R&S®NRPxxE DIODE POWER SENSORS

Specifications

Specifications
Version 01.00

ROHDE&SCHWARZ
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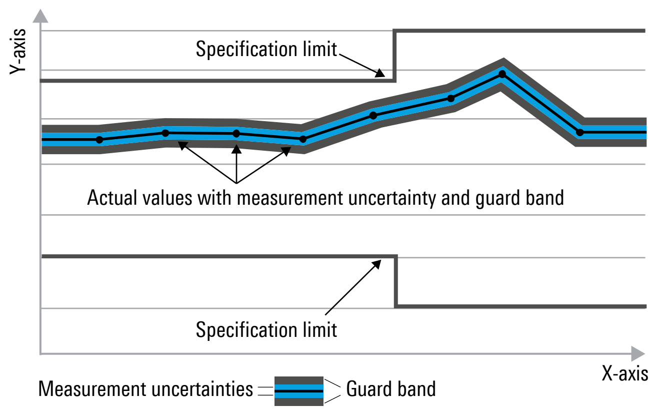
CONTENTS

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
Represent warranted product performance by means of a range of values for the specified parameter. These specifications are marked with limiting symbols such as <, ≤, >, ≥, ±, or descriptions such as maximum, limit of, minimum. Compliance is ensured by testing or is derived from the design. Test limits are narrowed by guard bands to take into account measurement uncertainties, drift and aging, if applicable.



Specifications without limits
Represent warranted product performance for the specified parameter. These specifications are not specially marked and represent values with no or negligible deviations from the given value (e.g. dimensions or resolution of a setting parameter). Compliance is ensured by design.

Typical values (typ.)
Characterizes product performance by means of representative information for the given parameter. When marked with <, > or as a range, it represents the performance met by approximately 80 % of the instruments at production time. Otherwise, it represents the mean value.

Nominal values (nom.)
Characterize product performance by means of a representative value for the given parameter (e.g. nominal impedance). In contrast to typical data, a statistical evaluation does not take place and the parameter is not tested during production.

Measured values (meas.)
Characterize expected product performance by means of measurement results gained from individual samples.

Uncertainties
Represent limits of measurement uncertainty for a given measurand. Uncertainty is defined with a coverage factor of 2 and has been calculated in line with the rules of the Guide to the Expression of Uncertainty in Measurement (GUM), taking into account environmental conditions, aging, wear and tear.

Device settings and GUI parameters are indicated as follows: “parameter: value”.

Typical data as well as nominal and measured values are not warranted by Rohde & Schwarz.

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

Specifications

R&S®NRP8E/NRP18E diode power sensors

Specifications from 10 MHz to 8 GHz apply to the R&S®NRP8E.
Specifications from 10 MHz to 18 GHz apply to the R&S®NRP18E.

Frequency range	R&S®NRP8E	10 MHz to 8 GHz	
	R&S®NRP18E	10 MHz to 18 GHz	
Impedance matching (SWR)	10 MHz to 2.4 GHz	< 1.13 (1.11)	( ): +15 °C to +35 °C
	> 2.4 GHz to 8.0 GHz	< 1.20 (1.18)	
	> 8.0 GHz to 18.0 GHz	< 1.25 (1.23)	
Power measurement range	continuous average	1 nW to 100 mW (–60 dBm to +20 dBm)	
	burst average	3 µW to 100 mW (–25 dBm to +20 dBm)	
	timeslot/gate average	3 nW to 100 mW (–55 dBm to +20 dBm) [1]	
	trace	20 nW to 100 mW (–47 dBm to +20 dBm) [2]	
Maximum power	average power	400 mW (+26 dBm) AVG, max. 10 V DC (An overload warning is triggered at an average power of 110 mW.)	
	peak envelope power	2 W (+33 dBm) for max. 10 µs	
Measurement subranges	path 1	–60 dBm to –15 dBm	
	path 2	–53 dBm to +5 dBm	
	path 3	–33 dBm to +20 dBm	
Transition regions	with automatic path selection [3]	(–20 ± 1) dBm to (–14 ± 1) dBm, (0 ± 1) dBm to (+6 ± 1) dBm	
Dynamic response	video bandwidth	> 100 kHz	
	rise time 10 %/90 %	< 5 µs	
Acquisition	sample rate (continuous)	2 Msps	
	accuracy of timebase	±5 ppm	
Triggering	internal		
	threshold level range	–28 dBm to +20 dBm	
	threshold level accuracy	identical to uncertainty for absolute power measurements	
	threshold level hysteresis	0 dB to 10 dB	
	dropout [4]	0 s to 10 s	
	external	EXTernal[1]: R&S®NRX/NRP2 or 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	
Zero offset	initial, without zeroing		
	path 1	< 235 pW	
	path 2	< 10.3 nW	
	path 3	< 0.93 µW	
	after external zeroing [5]		
	path 1	< 49 pW	
	path 2	< 2.1 nW	
	path 3	< 192 nW	
Zero drift [6]	path 1	< 12 pW	
	path 2	< 0.5 nW	
	path 3	< 47 nW	
Measurement noise [7]	path 1	< 230 pW	
	path 2	< 1.5 nW	
	path 3	< 136 nW	

Uncertainty for absolute power measurements [8] in dB

10 MHz to < 20 MHz

Power level in dBm	–60 to –20	–20 to 0	0 to +20
0 °C to +50 °C	*0.224*	*0.187*	*0.181*
+15 °C to +35 °C	*0.098*	*0.087*	*0.085*

20 MHz to < 100 MHz

Power level in dBm	–60 to –20	–20 to 0	0 to +20
0 °C to +50 °C	*0.195*	*0.177*	*0.172*
+15 °C to +35 °C	*0.089*	*0.085*	*0.083*

100 MHz to 2.4 GHz

Power level in dBm	–60 to –20	–20 to 0	0 to +20
0 °C to +50 °C	*0.161*	*0.168*	*0.163*
+15 °C to +35 °C	*0.084*	*0.086*	*0.085*

> 2.4 GHz to 8 GHz

Power level in dBm	–60 to –20	–20 to 0	0 to +20
0 °C to +50 °C	*0.162*	*0.168*	*0.164*
+15 °C to +35 °C	*0.088*	*0.089*	*0.088*

> 8 GHz to 12.4 GHz

Power level in dBm	–60 to –20	–20 to 0	0 to +20
0 °C to +50 °C	*0.166*	*0.172*	*0.166*
+15 °C to +35 °C	*0.096*	*0.096*	*0.095*

> 12.4 GHz to 18 GHz

Power level in dBm	–60 to –20	–20 to 0	0 to +20
0 °C to +50 °C	*0.174*	*0.182*	*0.178*
+15 °C to +35 °C	*0.110*	*0.111*	*0.112*

Uncertainty for relative power measurements [9] in dB

10 MHz to < 20 MHz

Power level 1 (dBm)	Temperature	−60 to −20	−14 to 0	+6 to +20
+6 to +20	0 °C to +50 °C	*0.267*	*0.239*	*0.027*
	+15 °C to +35 °C	*0.107*	*0.097*	*0.026*
−14 to 0	0 °C to +50 °C	*0.260*	*0.028*	*0.239*
	+15 °C to +35 °C	*0.103*	*0.024*	*0.097*
−60 to −20	0 °C to +50 °C	*0.022*	*0.260*	*0.267*
	+15 °C to +35 °C	*0.022*	*0.103*	*0.107*

Power level in dBm

20 MHz to < 100 MHz

Power level 1 (dBm)	Temperature	−60 to −20	−14 to 0	+6 to +20
+6 to +20	0 °C to +50 °C	*0.242*	*0.228*	*0.027*
	+15 °C to +35 °C	*0.100*	*0.096*	*0.026*
−14 to 0	0 °C to +50 °C	*0.235*	*0.028*	*0.228*
	+15 °C to +35 °C	*0.097*	*0.024*	*0.096*
−60 to −20	0 °C to +50 °C	*0.022*	*0.235*	*0.242*
	+15 °C to +35 °C	*0.022*	*0.097*	*0.100*

Power level in dBm

100 MHz to 2.4 GHz

Power level 1 (dBm)	Temperature	−60 to −20	−14 to 0	+6 to +20
+6 to +20	0 °C to +50 °C	*0.213*	*0.217*	*0.027*
	+15 °C to +35 °C	*0.093*	*0.093*	*0.026*
−14 to 0	0 °C to +50 °C	*0.208*	*0.028*	*0.217*
	+15 °C to +35 °C	*0.090*	*0.024*	*0.093*
−60 to −20	0 °C to +50 °C	*0.022*	*0.208*	*0.213*
	+15 °C to +35 °C	*0.022*	*0.090*	*0.093*

Power level in dBm

> 2.4 GHz to 8 GHz

Power level 1 (dBm)	Temperature	−60 to −20	−14 to 0	+6 to +20
+6 to +20	0 °C to +50 °C	*0.211*	*0.214*	*0.027*
	+15 °C to +35 °C	*0.095*	*0.093*	*0.026*
−14 to 0	0 °C to +50 °C	*0.205*	*0.028*	*0.214*
	+15 °C to +35 °C	*0.092*	*0.024*	*0.093*
−60 to −20	0 °C to +50 °C	*0.022*	*0.205*	*0.211*
	+15 °C to +35 °C	*0.022*	*0.092*	*0.095*

Power level in dBm

> 8 GHz to 12.4 GHz

Power level 1 (dBm)	Temperature	−60 to −20	−14 to 0	+6 to +20
+6 to +20	0 °C to +50 °C	*0.212*	*0.215*	*0.029*
	+15 °C to +35 °C	*0.099*	*0.097*	*0.027*
−14 to 0	0 °C to +50 °C	*0.207*	*0.029*	*0.215*
	+15 °C to +35 °C	*0.095*	*0.025*	*0.097*
−60 to −20	0 °C to +50 °C	*0.022*	*0.207*	*0.212*
	+15 °C to +35 °C	*0.022*	*0.095*	*0.099*

Power level in dBm

> 12.4 GHz to 18 GHz

Power level 1 (dBm)	Temperature	−60 to −20	−14 to 0	+6 to +20
+6 to +20	0 °C to +50 °C	*0.219*	*0.223*	*0.034*
	+15 °C to +35 °C	*0.109*	*0.108*	*0.033*
−14 to 0	0 °C to +50 °C	*0.212*	*0.031*	*0.223*
	+15 °C to +35 °C	*0.102*	*0.027*	*0.108*
−60 to −20	0 °C to +50 °C	*0.022*	*0.212*	*0.219*
	+15 °C to +35 °C	*0.022*	*0.102*	*0.109*

Power level in dBm

The example shows a level step of approx. 14 dB (–4 dBm → +10 dBm) at 1.9 GHz and an ambient temperature of +28 °C for an R&S®NRP8E diode power sensor. The expanded uncertainty for relative power measurements in this example is 0.093 dB.

100 MHz to 2.4 GHz

Power level 1 (dBm)	Temperature	−60 to −20	−14 to 0	+6 to +20
+6 to +20	0 °C to +50 °C	*0.213*	*0.217*	*0.027*
	+15 °C to +35 °C	*0.093*	*0.093*	*0.026*
−14 to 0	0 °C to +50 °C	*0.208*	*0.028*	*0.217*
	+15 °C to +35 °C	*0.090*	*0.024*	***0.093***
−60 to −20	0 °C to +50 °C	*0.022*	*0.208*	*0.213*
	+15 °C to +35 °C	*0.022*	*0.090*	*0.093*

Power level in dBm

Power level 1
–4 dBm

Power level 2: +10 dBm

Additional characteristics

Sensor type		three-path diode power sensor
Measurand		power of incident wave
		power of source (DUT) into 50 Ω [10]
RF connector		N (male)
Measurement functions	stationary and recurring waveforms	continuous average
		burst average
		timeslot/gate average
		trace
	single events	burst average
		timeslot/gate average
		trace
Continuous average function	measurand	mean power over recurring acquisition interval
	aperture	10 µs to 2.0 s (20 ms default)
	window function	uniform or von Hann [11]
	duty cycle correction [12]	0.001 % to 100.0 %
	capacity of measurement buffer [13]	1 result to 8192 results
Burst average function	measurand	mean power over burst portion of recurring signal (trigger settings required)
	detectable burst width [14]	5 µs to 8 s
	minimum gap between bursts	5 µs
	dropout period [15] for burst end detection	1 µs to 300 ms
	exclusion periods [16]	
	start	0 s to 1 s
	end	0 s to 1 s
	resolution (dropout and exclusion periods)	0.5 µs (sample period)
Timeslot/gate average function	measurand	mean power over individual timeslots/gates
	number of timeslots/gates	1 to 32 (consecutive)
	nominal length	10 µs to 0.1 s
	start of first timeslot/gate	at delayed trigger event
	exclusion periods	
	start	0 s to 1 s
	end	0 s to 1 s
	resolution (nominal length and exclusion periods)	0.5 µs (sample period)
Trace function	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 100 000
	resolution	≥ 0.5 µs (sample period)
Averaging filter	modes	auto off (fixed averaging number)
		auto on (continuously auto-adapted)
		auto once (automatically fixed once)
	auto off	
	supported measurement functions	all
	averaging number	1, 2, 4, 6, 8, 10 to 65536 (1 or all even numbers between 2 and 65536)
	auto on/once	
	supported measurement functions	continuous average, burst average, timeslot/gate average
	normal operating mode	averaging number adapted to resolution setting and power to be measured
	fixed noise operating mode	averaging number adapted to specified noise content
	result output	
	moving mode	continuous result output, independent of averaging number
	repeat mode	only final result

Attenuation correction	function	corrects the measurement result by means of a fixed factor (dB offset)
	range	–200.000 dB to +200.000 dB
Embedding	function	incorporates a two-port device at the sensor input so that the measurement plane is shifted to the input of this device
	parameters	S_{11}, S_{21}, S_{12} and S_{22} of device
	number of devices	0 to 999
	total number of frequencies	≤ 80000
Gamma correction	function	removes the influence of impedance mismatch from the measurement result so that the measurand corresponds to the power of the source (DUT) into 50 Ω
	parameters	magnitude and phase of reflection coefficient of source (DUT)
Frequency response correction	function	takes the frequency response of the sensor section and of the RF power attenuator into account (if applicable)
	parameter	center frequency of test signal
	residual uncertainty	see specification of calibration uncertainty and uncertainty for absolute and relative power measurements
Measurement times [17] Av: averaging number	continuous average	
	single measurements	2 × (aperture + 100 µs) × Av + t_z
	buffered measurements, without averaging	2 × (aperture + 116 µs) × buffer size + t_z t_z = 2 ms (typ.)
Zeroing (duration)		5.3 s
Measurement error due to modulation [18]	general	depends on CCDF and RF bandwidth of test signal
	WCDMA (3GPP test model 1 to 64)	
	worst case	–0.02 dB to +0.05 dB
	typical	–0.01 dB to +0.03 dB
	E-UTRA test model 1.1 (E-TM1.1), 20 MHz	
	worst case	–0.03 dB to +0.08 dB
	typical	–0.02 dB to +0.05 dB

Change of input reflection coefficient with respect to power [19]		+15 °C to +35 °C		0 °C to +50 °C
	10 MHz to 2.4 GHz	< 0.01		< 0.02
	> 2.4 GHz	< 0.02		< 0.03
Calibration uncertainty [20]		path 1	path 2	path 3
	10 MHz to < 100 MHz	*0.058 dB*	*0.052 dB*	*0.053 dB*
	100 MHz to 2.4 GHz	*0.060 dB*	*0.058 dB*	*0.058 dB*
	> 2.4 GHz to 8.0 GHz	*0.065 dB*	*0.062 dB*	*0.063 dB*
	> 8.0 GHz to 12.4 GHz	*0.075 dB*	*0.071 dB*	*0.072 dB*
	> 12.4 GHz to 18.0 GHz	*0.092 dB*	*0.088 dB*	*0.089 dB*
Host interface	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 according to the specification		
	remote control protocols	supports USB test and measurement device class (USBTMC) and legacy mode for compatibility with R&S®NRP-Zxx power sensors		
	trigger input EXTernal[1]	differential (0 V/+3.3 V)		
	reference clock			
	signal level	LVDS		
	frequency	20 MHz		
	permissible total cable length	≤ 5 m		
Trigger-I/O EXTernal2	mechanical	SMB built-in jack		
	impedance			
	input	10 kΩ (nom.) or 50 Ω (nom.) selectable		
	output	50 Ω (nom.)		
	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		
Dimensions (W × H × L)		48 mm × 30 mm × 138 mm (1.89 in × 1.18 in × 5.43 in)		
Weight		< 0.20 kg (0.44 lb)		

Accessories

Accessories are not approved for the usage in thermal vacuum chambers.

R&S®NRP-ZKU interface cables

The R&S®NRP-ZKU interface cables are used to connect Rohde & Schwarz power sensors described in these specifications to any standard-conforming USB downstream port (USB-A receptacle), e.g. on a PC, USB hub or a Rohde & Schwarz instrument.

Connectors	sensor side	8-pin female M12 connector (A-coded)
	host side	USB-A plug
Length	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 as well as commercially available M12 extension cables. Using such extension cables can affect the reliability of the high-speed data transfer.

R&S®NRP-ZKC interface cables

The R&S®NRP-ZKC interface cables are used to connect Rohde & Schwarz power sensors described in these specifications to any standard-conforming USB downstream port (USB-C receptacle), e.g. on a PC or mobile device.

Connectors	sensor side	8-pin female M12 connector (A-coded)
	host side	USB-C plug
Length	model .02	0.75 m
	model .03	1.50 m
	model .04	3.00 m

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

R&S®NRP-ZK6 interface cables

The R&S®NRP-ZK6 interface cables are used to connect Rohde & Schwarz power sensors described in these specifications to an R&S®NRX power meter, R&S®NRP2 power meter, R&S®NRP-Z5 sensor hub or a Rohde & Schwarz instrument providing a 6-pole circular receptacle for R&S®NRP power sensors.

Connectors	sensor side	8-pin female M12 connector (A-coded)
	host side	6-pole circular plug with push-pull locking
Length	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 as well as commercially available M12 extension cables. Using such extension or adapter cables can affect the reliability of the high-speed data transfer.

R&S®NRP-ZK8 interface cables

The R&S®NRP-ZK8 interface cables are used to connect Rohde & Schwarz power sensors described in these specifications to an R&S®NRX power meter. Compared to R&S®NRP-ZK6, they contain an additional signal pair for routing the common time base clock provided by the NRX to sensors A, B, C and D.

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

The R&S®NRP-ZK8 interface cables must not be combined with commercially available M12 extension cables. Using such extension cables can affect the reliability of the high-speed data transfer.

General data for power sensors and accessories

Temperature [21]	operating temperature range	0 °C to +50 °C
	permissible temperature range	–10 °C to +55 °C
	storage temperature range	–40 °C to +85 °C
Climatic resistance	damp heat	+25 °C/+55 °C cyclic at 95 % relative humidity with restrictions: noncondensing, in line with EN 60068-2-30
Mechanical resistance	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
Altitude	operating	max. 2000 m
	transport	max. 15000 m
Electromagnetic compatibility	EU: in line with EMC Directive 2014/30/EU	applied harmonized standards: • EN 61326-1 (industrial environment) • EN 55011 (class B)
RoHS	EU: in line with Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment	applied harmonized standard: EN IEC 63000
Calibration interval	recommended	2 years

Ordering information

Designation	Type	Order No.
Diode power sensors		
1 nW to 100 mW, 10 MHz to 8 GHz	R&S®NRP8E	1444.1090.02
1 nW to 100 mW, 10 MHz to 18 GHz	R&S®NRP18E	1444.1148.02
Recommended extras for R&S®NRP8E/NRP18E A minimum of one interface cable is required for power sensor operation.		
USB-A interface cable, length: 0.75 m	R&S®NRP-ZKU	1419.0658.02
USB-A interface cable, length: 1.50 m	R&S®NRP-ZKU	1419.0658.03
USB-A interface cable, length: 3.00 m	R&S®NRP-ZKU	1419.0658.04
USB-A interface cable, length: 5.00 m	R&S®NRP-ZKU	1419.0658.05
USB-C interface cable, length: 0.75 m	R&S®NRP-ZKC	1425.2442.02
USB-C interface cable, length: 1.50 m	R&S®NRP-ZKC	1425.2442.03
USB-C interface cable, length: 3.00 m	R&S®NRP-ZKC	1425.2442.04
6-pole interface cable, length: 1.50 m	R&S®NRP-ZK6	1419.0664.02
6-pole interface cable, length: 3.00 m	R&S®NRP-ZK6	1419.0664.03
6-pole interface cable, length: 5.00 m	R&S®NRP-ZK6	1419.0664.04
8-pole interface cable, length: 1.50 m	R&S®NRP-ZK8	1424.9408.02
8-pole interface cable, length: 3.00 m	R&S®NRP-ZK8	1424.9408.03
8-pole interface cable, length: 5.00 m	R&S®NRP-ZK8	1424.9408.04
Sensor hub	R&S®NRP-Z5	1146.7740.02
Documentation		
Documentation of calibration values	R&S®DCV-1	0240.2187.06
Printout of DCV (in combination with DCV only)	R&S®DCV-ZP	1173.6506.02

Warranty		
R&S®NRP power sensors and R&S®NRP-Z5		3 years
All other items		1 year
Service options		
Extended warranty, one year	R&S®WE1	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 [22]. Necessary calibration and adjustments carried out during repairs are also covered.

Extended warranty with calibration (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 [22] 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 [22] and accredited calibration at the recommended intervals as well as any accredited calibration carried out during repairs or option upgrades.

For product brochure, see PD 5213.5539.12 and www.rohde-schwarz.com

Endnotes

1 Specifications apply to timeslots/gates with a duration of 12.5 % referenced to the signal period (duty cycle 1:8). For other waveforms, the following equation applies: lower measurement limit = lower measurement limit for continuous average mode / √(duty cycle).

2 With a resolution of 256 pixel.

3 Specifications apply to the default transition setting of 0 dB. The transition regions can be shifted by as much as –20 dB using an adequate offset.

4 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.

5 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).

6 Within one hour after zeroing, permissible temperature change ±1 °C, following a two-hour warm-up of the power sensor.

7 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 √(10.24 s/integration time) yields the noise contribution at other integration times. Using a von Hann window function increases noise by a factor of 1.22.

8 Expanded uncertainty (k = 2) for absolute power measurements on CW signals with automatic path selection and the default transition setting of 0 dB. Specifications include calibration uncertainty, linearity and temperature effect. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers. As a rule of thumb, the contribution of zero offset can be neglected for power levels above –40 dBm. The contribution of measurement noise depends on power and integration time and can be neglected below 0.01 dB.

Example: The uncertainty of a power measurement at 32 nW (–45 dBm) and 1.9 GHz is to be determined for an R&S®NRP8E. The ambient temperature is +29 ºC and the averaging number is set to 32 in the continuous average mode with an aperture time of 20 ms.

Since path 1 is used for the measurement, the typical absolute uncertainty due to zero offset is 49 pW after external zeroing, which corresponds to a relative measurement uncertainty of

$$10 \lg \frac{32\text{ nW} + 49\text{ pW}}{32\text{ nW}}\text{ dB} = 0.007\text{ dB}.$$

Using the formula in footnote 7, the absolute noise contribution of path 1 is typically 230 pW × √(10.24 s/(32 × 2 × 0.02 s)) = 651 pW, which corresponds to a relative measurement uncertainty of

$$10 \lg \frac{32\text{ nW} + 651\text{ pW}}{32\text{ nW}}\text{ dB} = 0.087\text{ dB}.$$

Combined with the uncertainty of 0.084 dB for absolute power measurements under the given conditions, the total expanded uncertainty is

$$\sqrt{0.066^2 + 0.087^2 + 0.084^2}\text{ dB} = 0.138\text{ dB}.$$

The contribution of zero drift has been neglected in this case. It must be treated like zero offset if it is relevant for total uncertainty.

9 Expanded uncertainty (k = 2) for relative power measurements on CW signals of the same frequency with automatic path selection and a default transition setting of 0 dB. For reading the measurement uncertainty diagrams of universal, average and level control sensors.

Specifications include calibration uncertainty (only if different paths are affected), linearity and temperature effect. Zero offset, zero drift and measurement noise must additionally be taken into account when measuring low powers. As a rule of thumb, the contribution of zero offset can be neglected for power levels above –40 dBm. The contribution of measurement noise depends on power and integration time and can be neglected below 0.01 dB.

Example: The uncertainty of a power step from 0.5 mW (–3 dBm) to 100 nW (–40 dBm) at 5.4 GHz is to be determined for an R&S®NRP8E. The ambient temperature is +20 ºC and the averaging number is set to 64 for both measurements in the continuous average mode with an aperture time of 20 ms. For the calculation of total uncertainty, the relative contribution of noise, zero offset and zero drift must be taken into account for both measurements. In this example, all contributions at –3 dBm and the effect of zero drift at –40 dBm have been neglected.

Since path 1 is used for the –40 dBm measurement, the absolute uncertainty due to zero offset is 49 pW after external zeroing, which corresponds to a relative measurement uncertainty of

$$10 \lg \frac{100\text{ nW} + 49\text{ pW}}{100\text{ nW}}\text{ dB} = 0.002\text{ dB}.$$

Using the formula in footnote 7, the absolute noise contribution of path 1 is typically 230 pW × √(10.24 s/(64 × 2 × 0.02 s)) = 460 pW, which corresponds to a relative measurement uncertainty of

$$10 \lg \frac{100\text{ nW} + 460\text{ pW}}{100\text{ nW}}\text{ dB} = 0.020\text{ dB}.$$

Combined with the uncertainty of 0.092 dB for relative power measurements under the given conditions, the total expanded uncertainty is

$$\sqrt{0.002^2 + 0.020^2 + 0.092^2}\text{ dB} = 0.094\text{ dB}.$$

10 Gamma correction activated.

11 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.

12 For measuring the power of periodic bursts based on an average power measurement.

[13] To increase measurement speed, the power sensor can be operated in buffered mode. In this mode, measurement results are stored in a buffer of user-definable size and then output as a block of data when the buffer is full. To enhance measurement speed even further, the sensor can be set to record the entire series of measurements when triggered by a single event. In this case, the power sensor automatically starts a new measurement as soon as it has completed the previous one.

[14] For moving mode, the maximum burst width of a single burst is 8 s. For repeat mode the mean burst length is limited to 8 s/averaging number.

[15] This parameter enables power measurements on modulated bursts. The parameter must be longer in duration than modulation-induced power drops within the burst.

[16] To exclude unwanted portions of the signal from the measurement result.

[17] 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.

[18] Measurement error referenced to a CW signal of equal power and frequency. Specifications apply up to +20 dBm for automatic path selection or within a subrange to the maximum level of the subrange minus 3 dB.

[19] Change of the reflection coefficient (error vector magnitude) referenced to 0 dBm.

[20] Expanded uncertainty (k = 2) for absolute power measurements on CW signals at the calibration level within a temperature range from +20 °C to +25 °C and at the calibration frequencies. Specifications include zero offset and measurement noise (up to a 2σ value of 0.004 dB). The calibration level is –20 dBm for path 1 and 0 dBm for paths 2 and 3.

[21] 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.

[22] Excluding defects caused by incorrect operation or handling and force majeure. Wear-and-tear parts are not included.

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