band class 9	925.000 MHz to 958.750 MHz
	band class 10	851.000 MHz to 939.975 MHz
	band class 11	421.675 MHz to 493.475 MHz
	band class 12	915.0125 MHz to 920.9875 MHz
	band class 13	2620.000 MHz to 2690 MHz
	band class 14	1930.000 MHz to 1995.000 MHz
	band class 15	2110.000 MHz to 2155.000 MHz
	band class 16	2624.000 MHz to 2690.000 MHz
	band class 17	2624.000 MHz to 2690.000 MHz
	band class 18	757.000 MHz to 769.000 MHz
	band class 19	728.000 MHz to 746.000 MHz
	band class 20	1525.000 MHz to 1559.000 MHz
band class 21	2190.000 MHz to 2200.000 MHz	

### CDMA2000<sup>®</sup> WinIQSIM2<sup>™</sup> (R&S<sup>®</sup>CMW-KW800 option)

<b>Arbitrary waveform files</b>		CDMA_OQPSK.WV (PAR = 5.54 dB) or CDMA_HPSK.WV (PAR = 6.97 dB)
<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>	waveform file used: CDMA_OQPSK.WV or CDMA_HPSK.WV	see general technical specifications
<b>Output level resolution</b>		see general technical specifications

<b>Signal quality</b>		
Waveform quality (rho)	waveform file used: CDMA_OQPSK.WV or CDMA_HPSK.WV	> 0.99

### CDMA2000<sup>®</sup> RF analyzer (R&S<sup>®</sup>CMW-KM800 option)

<b>Frequency range</b>	band class 0	815.025 MHz to 848.985 MHz
	band class 1	1850.000 MHz to 1910.000 MHz
	band class 2	872.0125 MHz to 914.9875 MHz
	band class 3	887.0125 MHz to 924.9875 MHz
	band class 4	1750.000 MHz to 1780.000 MHz
	band class 5	411.675 MHz to 483.480 MHz
	band class 6	1920.000 MHz to 1979.950 MHz
	band class 7	776.000 MHz to 794.000 MHz
	band class 8	1710.000 MHz to 1784.950 MHz
	band class 9	880.000 MHz to 913.750 MHz

<sup>74</sup> R&S<sup>®</sup>CMW500 and R&S<sup>®</sup>CMW290 only.

	band class 10	806.000 MHz to 900.975 MHz
	band class 11	411.675 MHz to 483.475 MHz
	band class 12	870.0125 MHz to 875.9875 MHz
	band class 13	2500.000 MHz to 2570.000 MHz
	band class 14	1850.000 MHz to 1915.000 MHz
	band class 15	1710.000 MHz to 1755.000 MHz
	band class 16	2502.000 MHz to 2568.000 MHz
	band class 17	2502.000 MHz to 2567.950 MHz
	band class 18	787.000 MHz to 700.000 MHz
	band class 19	698.000 MHz to 716.000 MHz
	band class 20	1626.500 MHz to 1660.500 MHz
	band class 21	2000.000 MHz to 2029.950 MHz

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, C2K: free run, CDMA2000® signaling: superframe (80 ms)

## Modulation analysis

<b>Filter</b>		1.23 MHz, RRC, $\alpha = 0.22$ , CDMA filter
<b>Level range</b>		-28 dBm to +42 dBm <sup>75</sup>
<b>Analysis modes</b>		OQPSK, HPSK
<b>Measured parameters</b>	numeric results and standard deviation	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, rho, carrier feedthrough, I/Q imbalance, power, wideband power (8 MHz), narrowband power (1.23 MHz)
	graphical	EVM versus time, ME versus time, PE versus time

<b>Waveform quality (rho)</b>		
Uncertainty	for rho 0.9 to 1	< 0.003
Measurement length		616 chip (0.5 ms)

<b>Error vector magnitude (EVM)</b>		
Measurement range		up to 25 %, RMS
Inherent EVM		< 2.5 %, RMS
Measurement length		0.5 ms

<b>Frequency error</b>		
Measurement range		±3 kHz
Frequency measurement uncertainty		< 20 Hz + drift of timebase, see general technical specifications

<b>Carrier feedthrough</b>		
Inherent carrier feedthrough	for average $\geq 10$ measurements	< -55 dB

<b>I/Q imbalance</b>		
Inherent I/Q imbalance		< -50 dB

<sup>75</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

**Code domain**

<b>Filter</b>		1.23 MHz, RRC, $\alpha = 0.22$ , CDMA filter
<b>Level range</b>		-28 dBm to +42 dBm <sup>76</sup>
<b>Measured parameters</b>	numeric values of current, average, max. and min. values	code domain power (CDP), code domain error (CDE)
	graphical	code domain power versus code, code domain error versus code

<b>Code domain power versus code</b>		
Uncertainty		< 0.4 dB
Measurement length		616 chip (0.5 ms)

<b>Code domain error versus code</b>		
Measurement uncertainty		< 0.4 dB
Measurement length		616 chip (0.5 ms)

**Spectrum measurements**

<b>Adjacent channel power</b>	RMS detector, at the selected frequency offsets	
Filter	Gaussian	1 kHz, 6.25 kHz, 10 kHz, 12.5 kHz, 25 kHz, 30 kHz, 50 kHz
	Nyquist	100 kHz, 1 MHz, 1.23 MHz
Frequency offset interval	up to 20 adjacent channels on each side	-4 MHz to +4 MHz
Dynamic range		> 70 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	+1 dBm to +42 dBm <sup>76</sup>
Uncertainty	for -43 dBc adjacent channel level	< 0.5 dB
Measurement length	one power control group	1536 chip (1.25 ms)

**Power meter**

<b>MS power</b>		
Filter	narrowband	bandpass, 1.25 MHz
Filter	wideband	bandpass, 8 MHz
Level range		-55 dBm to +42 dBm <sup>76</sup>
Level uncertainty		see general technical specifications
Measurement length		616 chip (0.5 ms)

**CDMA2000<sup>®</sup> 1xRTT signaling (prerequisite: R&S<sup>®</sup>CMW-KS800, R&S<sup>®</sup>CMW-B200A or R&S<sup>®</sup>CMW-B200H, R&S<sup>®</sup>CMW-B220A options)**

<b>Frequency range</b>		
Band class 0 to band class 21	DL	see CDMA2000 <sup>®</sup> 1xRTT RF generator specifications
	UL	see CDMA2000 <sup>®</sup> 1xRTT RF analyzer specifications

<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>		see general technical specifications
<b>Output level resolution</b>		see general technical specifications

<b>Modulation</b>		
Dual BPSK, multiple QPSK		1.2288 Mcps
Waveform quality ( $\rho$ )		> 0.99
Code channel level uncertainty	relative to the total CDMA output power PICH, PCH, FCH, SCH0	approx. 0.1 dB
	all other channels	approx. 0.25 dB
Code channel resolution		0.1 dB
Code channel level range	relative to the total CDMA output power PICH, PCH, FCH, SCH0, SYNC	-20 dB to -1 dB
<b>Supported service options</b>		
Loopback service options		SO 2, 9, 55

<sup>76</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

Speech service options		SO 1, 3, 17, 68, 70, 73, 0x8000
Test data service option		SO 32
Packet data service option	prerequisite: R&S®CMW-B450D	SO 33
<b>Speech codecs</b>	prerequisite: R&S®CMW-B400B and R&S®CMW-B405A options	
Supported standards		8k (SO 1), 8k enhanced or EVRC-A (SO 3), 13k or QCELP (SO 17), EVRC-B (SO 68), EVRC-WB (SO 70), EVRC-NW (SO 73)

## CDMA2000® 1xEV-DO specifications – access terminal test <sup>77</sup>

<b>Standard</b>	CDMA2000® 1xEV-DO standards	TIA/EIA 856-2
	CDMA2000® 1xEV-DO test standards	TIA/EIA 866-A, TIA/EIA 866-B
<b>Symbol rate</b>		1.2288 Mcps

## CDMA2000® 1xEV-DO RF generator (prerequisite: R&S®CMW-B110A/R&S®CMW-B110D option with 40/80 MHz bandwidth unit; included with 160 MHz bandwidth unit)

<b>Frequency range</b>	band class 0	860.025 MHz to 893.985 MHz
	band class 1	1930.000 MHz to 1990.000 MHz
	band class 2	917.0125 MHz to 959.9875 MHz
	band class 3	832.0125 MHz to 869.9875 MHz
	band class 4	1840.000 MHz to 1870.000 MHz
	band class 5	421.675 MHz to 493.480 MHz
	band class 6	2110.000 MHz to 2169.950 MHz
	band class 7	746.000 MHz to 764.000 MHz
	band class 8	1805.000 MHz to 1879.950 MHz
	band class 9	925.000 MHz to 958.750 MHz
	band class 10	851.000 MHz to 939.975 MHz
	band class 11	421.675 MHz to 493.475 MHz
	band class 12	915.0125 MHz to 920.9875 MHz
	band class 13	2620.000 MHz to 2690 MHz
	band class 14	1930.000 MHz to 1995.000 MHz
	band class 15	2110.000 MHz to 2155.000 MHz
	band class 16	2624.000 MHz to 2690.000 MHz
	band class 17	2624.000 MHz to 2690.000 MHz
	band class 18	757.000 MHz to 769.000 MHz
	band class 19	728.000 MHz to 746.000 MHz
	band class 20	1525.000 MHz to 1559.000 MHz
band class 21	2190.000 MHz to 2200.000 MHz	

## 1xEV-DO WiniQSIM2™ (R&S®CMW-KW880 option)

<b>Arbitrary waveform file</b>		EVDO_DEFAULT.WV (PAR = 4.85 dB)
<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>	waveform file used: EVDO_DEFAULT.WV	see general technical specifications
<b>Output level resolution</b>		see general technical specifications
<b>Signal quality</b>		
Waveform quality (rho)	waveform file used: EVDO_DEFAULT.WV	> 0.99

<sup>77</sup> R&S®CMW500 and R&S®CMW290 only.

## CDMA2000® 1xEV-DO RF analyzer (R&S®CMW-KM880 option)

<b>Frequency range</b>	band class 0	815.025 MHz to 848.985 MHz
	band class 1	1850.000 MHz to 1910.000 MHz
	band class 2	872.0125 MHz to 914.9875 MHz
	band class 3	887.0125 MHz to 924.9875 MHz
	band class 4	1750.000 MHz to 1780.000 MHz
	band class 5	411.675 MHz to 483.480 MHz
	band class 6	1920.000 MHz to 1979.950 MHz
	band class 7	776.000 MHz to 794.000 MHz
	band class 8	1710.000 MHz to 1784.950 MHz
	band class 9	880.000 MHz to 913.750 MHz
	band class 10	806.000 MHz to 900.975 MHz
	band class 11	411.675 MHz to 483.475 MHz
	band class 12	870.0125 MHz to 875.9875 MHz
	band class 13	2500.000 MHz to 2570.000 MHz
	band class 14	1850.000 MHz to 1915.000 MHz
	band class 15	1710.000 MHz to 1755.000 MHz
	band class 16	2502.000 MHz to 2568.000 MHz
	band class 17	2502.000 MHz to 2567.950 MHz
	band class 18	787.000 MHz to 700.000 MHz
	band class 19	698.000 MHz to 716.000 MHz
	band class 20	1626.500 MHz to 1660.500 MHz
band class 21	2000.000 MHz to 2029.950 MHz	

<b>Statistics</b>		
Statistical count		1 to 1000
Values		current, average, minimum/maximum, standard deviation

<b>Trigger</b>		
Trigger sources		BASE: external TRIG A, BASE: external TRIG B, GPRF: gen, 1xEV-DO: free run, 1xEV-DO signaling: superframe (80 ms)

### Modulation analysis

<b>Filter</b>		1.23 MHz, RRC, $\alpha = 0.22$ , CDMA filter
<b>Level range</b>		-28 dBm to +42 dBm <sup>78</sup>
<b>Analysis modes</b>		dual BPSK
<b>Multicarrier</b>		single carrier or 3 carriers within -8 MHz to +8 MHz
<b>Measured parameters</b>	numeric results and standard deviation	error vector magnitude (EVM), magnitude error (ME), phase error (PE), frequency error, rho, carrier feedthrough, I/Q imbalance, power, wideband power (8 MHz for single carrier or 16 MHz for multicarrier), narrowband power (1.23 MHz)
	graphical	EVM versus time, ME versus time, PE versus time

<b>Waveform quality (rho)</b>		
Uncertainty	for rho 0.9 to 1	< 0.003
Measurement length	half-slot	1024 chip (833.33 $\mu$ s)

<sup>78</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.



<b>Error vector magnitude (EVM)</b>		
Measurement range		up to 25 %, RMS
Inherent EVM		< 2.5 %, RMS
Measurement length	half-slot	1024 chip (833.33 $\mu$ s)

<b>Frequency error</b>		
Measurement range		$\pm 3$ kHz
Frequency measurement uncertainty		< 20 Hz + drift of timebase, see general technical specifications

<b>Carrier feedthrough</b>		
Inherent carrier feedthrough	for average $\geq 10$ measurements	< -55 dB

<b>I/Q imbalance</b>		
Inherent I/Q imbalance		< -50 dB

## Code domain

<b>Filter</b>		
Level range		1.23 MHz, RRC, $\alpha = 0.22$ , CDMA filter -28 dBm to +42 dBm <sup>79</sup>
Measured parameters	numeric values of current, average, max. and min. values	code domain power (CDP), code domain error (CDE)
	graphical	code domain power versus code, code domain error versus code

<b>Code domain power versus code</b>		
Uncertainty		< 0.4 dB
Measurement length	half-slot	1024 chip (833.33 $\mu$ s)

<b>Code domain error versus code</b>		
Measurement uncertainty		< 0.4 dB
Measurement length	half-slot	1024 chip (833.33 $\mu$ s)

## Spectrum measurements

<b>Adjacent channel power</b>	RMS detector, at the selected frequency offsets	
Filter	Gaussian	1 kHz, 6.25 kHz, 10 kHz, 12.5 kHz, 25 kHz, 30 kHz, 50 kHz
	Nyquist	100 kHz, 1 MHz, 1.23 MHz
Frequency offset interval	up to 20 adjacent channels on each side	-4 MHz to +4 MHz to each carrier
Dynamic range		> 70 dB
Expected nominal power setting for full dynamic range	RF1 COM, RF2 COM	+1 dBm to +42 dBm <sup>79</sup>
Uncertainty	for -43 dBc adjacent channel level	< 0.5 dB
Measurement length	half-slot	1024 chip (833.33 $\mu$ s)

## Power meter

<b>MS power</b>		
Filter	narrowband	bandpass, 1.25 MHz
Filter	wideband	bandpass, 8 MHz for single carrier or 16 MHz for multicarrier
Level range		-55 dBm to +42 dBm <sup>79</sup>
Level uncertainty		see general technical specifications
Measurement length	half-slot	1024 chip (833.33 $\mu$ s)

<sup>79</sup> The maximum permissible continuous power is +34 dBm due to thermal limits.

## CDMA2000® 1xEV-DO signaling (prerequisite: R&S®CMW-KS880, R&S®CMW-KS881, R&S®CMW-B200A or R&S®CMW-B200H, R&S®CMW-B230A options)

<b>Frequency range</b>		
Band class 0 to band class 21	DL	see CDMA2000® 1xEV-DO RF generator specifications
	UL	see CDMA2000® 1xEV-DO RF analyzer specifications

<b>Output level range</b>	depends on PAR	see general technical specifications
<b>Output level uncertainty</b>		see general technical specifications
<b>Output level resolution</b>		see general technical specifications

<b>Modulation</b>		
Dual BPSK		1.2288 Mcps
Waveform quality (rho)		> 0.99

<b>Supported applications</b>		
Test applications		FTAP/RTAP, FETAP/RETAP
	prerequisite: R&S®CMW-KS881	FMCTAP/RMCTAP
Packet applications	prerequisite: R&S®CMW-B450D	

## Data application unit – DAU (R&S®CMW-B450B or R&S®CMW-B450D or R&S®CMW-B450H option)

The R&S®CMW-B450B/D/H option provides data test capabilities and a Gigabit Ethernet connector on the rear of the instrument.

### Data application

<b>IP configuration</b>		IPv4 address configuration, IPv6 address configuration
<b>File transfer protocol (FTP)</b>		FTP server, FTP traffic generator
<b>Hypertext transfer protocol (HTTP)</b>		HTTP server
<b>Domain name service (DNS)</b>		DNS server

### DAU throughput

<b>R&amp;S®CMW-B450B option</b>		max. 350 Mbit
<b>R&amp;S®CMW-B450D option</b>		max. 900 Mbit
<b>R&amp;S®CMW-B450H option</b>		max. 2000 Mbit

### DAU LAN Ethernet interface

<b>R&amp;S®CMW-B450D option</b>		Ethernet RJ-45 connector, 100 Mbps, 1 Gbps
<b>R&amp;S®CMW-B450H option</b>		Ethernet RJ-45 connector, 1 Gbps, 10 Gbps

### DAU USB interface

<b>R&amp;S®CMW-B450H option</b>		USB 3.0
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## Digital I/Q 1 to 4 (R&S®CMW-B510F option) and digital I/Q 5 to 8 (R&S®CMW-B520F option) <sup>80</sup>

The R&S®CMW-B510F option makes the first digital I/Q interface and AUX interface and the R&S®CMW-B520F option makes the second digital I/Q interface and AUX interface available on the rear of the instrument.

### Digital I/Q interface

The digital I/Q interface can be used to connect the R&S®CMW to the digital I/Q interface of other Rohde & Schwarz instruments (e.g. R&S®AMU200A, R&S®EX-IQ-Box).

<b>DIG I/Q IN 1/3/5/7</b>	input	26-pin MDR connector
Level		LVDS
Clock rate in		100 MHz
Clock rate out		100 MHz
<b>DIG I/Q OUT 2/4/6/8</b>	output	26-pin MDR connector
Level		LVDS
Clock rate		100 MHz
<b>Control signals</b>	general-purpose control, for future use	
	6 signals	100 MHz
<b>I/Q data</b>		
Resolution	for clock rate up to 100 MHz	18 bit for I and 18 bit for Q
<b>I/Q sample rate</b>		
Source		internal, digital input, digital output,
Range		1.92 Msample/s to 100 Msample/s
Predefined values <sup>81</sup>	standard-independent WCDMA, LTE	100 Msample/s 1.92 Msample/s, 3.84 Msample/s, 7.68 Msample/s, 9.6 Msample/s, 15.36 Msample/s, 19.2 Msample/s, 30.72 Msample/s
<b>I/Q enable/request rate</b>		
Digital input	transfer mode 1 (enable mode)	75 MHz, 100 MHz
	transfer mode 2 (request mode)	0 Hz to 100 MHz
Digital output	transfer mode 1 (enable mode)	100 MHz
	transfer mode 2 (request mode)	0 Hz to 100 MHz

### AUX interface

The AUX interface can be used to connect the R&S®CMW to other instruments, e.g. to trigger, clock and enable signals.

<b>AUX A/B/C/D</b>	bidirectional, half-duplex	BNC connectors
Level		3.3 V TTL
Clock rate		0 Hz to 100 MHz

### Included extras

<b>Digital I/Q cable (two sets)</b>	same cable as included in R&S®SMU-Z6	26-pin MDR connector
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<sup>80</sup> R&S®CMW500 and R&S®CMW270 only. Not possible with R&S®CMW-B500I SUA option.

<sup>81</sup> Further values in the range from 400 sample/s to 100 Msample/s can be provided on request.

## Digital I/Q QUAD (R&S®CMW-B540I option) <sup>82</sup>

With the R&S®CMW-B540I option, digital I/Q signals and AST IN interface are available on the rear panel of the instrument. The R&S®Digital I/Q HS Interface can be used for lossless connection to other Rohde & Schwarz instruments. The AST IN interface can be used to connect the R&S®CMW to other Rohde & Schwarz instruments.

### Digital I/Q HS interface

<b>DIG IQ HS</b>		
Interface	direction	full duplex
	connector	QSFP+
	level	CML
	bandwidth	40 Gbps

### AST IN interface

<b>AST IN</b>	input	BNC connectors
Level		3.3 V TTL

### Included extras

<b>Optical digital I/Q HS cable</b>	R&S®DIGIQ-HS HS DIG.IQ INTERFACE cable length: 3 m	QSFP+ connector
<b>AST cable</b>	cable length: 3 m	BNC

<sup>82</sup> R&S®CMW500 and R&S®CMW270 only. Possible with R&S®CMW-B500I SUA option only.

## General data

<b>RF connectors (front panel)</b>		
RF1 COM, RF2 COM		SnapN female, 50 Ω, compatible with N female connectors
RF1 OUT		combined RF input and RF output
		RF output
<b>Remote control interfaces (front panel)</b>		
LAN		Ethernet RJ-45 connector, 1000 Mbps
<b>Remote control interfaces (rear panel)</b>		
IEEE 488	R&S®CMW-B612A IEEE bus (single) interface option	IEC 60625-2 (IEEE 488.2), 24-pin Amphenol connector
	R&S®CMW-B612B IEEE bus (dual) interface option	2 × IEC 60625-2 (IEEE 488.2), 24-pin Amphenol connector
LAN REMOTE		Ethernet RJ-45 connector, 1000 Mbps
USB REMOTE		USB 2.0 type B connector
<b>Further interfaces (front panel)</b>		
USB	for keyboard, mouse, USB stick	3 × USB 2.0 type A connector
SENSOR		for R&S®NRP-Zxx power sensors
DIGITAL MONITOR	for external monitor, only included in R&S®CMW-S600A or R&S®CMW-S600C or R&S®CMW-S600G configuration (front panel without display or keypad)	DVI-D connector
<b>Further interfaces (rear panel)</b>		
USB	for keyboard, mouse, USB stick	2 × USB 2.0 type A connector
DVI	for external monitor, R&S®CMW-B620A DVI interface option	DVI-D connector
TRIG A, TRIG B	trigger input/output output trigger sources	2 × BNC connector standard-specific internal trigger sources
<b>Environmental conditions</b>		
Temperature	operating temperature range	+5 °C to +45 °C
	storage temperature range	-25 °C to +60 °C
Damp heat		+40 °C, 80 % rel. humidity, steady state, in line with EN 60068-2-78
<b>Product conformity</b>		
Electromagnetic compatibility	EU: in line with EMC Directive 2014/30/EC	applied harmonized standards: <ul style="list-style-type: none"> <li>EN 61326-1 (industrial environment)</li> <li>EN 61326-2-1</li> <li>EN 55011 (class A)</li> </ul>
Electrical safety	EU: in line with Low Voltage Directive 2014/35/EC	applied harmonized standard: EN 61010-1
	USA/Canada	applied harmonized standards: <ul style="list-style-type: none"> <li>UL 61010-1</li> <li>CAN C22.2 No. 61010.1</li> </ul>
International safety approvals	VDE – Association for Electrical, Electronic and Information Technologies	GS mark
	CSA – Canadian Standards Association	CSA <sub>UL</sub> mark
RoHS	EU: in line with Directive 2011/65/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment	EN 50581

<b>Mechanical resistance</b>		
Vibration	nonoperating mode sinusoidal	5 Hz to 55 Hz, 0.3 mm double amplitude const., 55 Hz to 150 Hz, 0.5 g const., in line with EN 60068-2-6
Vibration	random	10 Hz to 300 Hz, acceleration 1.2 g RMS, in line with EN 60068-2-64
Shock		40 g shock spectrum, in line with MIL-STD-810, method 516, procedure I
<b>Power rating</b>		
Rated voltage		100 V to 240 V AC ( $\pm 10\%$ )
Rated frequency		50 Hz to 60 Hz ( $\pm 5\%$ )
Rated power	with R&S®CMW-PS505 models .02/.04 or R&S®CMW-PS275 model .02 or R&S®CMW-PS290 model .02	max. 850 VA
	with R&S®CMW-PS505 model .06 or R&S®CMW-PS275 model .06 or R&S®CMW-PS291 model .06	max. 1050 VA
	standby	max. 13 W
Power consumption	single tester, nonsignaling	approx. 200 W
<b>Display</b>		
		selected with R&S®CMW-S600B or R&S®CMW-S600D or R&S®CMW-S600H configuration (front panel with display and keypad)
Size		21 cm TFT color display (8.4")
Resolution		800 × 600 pixel (SVGA resolution)
Pixel failure rate		$< 1.1 \times 10^{-5}$
<b>Dimensions</b>		
	W × H × D, overall	465.1 mm × 197.3 mm × 517.0 mm (18.31 in × 7.77 in × 20.35 in)
	for rackmounting	19" 1/1, 4 HU, 450
<b>Weight</b>	single tester, nonsignaling	approx. 14 kg (approx. 31 lb)
	with typical options	approx. 18 kg (approx. 40 lb)
<b>Calibration interval</b>		
	12 months	recommended for highest accuracy, see specified RF generator and RF analyzer level uncertainty
	24 months	add 0.2 dB to specified RF generator and RF analyzer level uncertainty

## Ordering information

Designation	Type	Order No.
<b>Wideband Radio Communication Tester</b> Base unit with following accessories: power cord, operating manual (quick start guide), comprehensive documentation on CD-ROM	R&S®CMW500	1201.0002K50
<b>Wireless Connectivity Tester</b> Base unit with following accessories: power cord, operating manual (quick start guide), comprehensive documentation on CD-ROM	R&S®CMW270	1201.0002K75
<b>Functional Radio Communication Tester</b> Base unit with following accessories: power cord, operating manual (quick start guide), comprehensive documentation on CD-ROM	R&S®CMW290	1201.0002K29

For more ordering information about available options, please see our product brochure (PD 5214.2833.12) or ask your local Rohde & Schwarz expert to find the solution that best meets your needs.

## Recommended extras

Designation	Type	Order No.
19" Rack Adapter	R&S®ZZA-411	1096.3283.00
Cable TVR 290, 26-pin MDR connector; additional cable for R&S®CMW-B510F used with e.g. R&S®AMU200A, R&S®EX-IQ-Box	R&S®SMU-Z6 <sup>83</sup>	1415.0201.02

## Service options

Service options		
Extended Warranty, one year	R&S®WE1	Please contact your local Rohde & Schwarz sales office.
Extended Warranty, two years	R&S®WE2	
Extended Warranty, three years	R&S®WE3	
Extended Warranty, four years	R&S®WE4	
Extended Warranty with Calibration Coverage, one year	R&S®CW1	
Extended Warranty with Calibration Coverage, two years	R&S®CW2	
Extended Warranty with Calibration Coverage, three years	R&S®CW3	
Extended Warranty with Calibration Coverage, four years	R&S®CW4	
Extended Warranty with Accredited Calibration Coverage, one year	R&S®AW1	
Extended Warranty with Accredited Calibration Coverage, two years	R&S®AW2	
Extended Warranty with Accredited Calibration Coverage, three years	R&S®AW3	
Extended Warranty with Accredited Calibration Coverage, four years	R&S®AW4	

### Extended warranty with a term of one to four years (WE1 to WE4)

Repairs carried out during the contract term are free of charge<sup>84</sup>. Necessary calibration and adjustments carried out during repairs are also covered.

### Extended warranty with calibration (CW1 to CW4)

Enhance your extended warranty by adding calibration coverage at a package price. This package ensures that your Rohde & Schwarz product is regularly calibrated, inspected and maintained during the term of the contract. It includes all repairs<sup>84</sup> and calibration at the recommended intervals as well as any calibration carried out during repairs or option upgrades.

### Extended warranty with accredited calibration (AW1 to AW4)

Enhance your extended warranty by adding accredited calibration coverage at a package price. This package ensures that your Rohde & Schwarz product is regularly calibrated under accreditation, inspected and maintained during the term of the contract. It includes all repairs<sup>84</sup> and accredited calibration at the recommended intervals as well as any accredited calibration carried out during repairs or option upgrades.

<sup>83</sup> R&S®CMW500 and R&S®CMW270 only.

<sup>84</sup> Excluding defects caused by incorrect operation or handling and force majeure. Wear-and-tear parts are not included.

## Service that adds value

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

## Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

[www.rohde-schwarz.com](http://www.rohde-schwarz.com)

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- | Environmental compatibility and eco-footprint
- | Energy efficiency and low emissions
- | Longevity and optimized total cost of ownership

Certified Quality Management  
**ISO 9001**

Certified Environmental Management  
**ISO 14001**

## Rohde & Schwarz training

[www.training.rohde-schwarz.com](http://www.training.rohde-schwarz.com)

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