

Prüfbericht-Nr.: <i>Test report no.:</i>	CN232NV4 001	Auftrags-Nr.: <i>Order no.:</i>	168421603	Seite 1 von 26 <i>Page 1 of 26</i>
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	N/A	Auftragsdatum: <i>Order date:</i>	2023-04-06	
Auftraggeber: <i>Client:</i>	Marquardt GmbH Scholss-Strasse 16, 78604 Rietheim-Weilheim, Germany			
Prüfgegenstand: <i>Test item:</i>	NFC Door Handle			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	HH4			
Auftrags-Inhalt: <i>Order content:</i>	Test Report			
Prüfgrundlage: <i>Test specification:</i>	CFR47 FCC Part 15: Subpart C Section 15.225 RSS-210 Issue 10			
Wareneingangsdatum: <i>Date of sample receipt:</i>	2023-04-06	Please refer to Photo Document		
Prüfmuster-Nr.: <i>Test sample no:</i>	A003448298-001~002			
Prüfzeitraum: <i>Testing period:</i>	2023-4-6 ~2023-4-10			
Ort der Prüfung: <i>Place of testing:</i>	TÜV Rheinland (Shenzhen) Co., Ltd.			
Prüflaboratorium: <i>Testing laboratory:</i>	TÜV Rheinland (Shenzhen) Co., Ltd.			
Prüfergebnis*: <i>Test result*:</i>	Pass			
geprüft von: <i>tested by:</i>			genehmigt von: <i>authorized by:</i>	
Datum: <i>Date:</i>	2023-04-27 Signed by: Bell Hu		Ausstellungsdatum: <i>Issue date:</i>	2023-04-27 Signed by: Lin Lin
Stellung / Position:	Sachverständige(r) / Expert		Stellung / Position:	Sachverständige(r) / Expert
Sonstiges / Other:	FCC ID: IYZHH4 IC: 2701A-HH4 PMN: NFC Door Handle HVIN:HH4			
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>	Prüfmuster vollständig und unbeschädigt Test item complete and undamaged			
* Legende:	1 = sehr gut P(ass) = entspricht o.g. Prüfgrundlage(n)	2 = gut 2 = good P(ass) = passed a.m. test specification(s)	3 = befriedigend F(ail) = entspricht nicht o.g. Prüfgrundlage(n) 3 = satisfactory F(ail) = failed a.m. test specification(s)	4 = ausreichend N/A = nicht anwendbar 4 = sufficient N/A = not applicable
* Legend:	1 = very good P(ass) = passed a.m. test specification(s)	2 = good 2 = good P(ass) = passed a.m. test specification(s)	3 = satisfactory F(ail) = failed a.m. test specification(s)	5 = mangelhaft N/T = nicht getestet 5 = poor N/T = not tested
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.				

Test Summary

5.1.1 ANTENNA REQUIREMENT

RESULT: Pass

5.1.2 20dB BANDWIDTH & 99% BANDWIDTH

RESULT: Pass

5.1.3 FREQUENCY STABILITY

RESULT: Pass

5.1.4 RADIATED SPURIOUS EMISSION (IN-BAND & OUT-BAND EMISSIONS)

RESULT: Pass

5.1.5 CONDUCTED EMISSIONS ON AC MAINS

RESULT: N/A

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1 General Remarks

1.1 Complementary Materials

All attachments are integral parts of this test report. This applies especially to the following appendix:

Appendix A: Photographs of the Test Set-up

Appendix B: Test Results.

2 Test Sites

2.1 Test Facilities

TÜV Rheinland (Shenzhen) Co., Ltd.

No. 362 Huanguan Road Middle, Longhua District, Shenzhen 518110, People's Republic of China

FCC Accreditation Designation No.: CN1260

ISED Wireless Device Testing Laboratory: 25069

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Unwanted Emission Testing (TS9975)				
Equipment	Manufacturer	Model No.	Serial No.	Cal. Until
EMI Test Receiver	R&S	ESR 7	102021	2023-08-02
System Controller Interface	R&S	SCI-100	S10010038	N/A
OSP	R&S	OSP 120	102040	N/A
Pre-amplifier	R&S	SCU08F1	08320031	2023-08-02
Trilog Broadband Antenna (30 MHz - 7 GHz)	Schwarzbeck	VULB 9162	193	2023-08-06
Active Loop Antenna	Schwarzbeck	FMZB 1513	302	2023-08-06
Test software	R&S	EMC32 (V10.60.10)	N/A	N/A
Control PC	Dell	OptiPlex 7050	36NV9P2	N/A
3m Semi-Anechoic Chamber	Albatross	SAC-3m	APC17151-SAC	2024-06-22
Conducted Emissions				
Equipment	Manufacturer	Model No.	Serial No.	Cal. Until
EMI Test Receiver	R&S	ESR3	102428	2023-07-31
Artificial Mains Network	R&S	ENV216	102333	2023-08-01
EMC32 test software	R&S	EMC32(Ver.10.50.00)	N/A	N/A

2.3 Traceability

All measurement equipment calibrations are traceable to NIM (National Institute of Metrology) or where calibration is performed in other countries, to equivalent nationally recognized standards organizations.

2.4 Calibration

Equipment requiring calibration is calibrated periodically by the manufacturer or according to manufacturer's specifications. Additionally all equipment is verified for proper performance on a regular

basics using in house standards or comparisons.

2.5 Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-7}$
Conducted Emission, (9kHz to 150kHz)/(150kHz to 30MHz)	$\pm 3.70 \text{ dB} / \pm 3.30 \text{ dB}$
Radiated Emission (3m SAC), 30MHz to 1000MHz	$\pm 4.52 \text{ dB}$
Radiated Emission (3m SAC), above 1000MHz	$\pm 4.37 \text{ dB}$
All emissions, radiated	$\pm 4.17 \text{ dB}$

2.6 Location of Original Data

The original copies of all test data taken during actual testing were attached at Appendix A & B of this report and delivered to the applicant. A copy has been retained in the TÜV Rheinland (Shenzhen) Co., Ltd. file for certification follow-up purposes.

2.7 Status of Facility Used for Testing

The TÜV Rheinland (Shenzhen) Co., Ltd. Test facility located at No. 362 Huanguan Road Middle, Longhua District, Shenzhen 518110, People's Republic of China is listed on the US Federal Communications Commission list of facilities approved to perform measurements.

3 General Product Information

3.1 Product Function and Intended Use

The EUT is NFC Door Handle, which supports card recognition (RFID) function.

For details refer to the User Manual, Technical Description and Circuit Diagram.

3.2 Ratings and System Details

Table 2: Technical Specification of EUT

General Information of EUT	Value
Kind of Equipment	NFC Door Handle
Type Designation	HH4
FCC ID	IYZHH4
IC	2701A-HH4
PMN	NFC Door Handle
HVIN	HH4
Operating Temperature Range	-40°C~80 °C
Operating Voltage	9-16 V DC
Testing Voltage	12V DC
Technical Specification of RFID	
Operating Frequency	13.56 MHz
Type of Modulation	ASK
Channel Number	1 channel
Antenna Type	Integral Antenna
Antenna gain	0dBi

3.3 Independent Operation Modes

The basic operation modes are:

- A. On, RFID transmitting mode
- B. Off

3.4 Noise Generating and Noise Suppressing Parts

Refer to Circuit Diagram for further details.

3.5 Submitted Documents

- Application Form
- User Manual

4 Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

Radio Spectrum: The equipment under test (EUT) was configured at its highest power output in order to measure its highest possible radiation and conducted level. The test modes were adapted accordingly in reference to the instructions for use.

Emission: The equipment under test (EUT) was configured to measure its highest possible radiation level. The test modes were adapted accordingly in reference to the instructions for use.

4.2 Test Operation and Test Software

Test operation refers to test setup in chapter 5. All tests were performed according to the procedures in ANSI C63.10: 2013.

According to clause 3.1, all tests were performed on model HH4 in this report.

4.3 Special Accessories and Auxiliary Equipment

Table 3: List of Accessories and Auxiliary Equipment

Description	Manufacturer	Model	S/N
--	--	--	--

4.4 Countermeasures to Achieve EMC Compliance

The test sample which has been tested contained the noise suppression parts as described in the Technical Construction File (TCF).

No additional measures were employed to achieve compliance.

4.5 Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test (Below 1GHz)

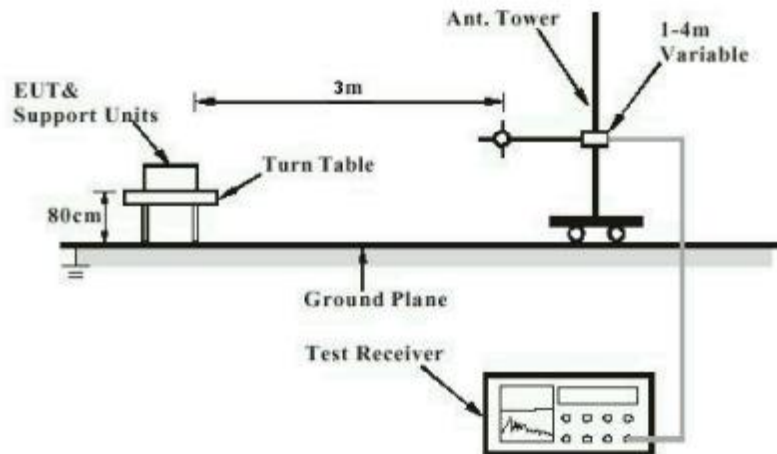


Diagram of Measurement Configuration for Radiation Test (Above 1GHz)

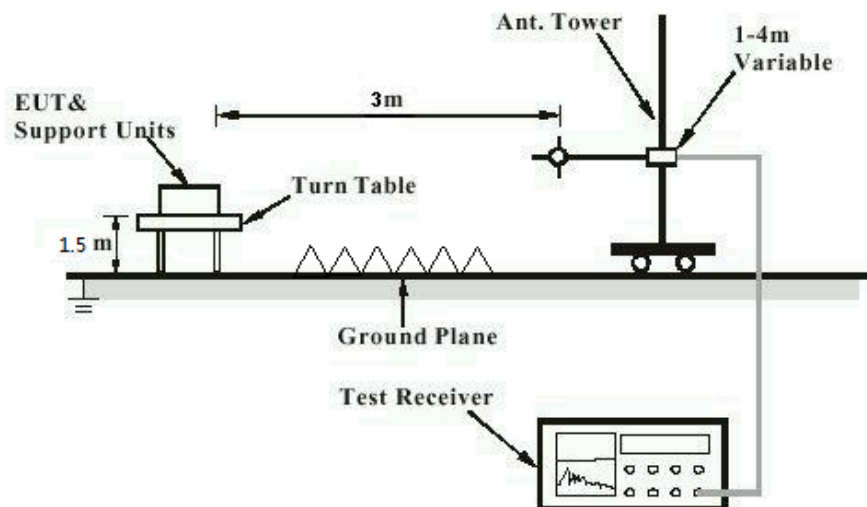


Diagram of Measurement Configuration for Conducted Transmitter Measurement

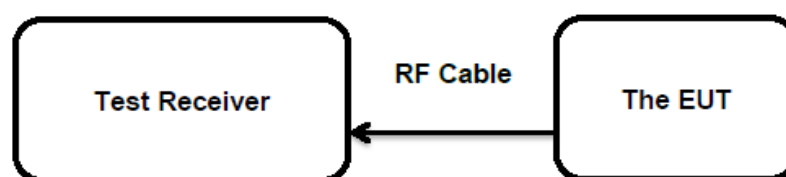
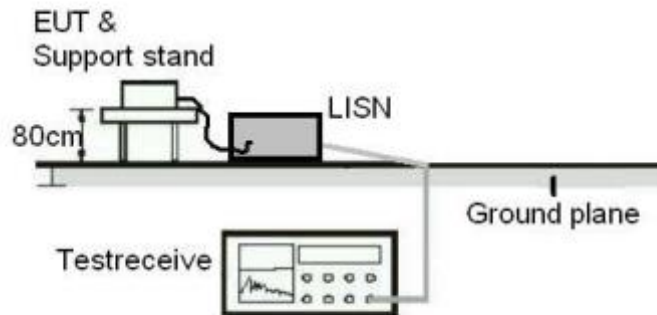


Diagram of Measurement Equipment Configuration for Mains Conduction Measurement



5 Test Results

5.1 Transmitter Requirement & Test Suites

5.1.1 Antenna Requirement

RESULT:

Pass

Test Specification

Test standard : FCC Part 15.203
RSS-Gen Clause 6.8

The EUT has an Integral Antenna, the directional gain of antenna of RFID is 0 dBi, and the antenna connector is designed with permanent attachment and no consideration of replacement.

Therefore the EUT is considered sufficient to comply with the provision.

Refer to EUT Photo for further details.

5.1.2 20dB Bandwidth & 99% Bandwidth

RESULT:
Pass

Test Specification

Test standard : FCC Part 15.215 (c)
 : RSS-Gen Clause 6.7
 Basic standard : ANSI C63.10: 2013
 Limits : N/A
 Kind of test site : Shielded Room

Test Setup

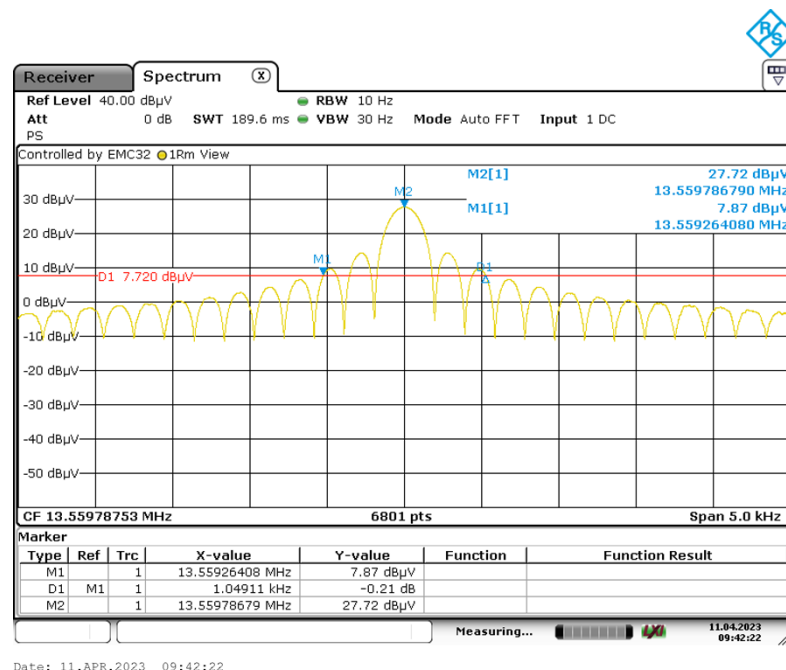
Date of testing : 2023-04-07
 Input voltage : DC 12V
 Operation mode : A
 Ambient temperature : 25 °C
 Relative humidity : 56 %
 Atmospheric pressure : 101 kPa

For details refer to following test result.

Table 4: Test Result of 20dB Bandwidth

Test Frequency (MHz)	20dB Bandwidth (KHz)	F _L (MHz)	F _H (MHz)	Limit (MHz)	Result
13.56	1.049	13.5593	13.5603	13.553-13.567	Pass

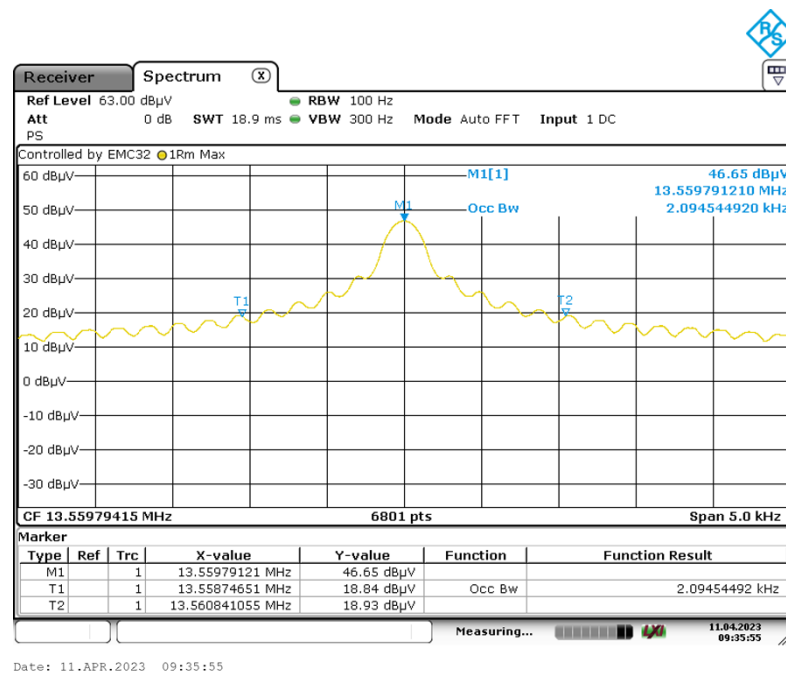
20dB bandwidth



99% bandwidth

Table 5: Test Result of 20dB Bandwidth

Test Frequency (MHz)	99% Bandwidth (KHz)	F _L (MHz)	F _H (MHz)	Limit (MHz)	Result
13.56	2.095	13.5587	13.5608	13.553-13.567	Pass



5.1.3 Frequency Stability

RESULT:

Pass

Test Specification

Test standard : FCC Part 15.225 (e)
 : RSS-210 Issue 10, B(6)(b)
 Basic standard : ANSI C63.10: 2013
 Limits : $\pm 0.01\%$ of Operating Frequency (1.356 KHz)
 Kind of test site : Shielded Room

Test Setup

Date of testing : 2023-04-09
 Input voltage : DC 12V
 Operation mode : A
 Ambient temperature : 25 °C
 Relative humidity : 56 %
 Atmospheric pressure : 101 kPa

For details refer to following test result.

Table 6: Test Result of Frequency Tolerance

Test Frequency (MHz)	Test Conditions		Test Results (KHz)	Deviation (KHz)	Limit (KHz)	Result
	Temp(°C)	Volt(V DC)				
13.56	-20	12	13559.761	0.239	$\pm 0.01\%$ (1.356 KHz)	Pass
	-10	12	13559.803	0.197		Pass
	0	12	13559.788	0.212		Pass
	10	12	13559.793	0.207		Pass
	20	12	13559.791	0.209		Pass
	30	12	13559.784	0.216		Pass
	40	12	13559.792	0.208		Pass
	50	12	13559.789	0.211		Pass
	20	9	13559.795	0.205		Pass
		16	13559.788	0.212		Pass

Note: Deviation (kHz) = (Test Result-13.56MHz)*1000

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Test Report No.:Seite 16 von 26
Page 16 of 26**5.1.4 Radiated Spurious Emission (In-Band & Out-Band Emissions)****RESULT:****Pass****Test Specification**

Test standard : FCC Part 15.225 (a)(b)(c)(d)
FCC Part 15.209 & 15.205
RSS-210 Issue 10, B(6)(a)

Basic standard : ANSI C63.10: 2013

Limits : Refer to FCC Part 15.209(a)
RSS-Gen Section 8.9 & 8.10

Kind of test site : 3m Semi-anechoic Chamber

Test Setup

Date of testing : 2023-04-07 to 2023-04-11

Input voltage : DC 12V

Operation mode : A

Ambient temperature : 22 °C

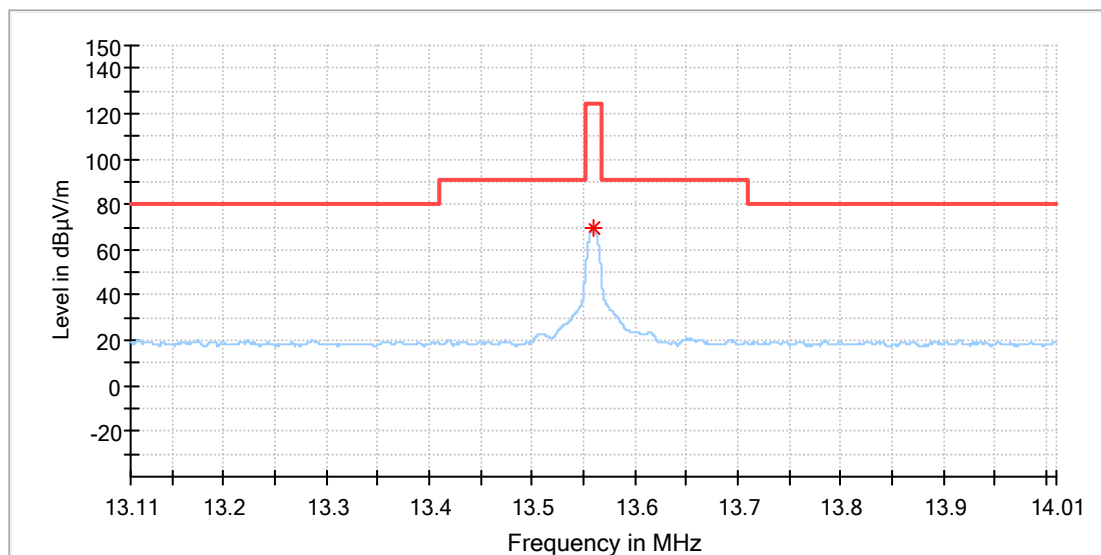
Relative humidity : 52 %

Atmospheric pressure : 101 kPa

Operation within the band 13.110-14.010 MHz

EUT Information

EUT Name:	NFC Door Handle
Model:	HH4
Test Mode:	NFC
Order No/Sample No:	168421603/A003448298-001
Test Voltage::	DC 12V
Remark:	Temp 22 Humi:55%
Test Standard:	FCC 15.225
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

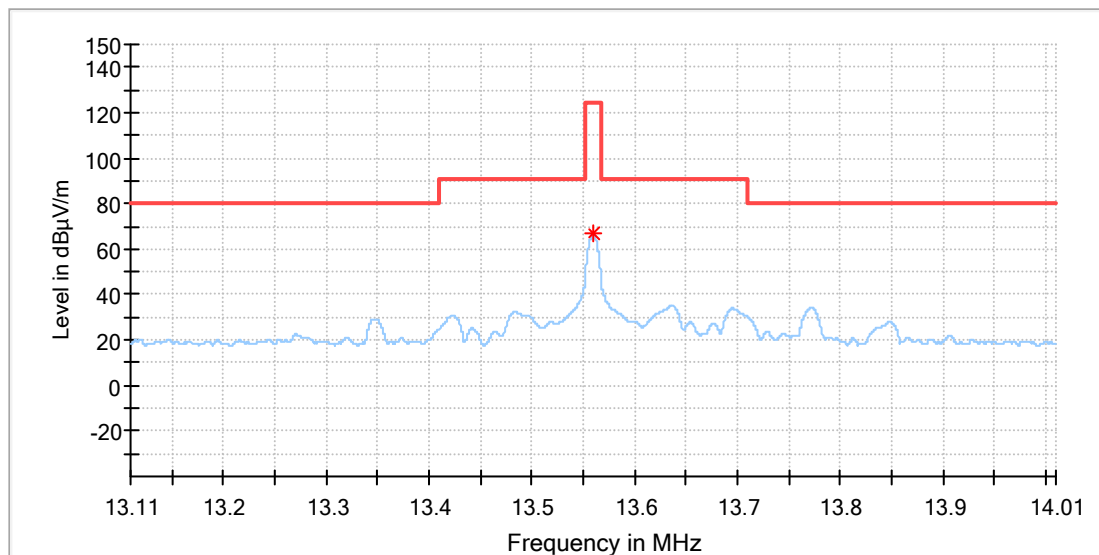
Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
13.560000	69.67	124.00	54.33	100.0	X	0.0	20.0

Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
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EUT Information

EUT Name:	NFC Door Handle
Model:	HH4
Test Mode:	NFC
Order No/Sample No:	168421603/A003448298-001
Test Voltage::	DC 12V
Remark:	Temp 22 Humi:55%
Test Standard:	FCC 15.225
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical Freqs

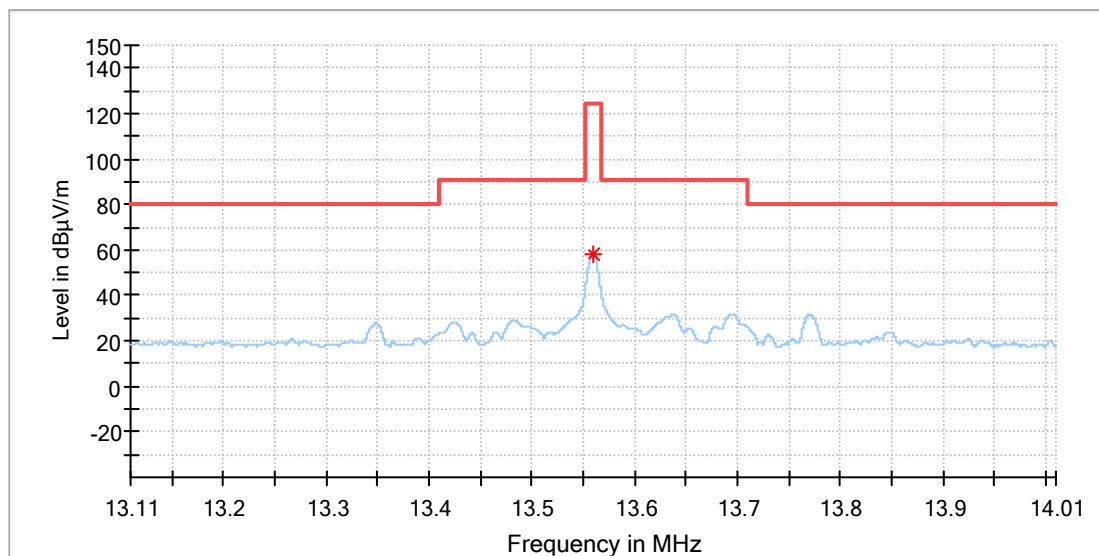
Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
13.560000	66.76	124.00	57.24	100.0	Y	123.0	20.0

Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
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EUT Information

EUT Name: NFC Door Handle
 Model: HH4
 Test Mode: NFC
 Order No./Sample No: 168421603/A003448298-001
 Test Voltage:: DC 12V
 Remark: Temp 22 Humi:55%
 Test Standard: FCC 15.225
 Tested By: Kei Zhang
 Reviewed By: Terry Yin



Critical_Freqs

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
13.560000	58.10	124.00	65.90	100.0	Z	33.0	20.0

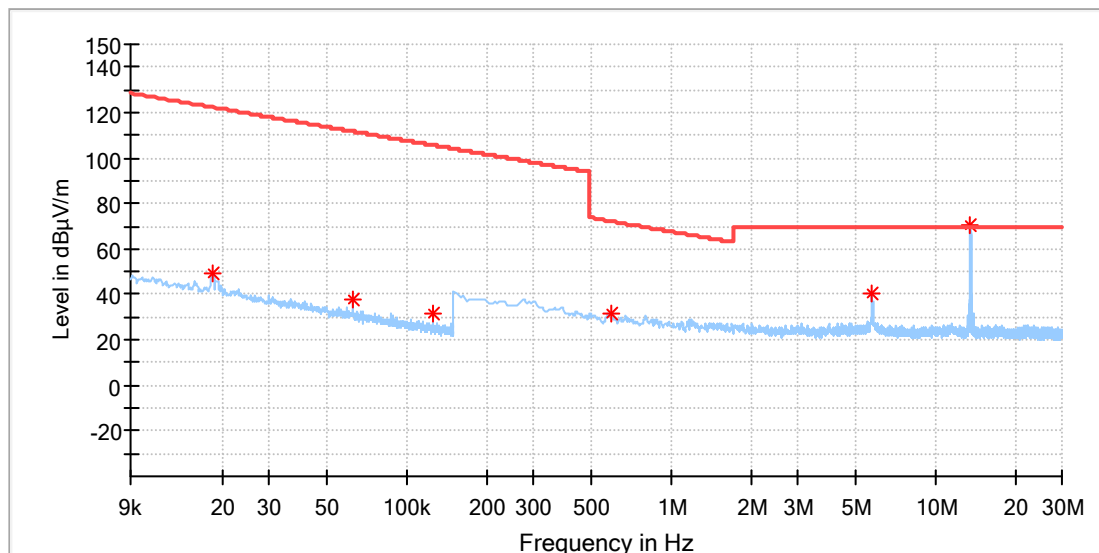
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Comment
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9KHz-30MHz:

EUT Information

EUT Name:	NFC Door Handle
Model:	HH4
Test Mode:	NFC
Order No/Sample No:	168421603/A003448298-001
Test Voltage::	DC 12V
Remark:	Temp 22 Humi:55%
Test Standard:	FCC 15.225
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
0.018266	48.90	122.36	73.45	100.0	X	25.0	20.1
0.062580	38.16	111.67	73.51	100.0	X	118.0	20.1
0.125224	31.79	105.64	73.86	100.0	X	145.0	20.1
0.593360	31.75	72.14	40.39	100.0	X	112.0	20.1
5.760044	40.81	69.50	28.69	100.0	X	198.0	20.3
13.560552*	70.21	69.50	-0.71	100.0	X	195.0	20.5

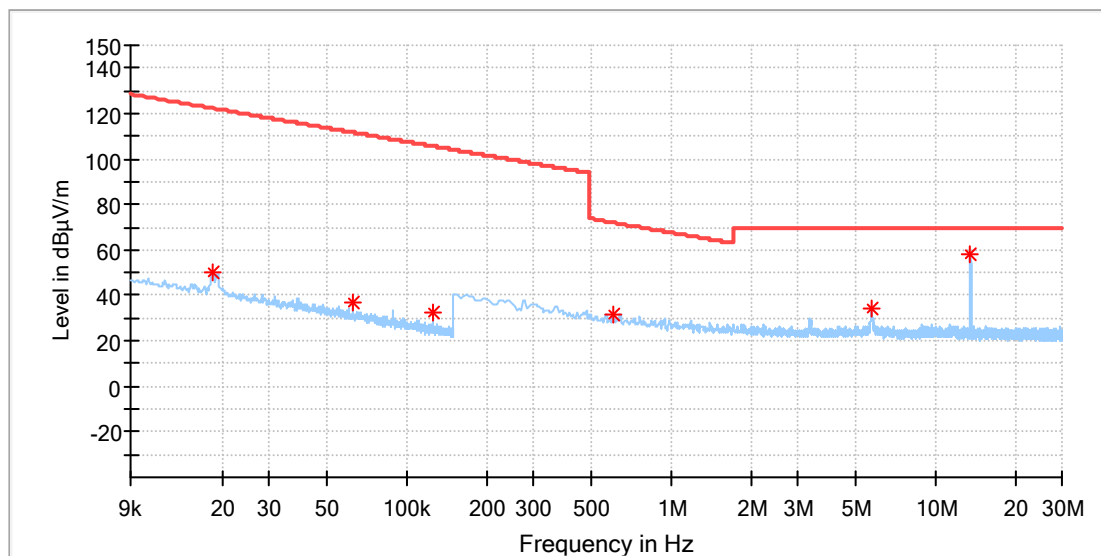
* The fundamental emission.

Final_Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
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EUT Information

EUT Name: NFC Door Handle
Model: HH4
Test Mode: NFC
Order No/Sample No: 168421603/A003448298-001
Test Voltage:: DC 12V
Remark: Temp 22 Humi:55%
Test Standard: FCC 15.225
Tested By: Kei Zhang
Reviewed By: Terry Yin



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
0.018366	50.41	122.31	71.90	100.0	Y	130.0	20.1
0.062580	36.98	111.67	74.69	100.0	Y	198.0	20.1
0.125124	32.05	105.65	73.60	100.0	Y	293.0	20.1
0.602140	31.51	72.02	40.50	100.0	Y	289.0	20.1
5.724927	34.50	69.50	35.00	100.0	Y	102.0	20.3
13.560552*	58.16	69.50	11.34	100.0	Y	171.0	20.5

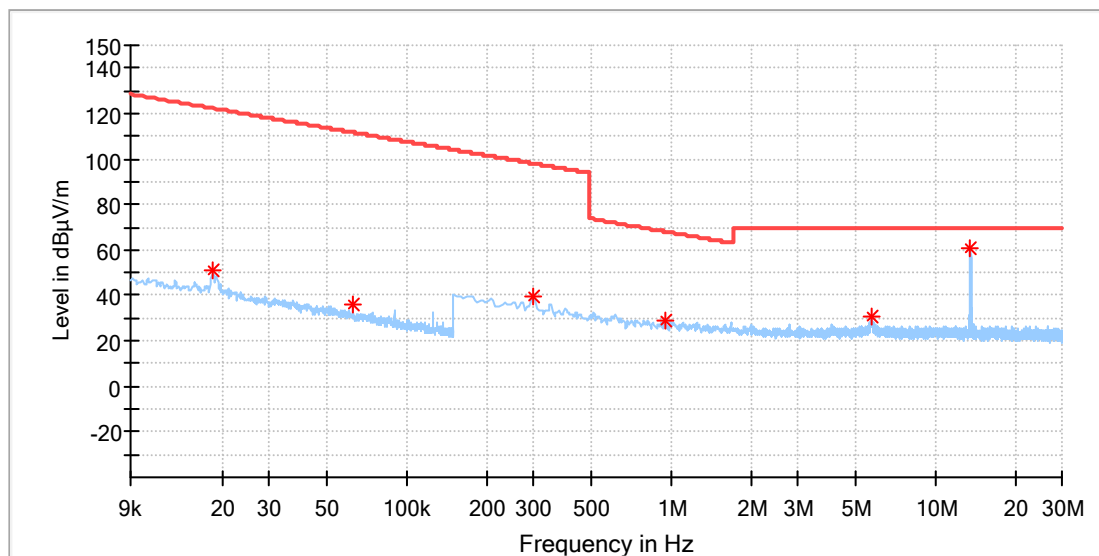
* The fundamental emission.

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
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EUT Information

EUT Name: NFC Door Handle
Model: HH4
Test Mode: NFC
Order No/Sample No: 168421603/A003448298-001
Test Voltage:: DC 12V
Remark: Temp 22 Humi:55%
Test Standard: FCC 15.225
Tested By: Kei Zhang
Reviewed By: Terry Yin



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
0.018366	50.79	122.31	71.52	100.0	Z	100.0	20.1
0.062580	36.33	111.67	75.33	100.0	Z	24.0	20.1
0.299250	39.21	98.08	58.87	100.0	Z	217.0	20.1
0.953316	28.93	68.04	39.10	100.0	Z	96.0	20.1
5.702978	30.46	69.50	39.04	100.0	Z	272.0	20.3
13.560552*	60.48	69.50	9.02	100.0	Z	194.0	20.5

* The fundamental emission.

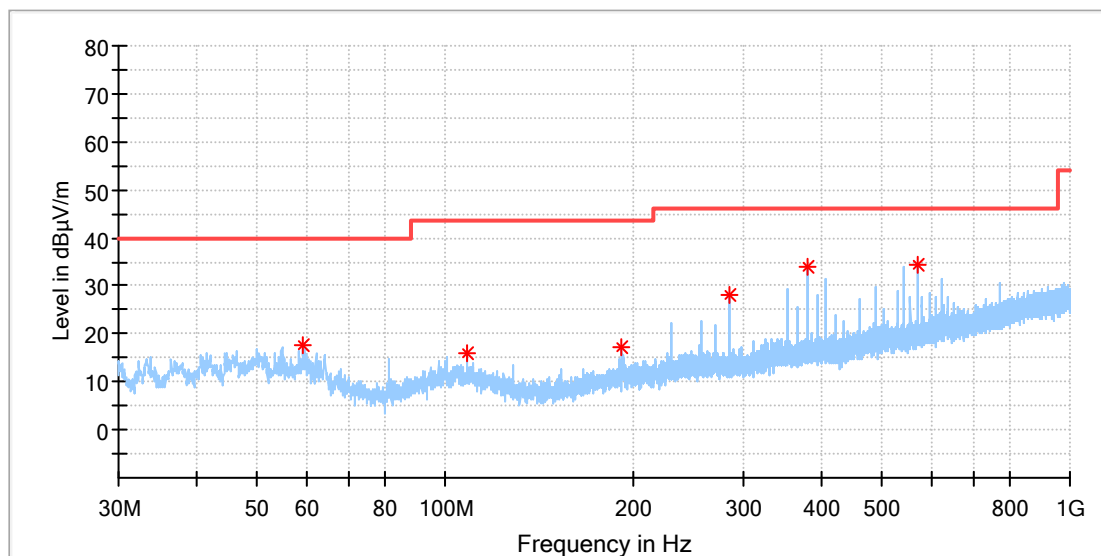
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---		---	---

30MHz-1000MHz:

EUT Information

EUT Name:	NFC Door Handle
Model:	HH4
Test Mode:	NFC
Order No/Sample No:	168421603/A003448298-001
Test Voltage::	DC 12V
Remark:	Temp 22 Humi:55%
Test Standard:	FCC 15.225
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

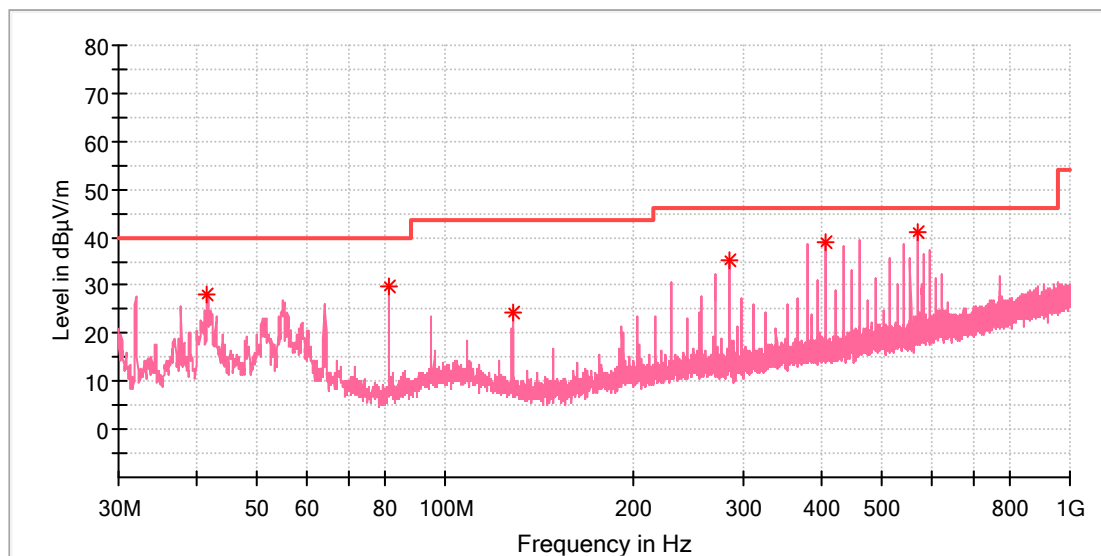
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
59.342500	17.79	40.00	22.21	100.0	H	275.0	-18.9
108.230500	16.08	43.50	27.42	100.0	H	350.0	-18.9
191.990000	17.22	43.50	26.28	100.0	H	254.0	-19.4
284.770500	28.29	46.00	17.71	100.0	H	64.0	-16.6
379.685000	33.95	46.00	12.05	100.0	H	111.0	-14.2
569.514000	34.17	46.00	11.83	100.0	H	356.0	-10.5

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
---	---	---	---	---	---	---	---

EUT Information

EUT Name: NFC Door Handle
Model: HH4
Test Mode: NFC
Order No/Sample No: 168421603/A003448298-001
Test Voltage:: DC 12V
Remark: Temp 22 Humi:55%
Test Standard: FCC 15.225
Tested By: Kei Zhang
Reviewed By: Terry Yin



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
41.640000	28.10	40.00	11.90	100.0	V	165.0	-19.7
81.361500	29.96	40.00	10.04	100.0	V	75.0	-23.2
128.697500	24.25	43.50	19.25	100.0	V	294.0	-21.7
284.770500	35.38	46.00	10.62	100.0	V	250.0	-16.6
406.796500	39.14	46.00	6.86	100.0	V	0.0	-13.6
569.514000	41.02	46.00	4.98	100.0	V	9.0	-10.5

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
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5.1.5 Conducted Emissions on AC Mains

RESULT:

N/A

Test Specification

Test standard	:	FCC Part 15.207(a) RSS-GEN 8.8
Basic standard	:	ANSI C63.10: 2013
Limits	:	FCC Part 15.207(a) RSS-GEN 8.8
Kind of test site	:	Shielded Room

DC powered only, not designed to be connected to the public utility AC power network, thus not required.

6 Photographs of the Test Set-Up

For photographs of the test set-up, refer to the appendix A.

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