Power Density Measurement Report

Application No.:	SZCR2408003031AT
Applicant:	KEYENCE CORPORATION
Address of Applicant:	1-3-14, Higashinakajima, Higashiyodogawa-ku, Osaka, 533-8555 Japan
Manufacturer:	KEYENCE CORPORATION
Address of Manufacturer:	1-3-14, Higashinakajima, Higashiyodogawa-ku, Osaka, 533-8555 Japan
Factory:	KEYENCE CORPORATION
Address of Factory:	1-3-14, Higashinakajima, Higashiyodogawa-ku, Osaka, 533-8555 Japan
Product Name:	Handheld Terminal
Model No.:	BT-A600
Trade Mark:	KEYENCE
FCC ID:	RF41761B
Standards:	FCC 47CFR §2.1093 IEC/IEEE 63195-1:2022 IEC/IEEE 62209-1528:2020
Date of Receipt:	2024/08/02
Date of Test:	2024/08/03 to 2024/08/06
Date of Issue:	2024/08/08
Test conclusion:	**PASS ***

*In the configuration tested, the EUT detailed in this report complied with the standards specified above.

Keny. xu

Keny Xu

EMC Laboratory Manager

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Revision History			
Report Number	***Revision***	***Description***	***Issue Date***
SZCR240800303101	01	Original	2024/08/08

Authorized for issue by:				
		Calvin Weng **Calvin Weng / Project Engineer**		
		Eric Fu **Eric Fu / Reviewer**		

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TEST SUMMARY

Frequency Band	Reported PD (W/m²)
WIFI 6E	8.05
PD Limit	10

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CONTENTS

1 GENERAL INFORMATION 5

1.1 TEST LOCATION 5
1.2 GENERAL DESCRIPTION OF EUT 5
1.3 TEST SPECIFICATION 6
1.4 RF EXPOSURE LIMIT FOR ABOVE 6GHZ 7

2 SYSTEM DESCRIPTION AND SETUP 8

2.1 POWER DENSITY MEASUREMENT SYSTEM 8
2.2 EUMMWAVE PROBE 9
2.3 SCAN CONFIGURATION 10

3 SYSTEM VERIFICATION PROCEDURE 11

3.1 PD TEST SYSTEM VERIFICATION 11
3.2 PD SYSTEM VERIFICATION RESULTS 12
3.3 DETAILED SYSTEM CHECK RESULTS 12

4 MEASUREMENT DATA 13

4.1 MEASUREMENT OF RF CONDUCTED POWER 13
4.2 PD TEST DATA 14

5 EQUIPMENT LIST 15

6 MEASUREMENT UNCERTAINTY 16

7 CALIBRATION CERTIFICATE 17

8 PHOTOGRAPHS 17

APPENDIX A: DETAILED SYSTEM CHECK RESULTS 17

APPENDIX B: DETAILED TEST RESULTS 17

APPENDIX C: CALIBRATION CERTIFICATE 17

APPENDIX D: PHOTOGRAPHS 17

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1 General Information

1.1 Test Location

Company:	SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch
Address:	No. 1 Workshop, M-10, Middle section, Science & Technology Park, Nanshan District, Shenzhen, Guangdong, China
Post code:	518057
Test Engineer:	Vito Wang

1.2 General Description of EUT

Device Type :	portable device		
Exposure Category:	uncontrolled environment / general population		
Product Name:	Handheld Terminal		
Model No.(EUT):	BT-A600		
FCC ID:	RF41761B		
Product Phase:	production unit		
Hardware Version:	V1.03		
Software Version:	T48		
Antenna Type:	FPC Antenna		
Modulation Mode:	OFDMA		
Frequency Bands:	Band	Tx (MHz)	Rx (MHz)
	UNII-5	5925-6425	5925-6425
	UNII-6	6425-6525	6425-6525
	UNII-7	6525-6875	6525-6875
	UNII-8	6875-7125	6875-7125

Note: *Since the above data and/or information is provided by the client relevant results or conclusions of this report are only made for these data and/or information, SGS is not responsible for the authenticity, integrity and results of the data and information and/or the validity of the conclusion.
Remark:
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1.3 Test Specification

Identity	Document Title
FCC 47CFR §2.1093	Radiofrequency Radiation Exposure Evaluation: Portable Devices
ANSI/IEEE C95.1-1992	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.
IEC/IEEE 62209-1528:2020	Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)
IEC/IEEE 63195-1:2022	Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz) – Part 1: Measurement procedure
KDB 447498 D04	Interim General RF Exposure Guidance v01
KDB 248227 D01	SAR Guidance for IEEE 802 11 Wi-Fi SAR v02r02

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1.4 RF exposure limit for above 6GHz

According to ANSI/IEEE C95.1-1992, the criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in §1.1310.

Peak Spatially Averaged Power Density was evaluated over a circular area of 4cm2 per interim FCC Guidance for near-field power density evaluations per October 2018 TCB Workshop notes

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f2)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f2)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

Note: 1.0 mW/cm^2 is equal to 10 W/m^2

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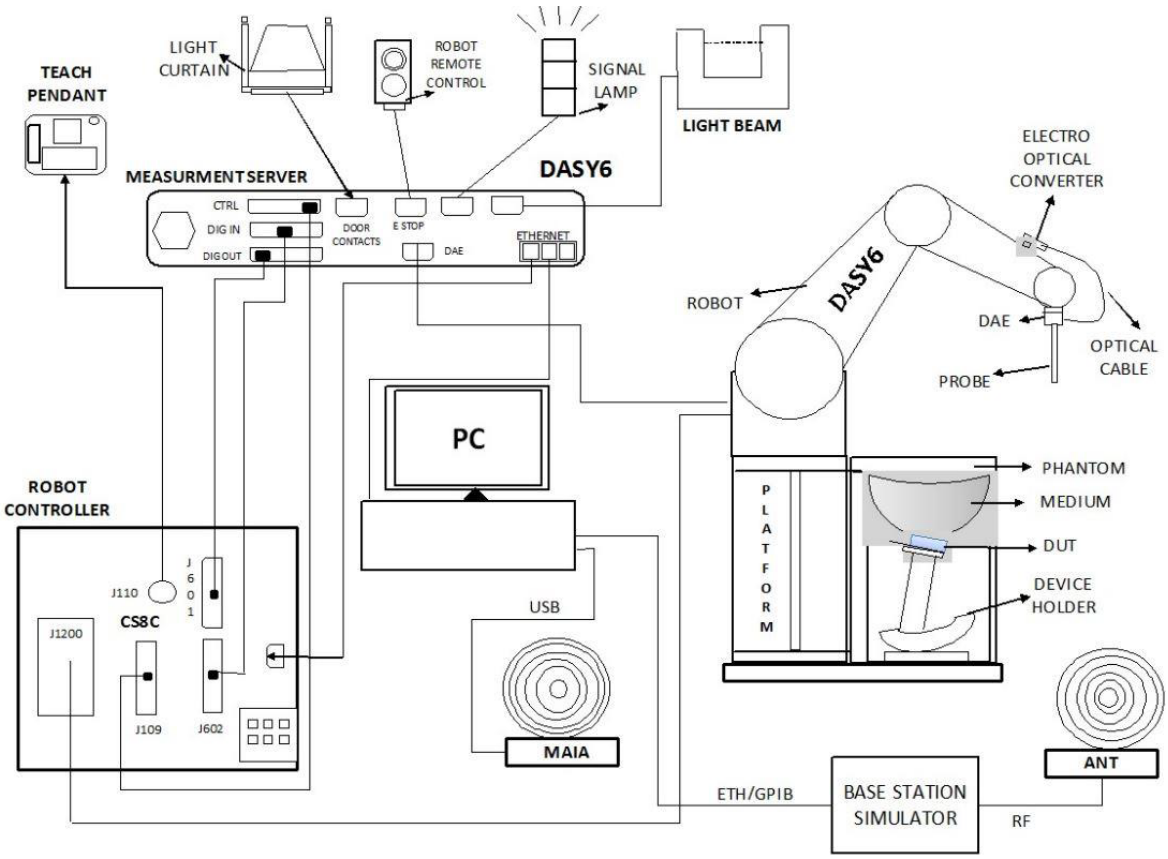
2 System Description and Setup

2.1 Power density measurement system

Power density measurements for mmWave frequencies were performed using SPEAG DASY6 with cDASY6 5G module. The DASY6 included a high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the 5G phantom cover.



Measurement System Configuration

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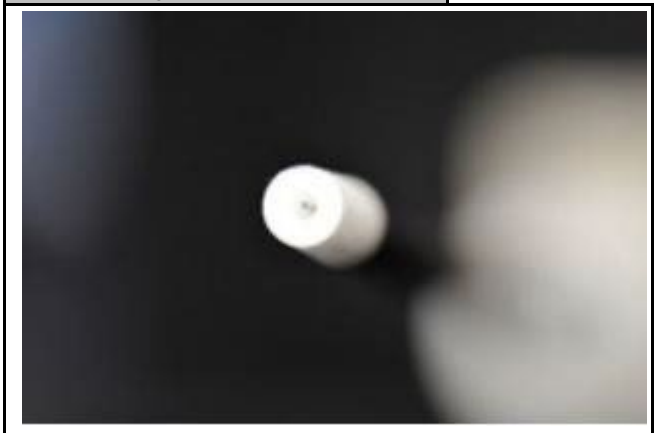
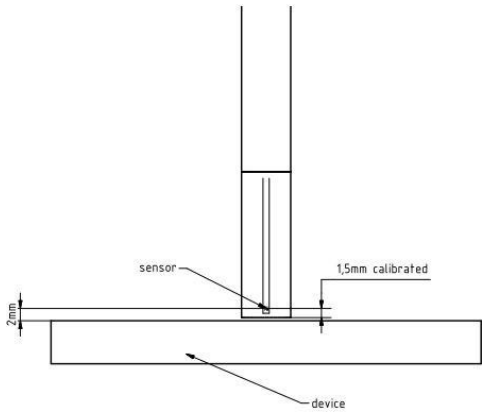
2.2 EUmmWaVe probe

Frequency	750 MHz – 110 GHz
Probe Overall Length	320 mm
Probe Body Diameter	8.0 mm
Tip Length	23.0 mm
Tip Diameter	8.0 mm
Probe's two dipoles length	0.9 mm – Diode loaded
Dynamic Range	< 20 V/m - 10000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm
Distance between diode sensors and probe's tip	1.5 mm
Minimum Mechanical separation between probe tip and a Surface	0.5 mm
Applications	E-field measurements of 5G devices and other mm-wave transmitters operating above 10GHz in < 2 mm distance from device (free-space) Power density, H-field and far-field analysis using total field reconstruction.
Compatibility	cDASY6 + 5G-Module SW1.0 and higher





The EUmmWaVe probe is based on the pseudo-vector probe design, which not only measures the field magnitude but also derives its polarization ellipse. The design entails two small 0.8mm dipole sensors mechanically protected by high-density foam, printed on both sides of a 0.9mm wide and 0.12mm thick glass substrate. The body of the probe is specifically constructed to minimize distortion by the scattered fields. The probe consists of two sensors with different angles (1 and 2) arranged in the same plane in the probe axis. Three or more measurements of the two sensors are taken for different probe rotational angles to derive the amplitude and polarization information. The probe design allows measurements at distances as small as 2mm from the sensors to the surface of the device under test (DUT). The typical sensor to probe tip distance is 1.5 mm. The exact distance is calibrated.

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Data Acquisition Electronics (DAE)

Model	DAE	
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.	
Measurement Range	-100 to +300 mV (16-bit resolution and two range settings: 4mV,400mV)	
Input Offset Voltage	< 5μV (with auto zero)	
Input Bias Current	< 50 f A	
Dimensions	60 x 60 x 68 mm	

2.3 Scan configuration

Fine-resolution scans on 2 different planes are performed to reconstruct the E- and H-fields as well as the power density; the z-distance between the 2 planes is set to λ/4. The (x, y) grid step is also setλ/4, the grid extent is set to sufficiently large to identify the field pattern and the peak.

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3 System Verification Procedure

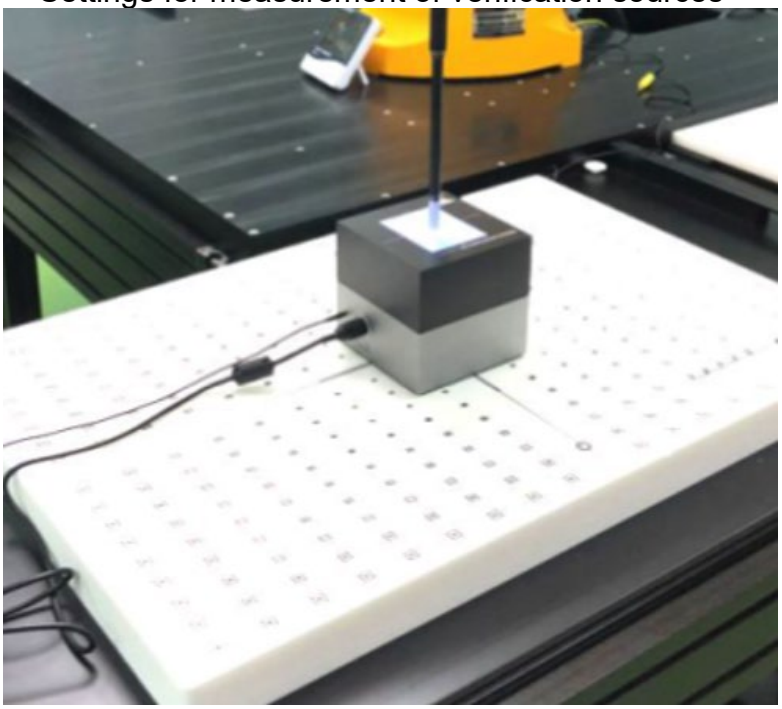
3.1 PD Test System Verification

The system was verified to be within ±0.66 dB of the power density targets on the calibration certificate according to the test system specification in the user's manual and calibration facility recommendation. The 0.66 dB deviation threshold represents the expanded uncertainty for system performance checks using SPEAG's mmWave verification sources. The same spatial resolution and measurement region used in the source calibration was applied during the system check.

The measured power density distribution of verification source was also confirmed through visual inspection to have no noticeable differences, both spatially (shape) and numerically (level) from the distribution provided by the manufacturer, per November 2017 TCBC Workshop Notes.

Frequency [GHz]	Grid step	Grid extent X/Y [mm]	Measurement points
10	0.25 ($\frac{\lambda}{4}$)	120/120	16 × 16
30	0.25 ($\frac{\lambda}{4}$)	60/60	24 × 24
60	0.25 ($\frac{\lambda}{4}$)	32.5/32.5	26 × 26
90	0.25 ($\frac{\lambda}{4}$)	30/30	36 × 36

Settings for measurement of verification sources



System Verification Setup Photo

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3.2 PD System Verification Results

PD System Validation Result(s)				
Frequent	Measured PD W/m²	Target PD W/m²	Circular Deviation (Within ±0.66dB)	Test Date
	4cm²	4cm²	4cm²	
10GHz Source	183.00	174	0.22	2024/8/6

3.3 Detailed System Check Results

Please see the Appendix A

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4 Measurement Data

1. The PD test was performed of a 2mm separation between sensor and EUT surface (the probe tip is 0.5mm to the EUT surface), 2 mm separation distance PD testing is for hotspot and body worn exposure conditions.

2. According to TCBC Workshop in October 2018, 4 cm^2 averaging area are used.

4.1 Measurement of RF Conducted Power

WIFI 6G				WIFI 6G SISO Ant1		WIFI 6G SISO Ant5		WIFI 6G MIMO	
mode	Channel	Frequency(MHz)	Data Rate(Mbps)	Average Power (dBm)	Tune up	Average Power (dBm)	Tune up	Average Power (dBm)	Tune up
802.11ax (HE20)	1	5955	MCS0	3.21	4.50	2.12	3.50	5.71	7.00
	97	6435		3.33	4.50	3.22	4.50	6.29	7.50
	117	6535		3.69	5.00	5.12	6.50	7.47	8.50
	189	6895		3.99	5.00	2.95	4.00	6.51	8.00
	233	7115		2.25	3.50	3.03	4.50	5.67	7.00
802.11ax (HE40)	3	5965	MCS0	4.90	6.00	3.20	4.50	7.14	8.50
	99	6445		4.61	6.00	6.35	7.50	8.58	10.00
	147	6685		3.88	5.00	4.32	5.50	7.12	9.00
	195	6925		4.92	6.00	6.33	7.50	8.69	10.00
	227	7085		3.70	5.00	4.83	6.00	7.31	8.50
802.11ax (HE80)	7	5985	MCS0	4.54	6.00	3.09	4.50	6.89	8.00
	103	6465		4.31	5.50	5.27	6.50	7.83	9.00
	151	6705		4.82	6.00	5.32	6.50	8.09	8.50
	199	6945		4.79	6.00	5.91	7.00	8.40	9.50
	215	7025		3.85	5.00	5.46	6.50	7.74	8.00
802.11ax (HE160)	15	6025	MCS0	1.85	3.00	1.21	2.50	4.55	6.00
	47	6185		1.99	3.00	0.63	2.00	4.37	5.50
	79	6345		1.74	3.00	2.19	3.50	4.98	6.00
	143	6665		2.38	3.50	3.67	5.00	6.08	7.50
	207	6985		1.10	2.50	3.14	4.50	5.25	6.50

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4.2 PD Test Data

Wi-Fi 6E SAR Test Record MIMO														
Test position	Test mode	Test ch./Freq.	Distance (mm)	Grid Step (λ)	Duty Cycle	Duty Cycle Scaled factor	iPDn	iPD ratio	Measured PD 4cm^2 (W/m^2)	Power drift (dB)	Conducted Power(dBm)	Tune up Limit(dBm)	Scaled factor	Scaled PD 4cm^2 (W/m^2)
Power Density Test DATA														
Front side	802.11ax HEW40	195/6925	2	0.0625	99.80%	1.002	/	/	1.12	0.05	8.69	10.00	1.352	1.52
Back side	802.11ax HEW40	195/6925	2	0.0625	99.80%	1.002	/	/	0.11	0.09	8.69	10.00	1.352	0.15
Left side	802.11ax HEW40	195/6925	2	0.0625	99.80%	1.002	42.50	-0.51	**5.94**	-0.10	8.69	10.00	1.352	**8.05**
Left side	802.11ax HEW40	195/6925	8.7	0.0625	99.80%	1.002	47.80		5.52	0.15	8.69	10.00	1.352	7.48
Right side	802.11ax HEW40	195/6925	2	0.0625	99.80%	1.002	/	/	2.29	0.01	8.69	10.00	1.352	3.10
Top side	802.11ax HEW40	195/6925	2	0.0625	99.80%	1.002	/	/	0.98	0.08	8.69	10.00	1.352	1.33
Left side	802.11ax HEW40	147/6685	2	0.0625	99.80%	1.002	/	/	0.83	0.07	7.12	9.00	1.542	1.28
Left side	802.11ax HEW40	3/5965	2	0.0625	99.80%	1.002	/	/	4.12	0.03	7.14	8.50	1.368	5.65
Left side	802.11ax HEW40	99/6445	2	0.0625	99.80%	1.002	/	/	4.78	-0.01	8.58	10.00	1.387	6.64
Left side	802.11ax HEW40	227/7085	2	0.0625	99.80%	1.002	/	/	1.16	0.09	7.31	8.50	1.315	1.53

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5 Equipment list

Test Platform	SPEAG DASY Professional
Description	PD Test System
Software Reference	cDASY6 V2.2.0.76

Hardware Reference

	Equipment	Manufacturer	Model	Inventory No.	Calibration Date	Due date of calibration
☒	Phantom	SPEAG	mmWave Phantom	SZ-WSR-A-029	NCR	NCR
☒	DAE	SPEAG	DAE4	SZ-WSR-M-031	2024-03-18	2025-03-17
☒	E-U Probe	SPEAG	EUmmWV4	SZ-WSR-M-048	2023-08-18	2024-08-17
☒	5G Verification Source	SPEAG	10GHz	SZ-WSR-M-049	2023-08-21	2024-08-20
☒	RF Bi-Directional Coupler	Agilent	86205-60001	SZ-WSR-A-004	NCR	NCR
☒	Signal Generator	Agilent	N5171B	SZ-WSR-M-006	2024/01/30	2025/01/29
☒	Preamplifier	Mini-Circuits	ZHL-42W	SZ-WSR-A-001	NCR	NCR
☒	Preamplifier	Compliance Directions Systems Inc.	AMP28-3W	SZ-WSR-A-002	NCR	NCR
☒	Power Meter	Agilent	E4416A	SZ-WSR-M-007	2024/01/30	2025/01/29
☒	Power Sensor	Agilent	8481H	SZ-WSR-M-008	2024/01/30	2025/01/29
☒	Power Sensor	R&S	NRP-Z92	SZ-WSR-M-009	2024/01/30	2025/01/29
☒	Attenuator	SHX	TS2-3dB	SZ-WSR-A-012	NCR	NCR
☒	Humidity and Temperature Indicator	CHIGAO	HTC-1	SZ-WSR-M-013	2024/05/28	2025/05/27

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6 Measurement Uncertainty

cDASY6 Module mmWave Uncertainty Budget for PD Evaluation Distances to the Antennas≧ λ/5						
a	b	c	d	e	f=b*e/d	g
Error Description	Uncertainty Value (±dB)	Probability	Div.	Ci	Standard Uncertainty (±dB)	Vi (Veff)
Uncertainty terms dep endent on the measurement system						
Probe Calibration	0.49	N	1	1	0.49	∞
Probe correction	0.00	R	1.732	1	0.00	∞
Frequency response (BW ≤1 GHz)	0.20	R	1.732	1	0.12	∞
Sensor cross coupling	0.00	R	1.732	1	0.00	∞
Isotropy	0.50	R	1.732	1	0.29	∞
Linearity	0.20	R	1.732	1	0.12	∞
Probe scattering	0.00	R	1.732	1	0.00	∞
Probe positioning offset	0.30	R	1.732	1	0.17	∞
Probe positioning repeatability	0.04	R	1.732	1	0.02	∞
Sensor mechanical offset	0.00	R	1.732	1	0.00	∞
Probe spatial resolution	0.00	R	1.732	1	0.00	∞
Field impedance dependance	0.00	R	1.732	1	0.00	∞
Amplitude and phase drift	0.00	R	1.732	1	0.00	∞
Amplitude and phase noise	0.04	R	1.732	1	0.02	∞
Measurement area truncation	0.00	R	1.732	1	0.00	∞
Data acquisition	0.03	N	1	1	0.03	∞
Sampling	0.00	R	1.732	1	0.00	∞
Field reconstruction	2.00	R	1.732	1	1.15	∞
Forward transformation	0.00	R	1.732	1	0.00	∞
Power density scaling	0.00	R	1.732	1	0.00	∞
Spatial averaging	0.10	R	1.732	1	0.06	∞
System detection limit	0.04	R	1.732	1	0.02	∞
Uncertainty terms dep endent on the DUT and environmental factors						
Probe coupling with DUT	0.00	R	1.732	1	0.00	∞
Modulation response	0.40	R	1.732	1	0.23	∞
Integration time	0.00	R	1.732	1	0.00	∞
Response time	0.00	R	1.732	1	0.00	∞
Device holder influence	0.10	R	1.732	1	0.06	∞
DUT alignment	0.00	R	1.732	1	0.00	∞
RF ambient conditions	0.04	R	1.732	1	0.02	∞
Ambient reflections	0.04	R	1.732	1	0.02	∞
Immunity / secondary reception	0.00	R	1.732	1	0.00	∞
Drift of the DUT		R	1.732	1	0.00	∞
Combined Std. Uncertainty					1.33	
Expanded STD Uncertainty (95%)，K=2					2.67	

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7 Calibration certificate

Please see the Appendix C

8 Photographs

Please see the Appendix D

Appendix A: Detailed System Check Results

Appendix B: Detailed Test Results

Appendix C: Calibration certificate

Appendix D: Photographs

---END---

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