

# R&S® NRPM

## Over-the-Air (OTA) Power Measurement Solution

### Specifications

3 year warranty



# CONTENTS

<b>Definitions .....</b>	<b>3</b>
<b>R&amp;S®NRPM3 three-channel sensor module .....</b>	<b>4</b>
<b>R&amp;S®NRPM-A66 single-polarized antenna module.....</b>	<b>6</b>
Measurement uncertainty from 57 GHz to 71 GHz.....	6
Measurement accuracy from 27.5 GHz to < 57 GHz and > 71 GHz to 75 GHz .....	6
<b>Accessories for R&amp;S®NRP OTA power sensors.....</b>	<b>7</b>
R&S®NRP-ZKU USB interface cables.....	7
R&S®NRP-ZK6 six-pole interface cables .....	7
R&S®NRPM-ZKD3 interface cable.....	7
R&S®NRPM-ZD3 filtered cable feedthrough .....	7
R&S®NRPM-Z3 interface module.....	7
<b>General data .....</b>	<b>8</b>
R&S®NRPM3, R&S®NRPM-ZKD3, R&S®NRP-ZKU and R&S®NRP-ZK6.....	8
R&S®NRPM-A66, R&S®NRPM-ZD3 and R&S®NRPM-Z3 .....	8
<b>Appendix.....</b>	<b>9</b>
Technical drawings of the R&S®NRPM-A66.....	9
<b>Ordering information .....</b>	<b>10</b>
<b>Footnotes.....</b>	<b>11</b>

## Definitions

Product data applies under the following conditions:

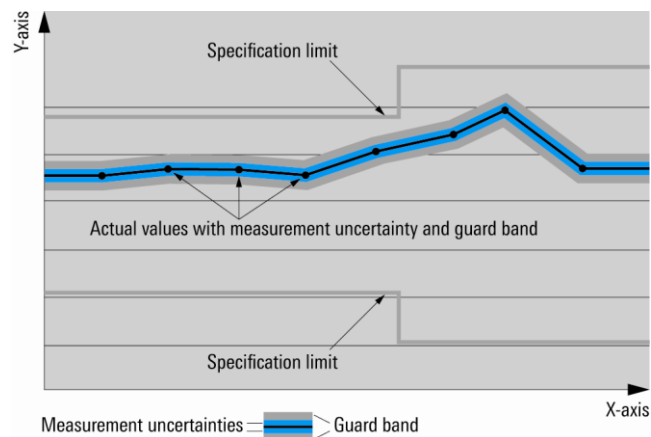
- Three hours storage at the expected operating temperature followed by 30 minutes warm-up, unless otherwise stated
- Specified environmental conditions met
- Recommended calibration interval adhered to
- All internal automatic adjustments performed, if applicable

### Specifications with limits

Describe warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as  $<$ ,  $\leq$ ,  $>$ ,  $\geq$ ,  $\pm$ , or descriptions such as maximum and minimum.

Specifications in normal print refer to parameters where compliance is ensured by the design or derived from the measurement of related parameters.

Specifications in **bold** print are 100 % tested. Test limits have been narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



### Specifications without limits

Describe warranted product performance by means of a representative value for the specified parameter. Limits are omitted whenever they are not relevant for the specification (e.g. dimensional data).

### Typical values (typ.)

Represent the population mean for the given parameter, derived from the design and/or production testing. Typical values are not warranted by Rohde & Schwarz.

### Limits of uncertainty

Expanded uncertainties with a coverage factor of 2, calculated from the test assembly specifications and the modeled behavior of the sensor, including environmental conditions, aging, wear and tear, if applicable. The given values represent limits of uncertainty that are met by the Rohde & Schwarz instrument after calibration at a production or service site. Limits of uncertainty (in italics) are defined in EN 60359 and have been determined in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM).

## R&S®NRPM3 three-channel sensor module

<b>Sensor type</b>		sensor module for R&S®NRP OTA antenna modules
<b>Measurand</b> <sup>1</sup>		power of incident electromagnetic wave towards the antenna module
<b>Number of measurement channels</b>		3 parallel channels
<b>Measurement functions</b>	stationary and recurring waveforms and single events	continuous average trace
<b>Continuous average function</b>	measurand	mean power over recurring acquisition interval
	aperture	10 µs to 2.0 s (default: 20 ms)
	window function	uniform or von Hann <sup>2</sup>
	duty cycle correction <sup>3</sup>	0.001 % to 100.0 %
<b>Trace function</b>	measurand	mean, random, maximum and minimum power over pixel length
	acquisition	
	length	10 µs to 3.0 s
	start (referenced to delayed trigger)	-3.0 s to 3.0 s
	result	
	pixel	1 to 100000
	resolution	≥ 0.5 µs (sample period)
<b>Averaging filter</b>	supported measurement functions	all
	averaging number	1 to 65535
	result output	
	moving mode	continuous result output, independent of averaging number
	repeat mode	only final result
<b>Attenuation correction</b>	function	corrects the measurement result by means of a fixed factor (dB offset)
	range	-200.000 dB to +200.000 dB
<b>Frequency response correction</b>	function	takes the frequency response of the antenna module into account
	parameter	center frequency of test signal
	residual uncertainty	see specification of calibration uncertainty and uncertainty for absolute and relative power measurements

<b>Measurement times</b> <sup>4</sup> Av: averaging number	continuous average	$2 \times (\text{aperture} + 100 \mu\text{s}) \times Av + t_z$ $t_z = 2 \text{ ms (typ.)}$
<b>Zeroing (duration)</b>		5.3 s

<b>Acquisition</b>	sample rate (continuous)	2 Msps
<b>Triggering</b>	internal	
	threshold level range and accuracy	see R&S®NRP OTA antenna module
	threshold level hysteresis	0 dB to 10 dB
	dropout <sup>5</sup>	0 s to 10 s
	external	EXTernal[1]: R&S®NRP-Z5 EXTernal2: coaxial trigger I/O
	slope (external, internal)	pos./neg.
	delay	-5 s to +10 s
	hold-off	0 s to 10 s
	resolution (delay, hold-off, dropout)	0.5 µs (sample period)
	source	INTernal, EXTernal[1], EXTernal2, IMMEDIATE, BUS, HOLD

<b>Analog interface</b>	mechanical	16-pin female push-pull connector
<b>Host interface</b>	mechanical	8-pin male M12 connector (A-coded)
	power supply	+5 V/0.5 A (USB high-power device)
	speed	supports high-speed and full-speed modes in line with the specification
	remote control protocols	supports USB test and measurement device class (USBTMC)
	trigger input EXTERNAL[1]	differential (0 V/+3.3 V)
	reference clock	
	signal level	LVDS
	frequency	20 MHz
	permissible total cable length	≤ 5 m
<b>Trigger-I/O EXTERNAL2</b>	mechanical	SMB built-in jack
	impedance	
	input	10 kΩ or 50 Ω
	output	50 Ω
	signal level	
	input	compatible with 3 V or 5 V logic, max. -1 V to +6 V
output	≥ 2 V into 50 Ω load, max. 5.3 V	
<b>Dimensions (W × H × L)</b>		48 mm × 30 mm × 115 mm (1.89 in × 1.18 in × 4.53 in)
<b>Weight</b>		150 g (0.33 lb)

# R&S®NRPM-A66 single-polarized antenna module

All power levels represent equivalent isotropic received power levels as defined in footnote 1.

<b>Frequency range</b>		27.5 GHz to 75 GHz	
<b>Power measurement range</b>	continuous average	30 pW to 3 µW (-75 dBm to -25 dBm)	
	trace	630 pW to 3 µW (-62 dBm to -25 dBm) <sup>6</sup>	
<b>Max. power</b>	average power	1.6 mW (+2 dBm)	
	peak envelope power	10 mW (+10 dBm) for max. 10 µs	
<b>Dynamic response</b>	video bandwidth	> 220 kHz (> 300 kHz)	( ): > +15 °C
	rise/fall time 10 %/90 %	< 2.2 µs (< 1.6 µs)	
<b>Far-field distance</b> <sup>7</sup>		< 175 mm	
<b>Radar cross section</b>		< -25 dBsm (typ.)	
<b>Cross-polarization</b>		< -20 dB (typ.)	
<b>Trigger threshold</b>	threshold level range	-48 dBm to -25 dBm	
	threshold level accuracy	identical to uncertainty for absolute power measurements	
<b>Zero offset</b>	initial, without zeroing	< 22 (4) pW	( ): typical at +15 °C to +35 °C
	after external zeroing <sup>8</sup>	< 4.5 (2.2) pW	
<b>Zero drift</b> <sup>9</sup>		< 3 (1) pW	
<b>Measurement noise</b> <sup>10</sup>		< 3.2 (1.5) pW	

<b>Dimensions (W x H x L)</b>	without cable	53 mm x 30 mm x 75 mm (2.09 in x 1.18 in x 2.95 in)
<b>Cable</b>	length	550 mm (21.7 in)
	connector durability	min. 30 mating cycles
<b>Weight</b>		36 g (0.08 lb)

## Measurement uncertainty from 57 GHz to 71 GHz

<b>Uncertainty for absolute power measurements</b> <sup>11</sup> RH: relative humidity		+20 °C to +25 °C	+15 °C to +35 °C	+5 °C to +40 °C
	0 % to < 40 % RH	0.87 dB	0.91 dB	0.96 dB
	40 % to 60 % RH	0.72 dB	0.76 dB	0.81 dB
	> 60 % to 75 % RH	1.04 dB	1.07 dB	1.12 dB
<b>Uncertainty for relative power measurements</b> <sup>12</sup>	levels ≤ -35 dBm	0.05 dB		
	at least one level > -35 dBm	0.09 dB		
<b>Calibration uncertainty</b> <sup>13</sup>		0.70 dB		

## Measurement accuracy from 27.5 GHz to < 57 GHz and > 71 GHz to 75 GHz

<b>Accuracy for absolute power measurements</b> <sup>14</sup>	27.5 GHz to < 50 GHz	< 3.5 dB (typ.)
	50 GHz to < 57 GHz	< 2.2 dB (typ.)
	> 71 GHz to 75 GHz	< 2.5 dB (typ.)
<b>Accuracy for relative power measurements</b>	levels ≤ -35 dBm	< 0.1 dB (typ.)
	at least one level > -35 dBm	< 0.2 dB (typ.)

## Accessories for R&S®NRP OTA power sensors

### R&S®NRP-ZKU USB interface cables

The R&S®NRP-ZKU interface cables are used to connect the R&S®NRPM3 sensor module to any standard-conforming USB downstream port (type A receptacle), e.g. on a PC, USB hub or a Rohde & Schwarz instrument.

<b>Connectors</b>	sensor side	8-pin female M12 connector (A-coded)
	host side	USB type A plug
<b>Length</b>	model .02	0.75 m
	model .03	1.50 m
	model .04	3.00 m
	model .05	5.00 m

The R&S®NRP-ZKU interface cables must not be combined with passive USB extension cables or commercially available M12 extension cables. Using such extension cables can affect the reliability of the high-speed data transfer.

### R&S®NRP-ZK6 six-pole interface cables

The R&S®NRP-ZK6 interface cables are used to connect the R&S®NRPM3 sensor module to an R&S®NRP-Z5 sensor hub.

<b>Connectors</b>	sensor side	8-pin female M12 connector (A-coded)
	host side	6-pole circular plug with push-pull locking
<b>Length</b>	model .02	1.50 m
	model .03	3.00 m
	model .04	5.00 m

The R&S®NRP-ZK6 interface cables must not be combined with the R&S®NRP-Z2/-Z3/-Z4 cables or commercially available M12 extension cables. Using such extension or adapter cables can affect the reliability of the high-speed data transfer.

### R&S®NRPM-ZKD3 interface cable

The R&S®NRPM-ZKD3 sensor cable is used to connect an R&S®NRPM3 sensor module to an R&S®NRPM-ZD3 feedthrough module.

<b>Connectors</b>	sensor side	16-pin male push-pull connector
	side of feedthrough module	15-pin male D-Sub connector
<b>Length</b>	model .02	0.75 m

The R&S®NRPM-ZKD3 sensor cables must not be combined with commercially available D-Sub extension cables.

### R&S®NRPM-ZD3 filtered cable feedthrough

The R&S®NRPM-ZD3 feedthrough module is used in combination with anechoic chambers to feed the antenna signals from inside to outside the chamber. It combines the signals from up to three R&S®NRPM-A66 antenna modules to one R&S®NRPM3 sensor module.

<b>Connectors</b>	outside	15-pin female D-Sub connector
	inside	3 x 10-pin antenna cable connectors
<b>Dimensions (W x H x L)</b>	feedthrough module with cover	80 mm x 64 mm x 40 mm (3.15 in x 2.52 in x 1.58 in)
<b>Weight</b>	feedthrough module with cover	112 g (0.25 lb)

### R&S®NRPM-Z3 interface module

The R&S®NRPM-Z3 interface module is directly connected to the R&S®NRPM3 three-channel sensor module and hosts up to three R&S®NRPM-A66 antenna modules.

<b>Connectors</b>	sensor module interface	16-pin male push-pull connector
	antenna interface	3 x 10-pin antenna cable connectors
<b>Dimensions (W x H x L)</b>		68 mm x 48 mm x 26.5 mm (2.68 in x 1.89 in x 1.04 in)
<b>Weight</b>		105 g (0.23 lb)

## General data

### R&S®NRPM3, R&S®NRPM-ZKD3, R&S®NRP-ZKU and R&S®NRP-ZK6

<b>Temperature</b> <sup>15</sup>	operating temperature range	0 °C to +50 °C
	permissible temperature range	-10 °C to +55 °C
	storage temperature range	-40 °C to +85 °C
<b>Climatic resistance</b>	damp heat	+25 °C/+55 °C cyclic at 95 % relative humidity with restrictions: noncondensing, in line with EN 60068-2-30
<b>Mechanical resistance</b>	vibration	
	sinusoidal	5 Hz to 55 Hz, 0.15 mm amplitude, 1.8 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g constant, in line with EN 60068-2-6
	random	8 Hz to 650 Hz, 1.9 g (RMS), in line with EN 60068-2-64
	shock	45 Hz to 2 kHz, max. 40 g shock spectrum, in line with MIL-STD-810E, method 516.4, procedure I
<b>Air pressure</b>	operating	795 hPa (2000 m) to 1060 hPa
	transport	566 hPa (4500 m) to 1060 hPa
<b>Electromagnetic compatibility</b>		applied harmonized standards: <ul style="list-style-type: none"> <li>• EN 61326-1</li> <li>• EN 61326-2-1</li> <li>• EN 55011 (class B)</li> </ul>
<b>Calibration interval</b>	recommended	2 year

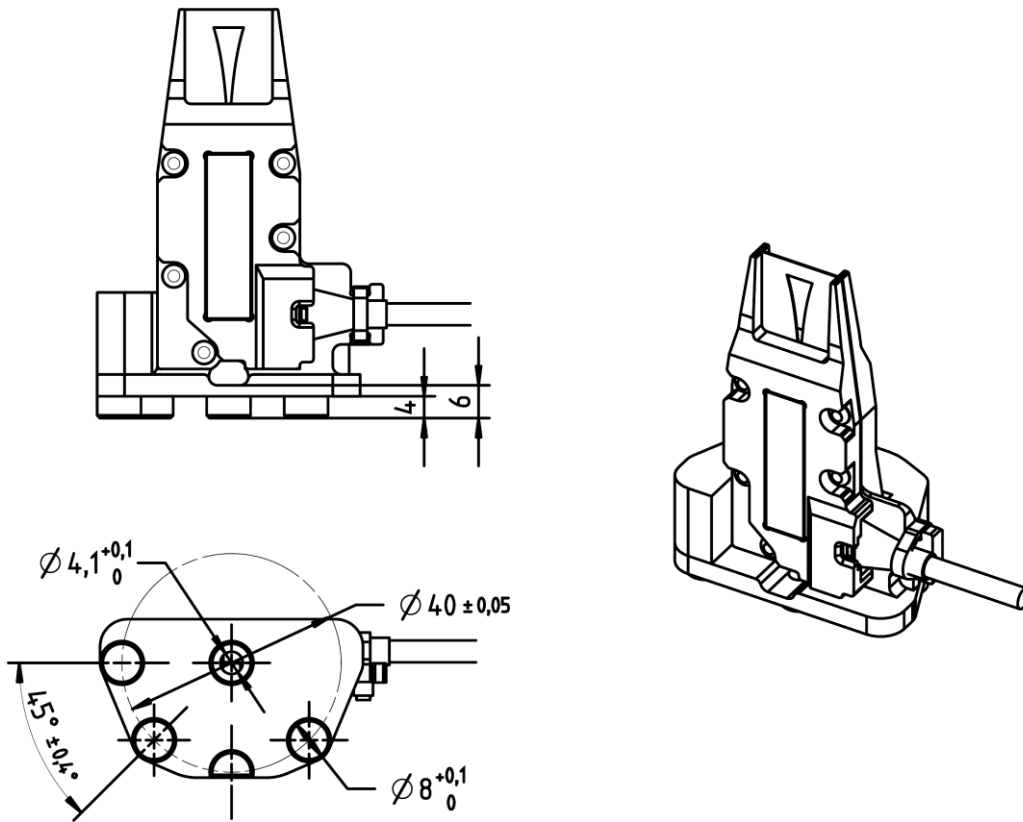
### R&S®NRPM-A66, R&S®NRPM-ZD3 and R&S®NRPM-Z3

<b>Temperature</b>	operating temperature range	5 °C to +40 °C
	permissible temperature range	0 °C to +50 °C
	storage temperature range	-20 °C to +70 °C
<b>Climatic resistance</b>	damp heat	+25 °C/+40 °C cyclic at 95 % relative humidity with restrictions: noncondensing, in line with EN 60068-2-30
<b>Mechanical resistance</b>	vibration	
	sinusoidal	5 Hz to 55 Hz, 0.15 mm amplitude, 1.8 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g constant, in line with EN 60068-2-6
	random	8 Hz to 500 Hz, 1.2 g (RMS), in line with EN 60068-2-64
	shock	45 Hz to 2 kHz, max. 40 g shock spectrum, in line with MIL-STD-810E, method 516.4, procedure I
<b>Air pressure</b>	operating	795 hPa (2000 m) to 1060 hPa
	transport	566 hPa (4500 m) to 1060 hPa
<b>Electromagnetic compatibility</b> <sup>16</sup>		applied harmonized standards: <ul style="list-style-type: none"> <li>• EN 61326-1</li> <li>• EN 61326-2-1</li> <li>• EN 55011 (class B)</li> </ul>
<b>Calibration interval</b>	recommended	1 year



## Appendix

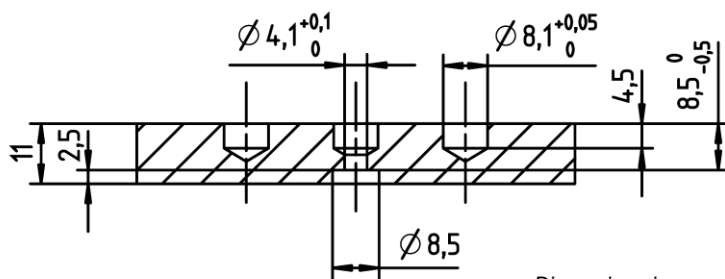
### Technical drawings of the R&S®NRPM-A66



Dimensions in mm.

#### Layout for mounting with expanding rivet

Recommended rivet: Essentra Components, SR-4120B or SR-4120W



Dimensions in mm.

## Ordering information

Designation	Type	Order No.
Three-Channel Sensor Module, for R&S®NRPM-A66 antenna modules	R&S®NRPM3	1425.8563.02
Single-Polarized Antenna Module, with integrated diode detector from 27.5 GHz to 75 GHz	R&S®NRPM-A66	1425.8740.02
<b>Accessories</b>		
Filtered Cable Feedthrough, for anechoic chamber (e.g. R&S®TS7124 shielded RF test box)	R&S®NRPM-ZD3	1425.8786.02
Interface Cable, connecting R&S®NRPM-ZD3 filtered cable feedthrough with R&S®NRPM3 sensor module	R&S®NRPM-ZKD3	1425.8770.02
Interface Module, for operation without anechoic chamber	R&S®NRPM-Z3	1426.7602.02
USB Interface Cable, length: 0.75 m	R&S®NRP-ZKU	1419.0658.02
USB Interface Cable, length: 1.50 m	R&S®NRP-ZKU	1419.0658.03
USB Interface Cable, length: 3.00 m	R&S®NRP-ZKU	1419.0658.04
USB Interface Cable, length: 5.00 m	R&S®NRP-ZKU	1419.0658.05
Six-Pole Interface Cable, length: 1.50 m	R&S®NRP-ZK6	1419.0664.02
Six-Pole Interface Cable, length: 3.00 m	R&S®NRP-ZK6	1419.0664.03
Six-Pole Interface Cable, length: 5.00 m	R&S®NRP-ZK6	1419.0664.04

<b>Warranty</b>		
R&S®NRPM3, R&S®NRPM-A66		3 years
All other items <sup>17</sup>		1 year
<b>Options</b>		
Extended Warranty, one year	R&S®WE1	Please contact your local Rohde & Schwarz sales office.
Extended Warranty, two years	R&S®WE2	
Extended Warranty with Calibration Coverage, one year	R&S®CW1	
Extended Warranty with Calibration Coverage, two years	R&S®CW2	
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 a term of one and two years (WE1 and WE2)

Repairs carried out during the contract term are free of charge <sup>18</sup>. Necessary calibration and adjustments carried out during repairs are also covered.

### Extended warranty with calibration coverage (CW1 and CW2)

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>18</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 and AW2)

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>18</sup> and accredited calibration at the recommended intervals as well as any accredited calibration carried out during repairs or option upgrades.

## Footnotes

- <sup>1</sup> The power of the incident electromagnetic wave towards the antenna module can be measured in various quantities:
  - a) Equivalent isotropically received power  $P_{ISO}$  in W or dBm (default): Equivalent detected power of an isotropic antenna with an ideal power detector at the phase center location of the R&S®NRPM antenna module assuming radiation only from boresight direction.
  - b) Power at the internal RF detector in W or dBm: The measurement result without including antenna gain and frequency dependent calibration factors.
  - c) Power density  $S$  in W/m<sup>2</sup>, calculated as  $S = \frac{4\pi}{\lambda^2} \cdot P_{ISO}$ .
  - d) Electric field strength  $E_{eff}$  in V/m, calculated as  $E_{eff} = \sqrt{S \cdot Z_0}$  with  $Z_0 = 376.73\Omega$ .
  - e) Magnetic field strength  $H_{eff}$  in A/m, calculated as  $H_{eff} = \sqrt{S/Z_0}$  with  $Z_0 = 376.73\Omega$ .
- <sup>2</sup> Preferably used with determined modulation when the aperture time cannot be matched to the modulation period. Compared to a uniform window, measurement noise is about 22 % higher.
- <sup>3</sup> For measuring the power of periodic bursts based on an average power measurement.
- <sup>4</sup> Specifications are valid for repeat mode, extending from the beginning to the end of all transfers. The actual values depend on the host system, therefore typical values are specified. They have been measured with a USB connection including one USB hub using the USBTMC protocol.
- <sup>5</sup> Time span prior to triggering, where the trigger signal must be entirely below the threshold level in the case of a positive slope and vice versa in the case of a negative slope.
- <sup>6</sup> With a resolution of 256 pixel.
- <sup>7</sup> Far-field distance calculated according to the equation  $\frac{2D^2}{\lambda}$ , where  $D$  is the largest lateral dimension of the antenna and  $\lambda$  is the wavelength.
- <sup>8</sup> Specifications expressed as an expanded uncertainty with a confidence level of 95 % (two standard deviations). For calculating zero offsets at higher confidence levels, use the properties of the normal distribution (e.g. 99.7 % confidence level for three standard deviations).
- <sup>9</sup> Within one hour after zeroing, permissible temperature change  $\pm 1$  °C, following a two-hour warm-up of the antenna module.
- <sup>10</sup> Two standard deviations at 10.24 s integration time in continuous average mode, with aperture time set to default value.  
The integration time is defined as the total time used for signal acquisition, i.e. the product of twice the aperture time and the averaging number. Multiplying the noise specifications by  $\sqrt{(10.24 \text{ s}/\text{integration time})}$  yields the noise contribution at other integration times. Using a von Hann window function increases noise by a factor of 1.22.
- <sup>11</sup> Expanded uncertainty ( $k = 2$ ) for absolute power measurements on CW signals in the far-field range with a maximum alignment error of  $\pm 2^\circ$  in azimuth and elevation relative to the reference boresight of the R&S®NRPM-A66. Specifications include calibration uncertainty, linearity, temperature and humidity effect. Humidity effect is treated as systematic effect and therefore added linearly to the expanded uncertainty as proposed in the GUM, JCGM\_100\_2008\_E.pdf, F.2.4.5. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers.
- <sup>12</sup> Expanded uncertainty ( $k = 2$ ) for relative power measurements on CW signals of the same frequency. Specifications include linearity and temperature effect. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers.
- <sup>13</sup> Expanded uncertainty ( $k = 2$ ) for absolute power measurements on CW signals at the calibration level (+3 dBm input power at the transmit antenna) and the calibration frequencies (in steps of 250 MHz from 57 GHz to 66 GHz) in the far-field range with a maximum alignment error of  $\pm 1.25^\circ$  in azimuth and elevation relative to the reference boresight of the R&S®NRPM-A66. The calibration setup is positioned in an anechoic chamber within a temperature range from +20 °C to +25 °C and a relative humidity range from +40 % to +60 %. A standard gain horn with a gain of approx. 23 dB is used as transmit antenna. The calibration distance is 1 m. Specifications include zero offset and measurement noise (up to a  $2\sigma$  value of 0.004 dB).
- <sup>14</sup> In the frequency range from 27.5 GHz to < 50 GHz default calibration factors are stored into the antenna module. In the frequency range from 50 GHz to < 57 GHz and from > 66 GHz to 75 GHz the antenna modules are individually calibrated.
- <sup>15</sup> The operating temperature range defines the span of ambient temperature in which the instrument complies with specifications. In the permissible temperature range, the instrument is still functioning but compliance with specifications is not warranted.
- <sup>16</sup> Immunity tests have been performed with the R&S®NRPM-A66 antenna module mounted into an anechoic chamber using the R&S®NRPM-ZD3 filtered cable feedthrough. In case of a measurement setup with the R&S®NRPM-Z3 interface module the R&S®NRPM-A66, the R&S®NRPM3 and the R&S®NRPM-Z3 have been arranged inside an anechoic environment.
- <sup>17</sup> For options that are installed, the remaining base unit warranty applies if longer than 1 year. Exception: all batteries have a 1 year warranty.
- <sup>18</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.

## Sustainable product design

- | 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 GmbH & Co. KG

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## Rohde & Schwarz training

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R&S®NRPM Over-the-Air (OTA) Power Measurement Solution

Data without tolerance limits is not binding | Subject to change

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