

NCC Test Report

Equipment : Security Controller
Brand Name : Tesla
Model No. : 1089774
Applicant : 台灣特斯拉汽車有限公司
臺北市內湖區民權東路 6 段 11 巷 6 號
Manufacturer : TESLA INC
45500 FREMONT BLVD FREMONT CA 94538-6326
Standard : LP0002 Section 3.2 (2018-01-10)

The product sample received on May 03, 2017 and completely tested on Mar. 30, 2019. We, SPORTON, would like to declare that the tested sample has been evaluated in accordance with the procedures given in ANSI C63.10-2013 and shown compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.



Approved by: Allen Lin

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory

No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)

Table of Contents

1	GENERAL DESCRIPTION	5
1.1	Information.....	5
1.2	Testing Applied Standards	7
1.3	Testing Location Information	7
1.4	Measurement Uncertainty	7
2	TEST CONFIGURATION OF EUT.....	8
2.1	The Worst Case Modulation Configuration	8
2.2	Test Channel Frequencies Configuration.....	8
2.3	The Worst Case Measurement Configuration.....	9
2.4	Support Equipment.....	10
2.5	Test Setup Diagram	11
3	TRANSMITTER TEST RESULT	13
3.1	AC Power-line Conducted Emissions	13
3.2	Emission Bandwidth	19
3.3	Field Strength of Fundamental Emissions and Spectrum Mask	21
3.4	Transmitter Radiated Unwanted Emissions	23
3.5	Receiver Radiated Spurious Emissions	30
3.6	Frequency Stability	41
4	TEST EQUIPMENT AND CALIBRATION DATA	43

APPENDIX A. TEST PHOTOS

PHOTOGRAPHS OF EUT V01

Summary of Test Result

Report Clause	Ref. Std. Clause	Test Items	Result (PASS/FAIL)	Remark
1.1.2	2.2	Antenna Requirement	PASS	LP0002-2.2
3.1	2.3	AC Power-line Conducted Emissions	PASS	LP0002-2.3
3.2	3.2	Emission Bandwidth	PASS	Fall in band $F_L \geq 13.553 \text{ MHz}$ $F_H \leq 13.567 \text{ MHz}$
3.3	3.2.1.1	Field Strength of Fundamental Emissions	PASS	124 dBuV/m at 3m
3.4	3.2.1.2	Transmitter Radiated Unwanted Emissions	PASS	LP0002-2.8
3.5	2.11	Receiver Radiated Unwanted Emissions	PASS	LP0002-2.8
3.6	3.2.1.3	Frequency Stability	PASS	$\pm 0.01\%$ (100ppm)



SPORTON INTERNATIONAL INC.
TEL : 886-3-327-3456
FAX : 886-3-327-0973

1 General Description

1.1 Information

1.1.1 RF General Information

NFC Chip	Brand Name	Model Name
	ST25R3915	1089774

RF General Information				
Frequency Range	Modulation	Ch. Frequency (MHz)	Channel Number	Field Strength (dBuV/m)
13.553 – 13.567 MHz	ISO 14443-3A (ASK)	13.56	1	59.27
Note 1: Field strength performed peak level at 3m.				

1.1.2 Antenna Information

Antenna Category	
☐	Equipment placed on the market without antennas
☒	Integral antenna (antenna permanently attached)
☐	External antenna (dedicated antennas)

Antenna General Information		
No.	Ant. Cat.	Ant. Type
1	Integral	LOOP

1.1.3 Type of EUT

Identify EUT	
EUT Serial Number	N/A
Presentation of Equipment	☐ Production ; ☐ Pre-Production ; ☒ Prototype
Type of EUT	
☒	Stand-alone
☐	Combined (EUT where the radio part is fully integrated within another device) Combined Equipment - Brand Name / Model No.: ...
☐	Plug-in radio (EUT intended for a variety of host systems) Host System - Brand Name / Model No.: ...
☐	Other:

1.1.4 Test Signal Duty Cycle

Duty Cycle Operation Restriction	
The transmitter is used for	The transmitter is operated
☒ Inductive applications	☒ Automatically triggered
☐ Duty cycle fixed mode	☒ Duty cycle random mode
☒ Duty cycle mode - NFC-A (ISO 14443-3A)	
Declare transmitter duty cycle / 1 hour =	100%
☐ Duty cycle mode - NFC-B (ISO 14443-3B)	
Declare transmitter duty cycle / 1 hour =	100%
☐ Duty cycle mode - NFC-F (ISO 18092)	
Declare transmitter duty cycle / 1 hour =	100%
☐ Duty cycle mode - NFC-V (ISO 15693)	
Declare transmitter duty cycle / 1 hour =	100%

1.1.5 EUT Operational Condition

Supply Voltage	☐ AC mains	☒ DC	
Type of DC Source	☒ Internal DC supply	☐ External AC adapter	☐ Battery
Test Voltage	☒ Vnom (12 V)	☒ Vmax (13.8 V)	☒ Vmin (10.5 V)
Test Climatic	☒ Tnom (20°C)	☒ Tmax (85°C)	☒ Tmin (-40°C)

1.2 Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ LP0002 Section 3.2 (2018-01-10)
- ♦ ANSI C63.10-2013
- ♦ KDB 174176 D01 v01r01

1.3 Testing Location Information

Testing Location				
☒	HWA YA	ADD : No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)		
		TEL : 886-3-327-3456 FAX : 886-3-327-0973		
Test Condition	Test Site No.	Test Engineer	Test Environment	Test Date
RF Conducted	TH06-HY	Gary	21.5°C / 61%	31/May/2017
Radiated - TX	03CH02-HY	Lynus	24.5°C / 58%	06/Jun/2017
Radiated - RX	03CH02-HY	Patrick	24.1~25.6°C / 53.8~55.1%	29/Mar/2019
AC Conduction	CO04-HY	Lego	22.2~25.1°C / 56.4~58.6%	26/Mar/2019~30/Mar/2019

1.4 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2))

Measurement Uncertainty		
Test Item		Uncertainty
AC power-line conducted emissions		±2.2 dB
Emission bandwidth		±1.4 %
Unwanted emissions, conducted	9 – 150 kHz	±0.38 dB
	0.15 – 30 MHz	±0.42 dB
	30 – 1000 MHz	±0.51 dB
All emissions, radiated	9 – 150 kHz	±2.49 dB
	0.15 – 30 MHz	±2.28 dB
	30 – 1000 MHz	±2.56 dB
Temperature		±0.8 °C
Humidity		±3 %
DC and low frequency voltages		±3 %
Time		±1.4 %
Duty Cycle		±1.4 %

2 Test Configuration of EUT

2.1 The Worst Case Modulation Configuration

Modulation Used for Conformance Testing	
Modulation Mode	Field Strength (dBuV/m at 3 m)
NFC-Read/Write	59.27

2.2 Test Channel Frequencies Configuration

Modulation Mode	Test Channel Frequencies (MHz)
NFC-Read/Write	13.56

2.3 The Worst Case Measurement Configuration

The Worst Case Mode for Following Conformance Tests	
Tests Item	AC power-line conducted emissions
Condition	AC power-line conducted measurement for line and neutral Test Voltage: 120Vac / 60Hz
Operating Mode	☒ 1. DC Power Supply mode CTX/CRX

The Worst Case Mode for Following Conformance Tests		
Tests Item	Emission Bandwidth, Field Strength of Fundamental Emissions Spectrum Mask, Transmitter Radiated Unwanted Emissions, Frequency Stability, Receiver Radiated Unwanted Emissions	
Test Condition	Radiated measurement	
User Position	☐ EUT will be placed in fixed position.	
	☒ EUT will be placed in mobile position and operating multiple positions. EUT shall be performed three orthogonal planes.	
	☐ EUT will be a hand-held or body-worn battery-powered devices and operating multiple positions. EUT shall be performed three orthogonal planes.	
Pretest Mode	☒ 1. EUT Built in NFC A type	
	☐ 2. EUT Built in NFC B type	
	☐ 3. EUT Built in NFC F type	
	☐ 4. EUT Built in NFC V type	
Operating Mode	☒ 1. DC Power Supply mode CTX/CRX	
Modulation Mode	NFC-Read/Write	
Orthogonal Planes of EUT	Y Plane	Z Plane
		
Worst Planes of EUT	V	

2.4 Support Equipment

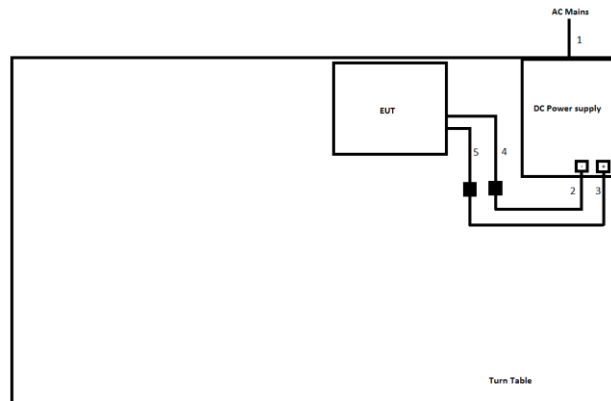
Support Equipment - Radiated			
No.	Equipment	Brand Name	Model Name
1	DC power supply	GW	GPS-3030DD

Support Equipment RF Conducted			
No.	Equipment	Brand Name	Model Name
1	DC power supply	GW	GPS-3030DD

Support Equipment - AC Conduction			
No.	Equipment	Brand Name	Model Name
1	DC power supply	GW	GPS-3030DD

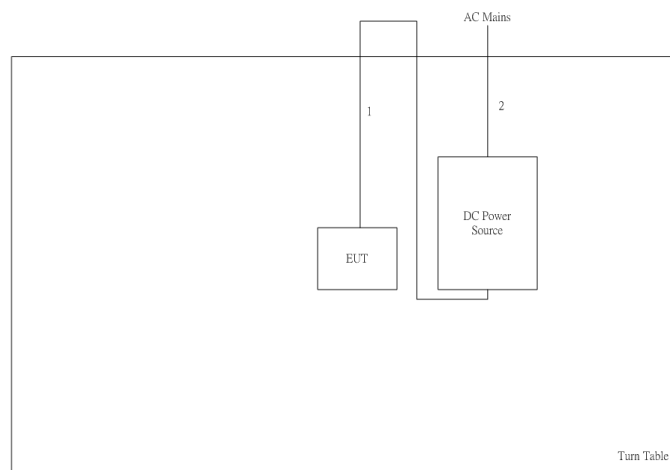
2.5 Test Setup Diagram

Test Setup Diagram – AC Line Conducted Emission Test



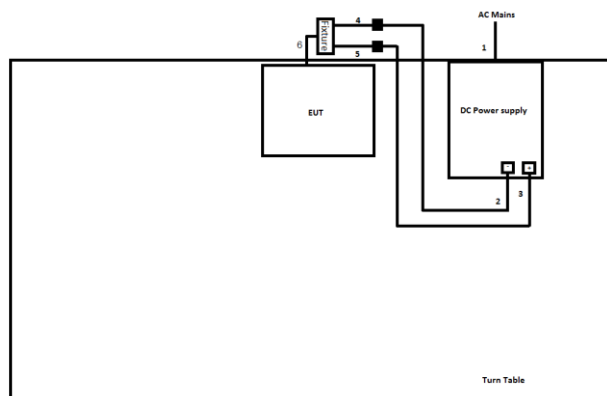
Item	Connection	Shielded	Length(m)	Remark
1	AC Power line	No	1.5	-
2	DC Power line	No	1.0	-
3	DC Power line	No	1.0	-
4	DC Power line	No	0.2	-
5	DC Power line	No	0.2	-

Test Setup Diagram - Radiated Test -TX



Item	Connection	Shielded	Length(m)
1	Fixture cable	No	2.4m
2	AC Power cable	No	1.5m

Test Setup Diagram – Radiated Test -RX



Item	Connection	Shielded	Length(m)	Remark
1	AC Power line	No	1.5	-
2	DC Power line	No	1.0	-
3	DC Power line	No	1.0	-
4	DC Power line	No	0.2	-
5	DC Power line	No	0.2	-
6	Fixture cable	No	2.35	-

3 Transmitter Test Result

3.1 AC Power-line Conducted Emissions

3.1.1 AC Power-line Conducted Emissions Limit

AC Power-line Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

Note 1: * Decreases with the logarithm of the frequency.

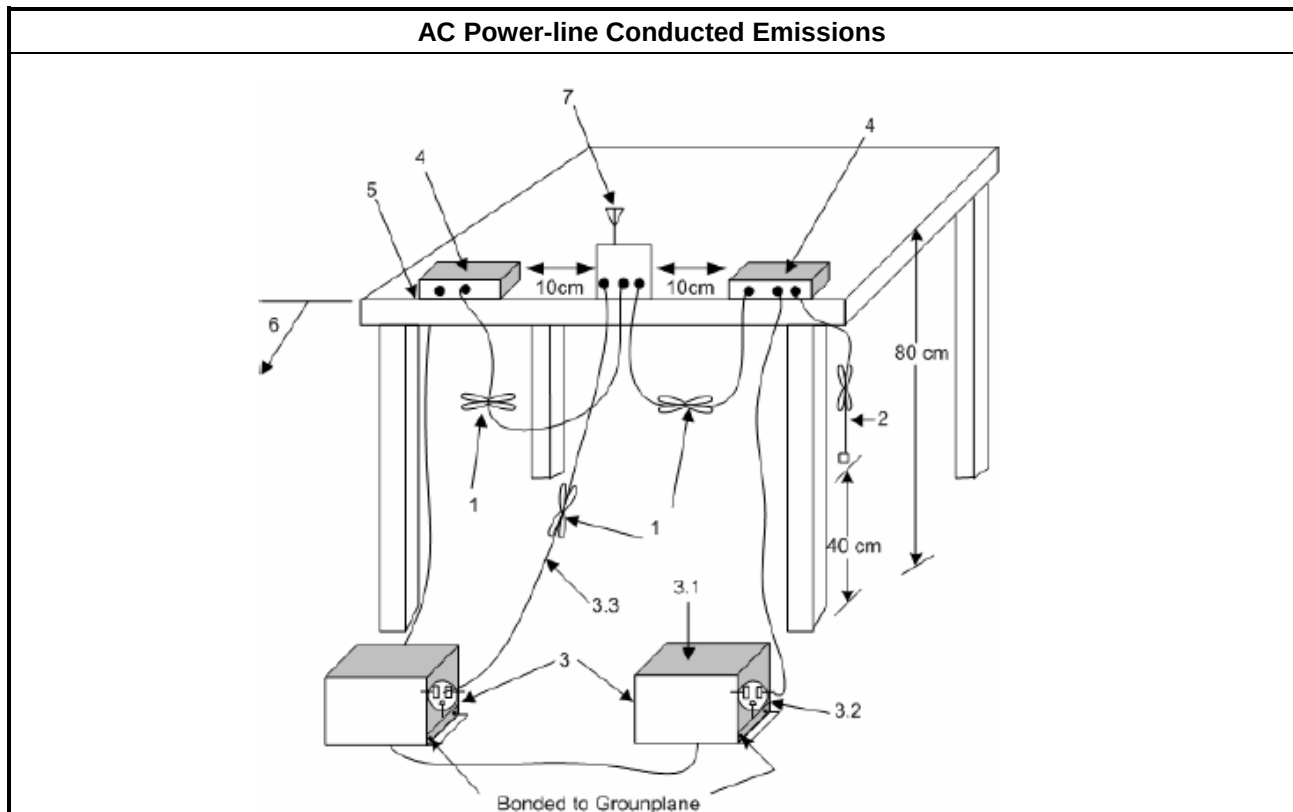
3.1.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

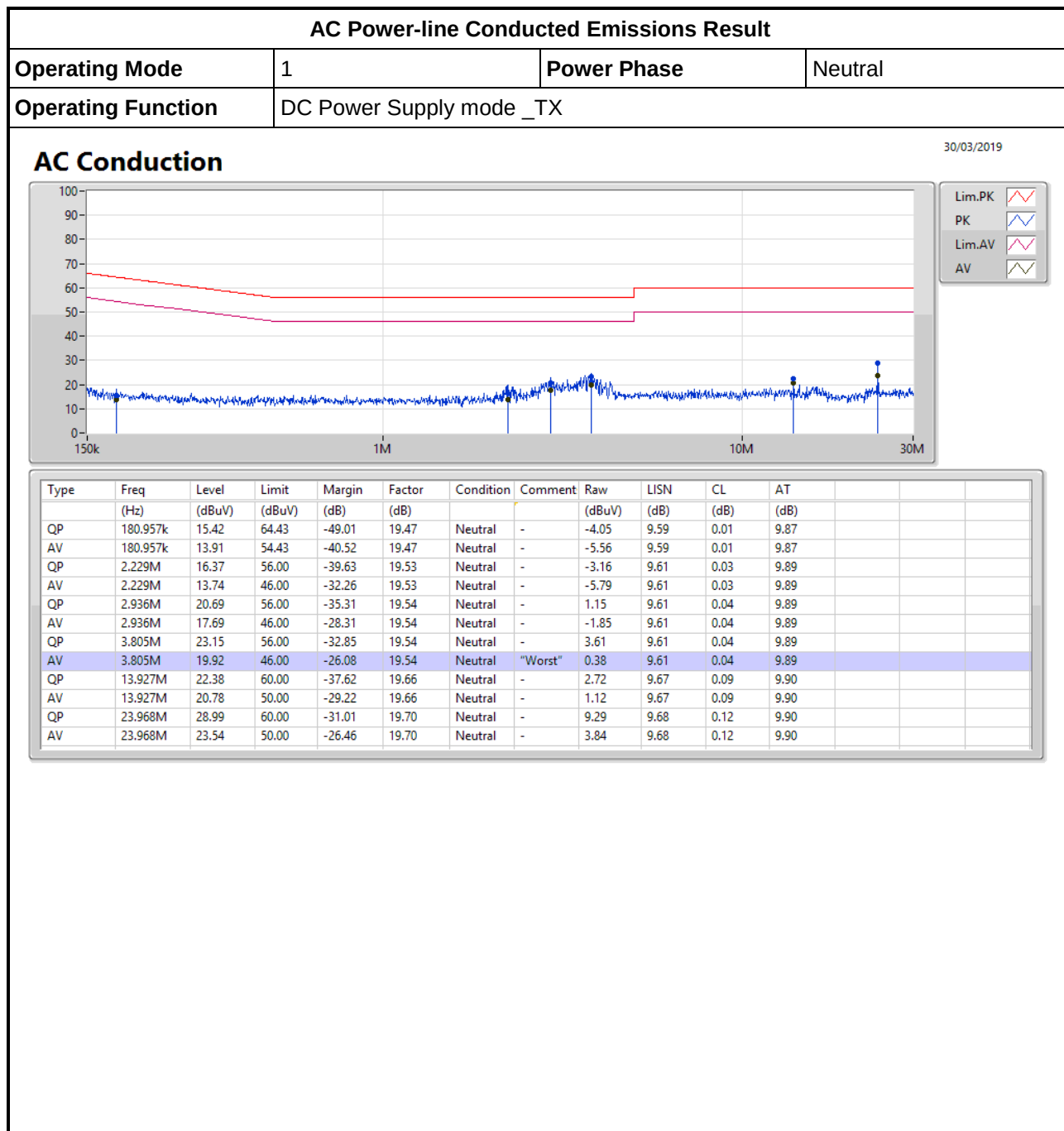
3.1.3 Test Procedures

Test Method	
☒	Refer as ANSI C63.10-2013, clause 6.2 for AC power-line conducted emissions.
☒	If AC conducted emissions fall in operating band, then following below test method confirm final result.
☐	Accept measurements done with a suitable dummy load replacing the antenna under the following conditions: (1) Perform the AC line conducted tests with the antenna connected to determine compliance with LP0002-2.3 limits outside the transmitter's fundamental emission band; (2) Retest with a dummy load to determine compliance with LP0002-2.3 limits within the transmitter's fundamental emission band.
☒	For a device with a permanent antenna operating at or below 30 MHz, accept measurements done with a suitable dummy load, in lieu of the permanent antenna under the following conditions: (1) Perform the AC line conducted tests with the permanent antenna to determine compliance with the LP0002-2.3 limits outside the transmitter's fundamental emission band; (2) Retest with a dummy load in lieu of the permanent antenna to determine compliance with the LP0002-2.3 limits within the transmitter's fundamental emission band.

3.1.4 Test Setup



3.1.5 Test Result of AC Power-line Conducted Emissions

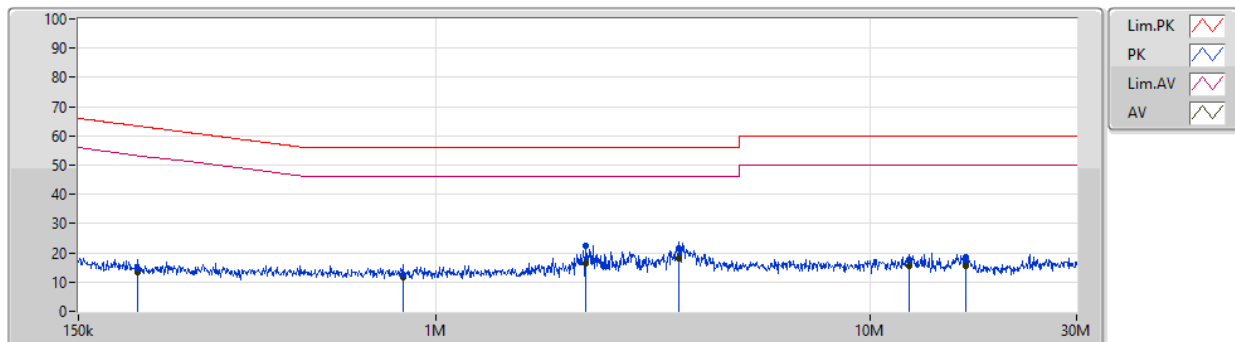


AC Power-line Conducted Emissions Result

Operating Mode	1	Power Phase	Line
Operating Function	DC Power Supply mode _TX		

AC Conduction

30/03/2019



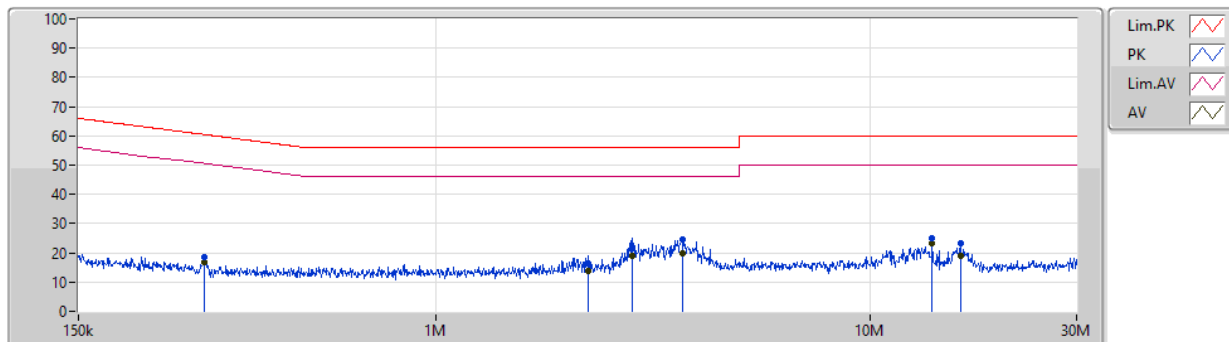
Type	Freq (Hz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Factor (dB)	Condition	Comment	Raw (dBuV)	LISN (dB)	CL (dB)	AT (dB)			
QP	205.615k	14.83	63.38	-48.55	19.48	Line	-	-4.65	9.60	0.01	9.87			
AV	205.615k	13.25	53.38	-40.13	19.48	Line	-	-6.23	9.60	0.01	9.87			
QP	838.149k	12.65	56.00	-43.35	19.50	Line	-	-6.85	9.60	0.02	9.88			
AV	838.149k	11.64	46.00	-34.36	19.50	Line	-	-7.86	9.60	0.02	9.88			
QP	2.211M	22.27	56.00	-33.73	19.54	Line	-	2.73	9.62	0.03	9.89			
AV	2.211M	16.43	46.00	-29.57	19.54	Line	-	-3.11	9.62	0.03	9.89			
QP	3.642M	21.57	56.00	-34.43	19.56	Line	-	2.01	9.63	0.04	9.89			
AV	3.642M	18.13	46.00	-27.87	19.56	Line	"Worst"	-1.43	9.63	0.04	9.89			
QP	12.355M	17.86	60.00	-42.14	19.64	Line	-	-1.78	9.66	0.08	9.90			
AV	12.355M	15.40	50.00	-34.60	19.64	Line	-	-4.24	9.66	0.08	9.90			
QP	16.668M	18.33	60.00	-41.67	19.64	Line	-	-1.31	9.64	0.10	9.90			
AV	16.668M	15.66	50.00	-34.34	19.64	Line	-	-3.98	9.64	0.10	9.90			

AC Power-line Conducted Emissions Result

Operating Mode	1	Power Phase	Neutral
Operating Function	DC Power Supply mode _RX		

AC Conduction

29/03/2019



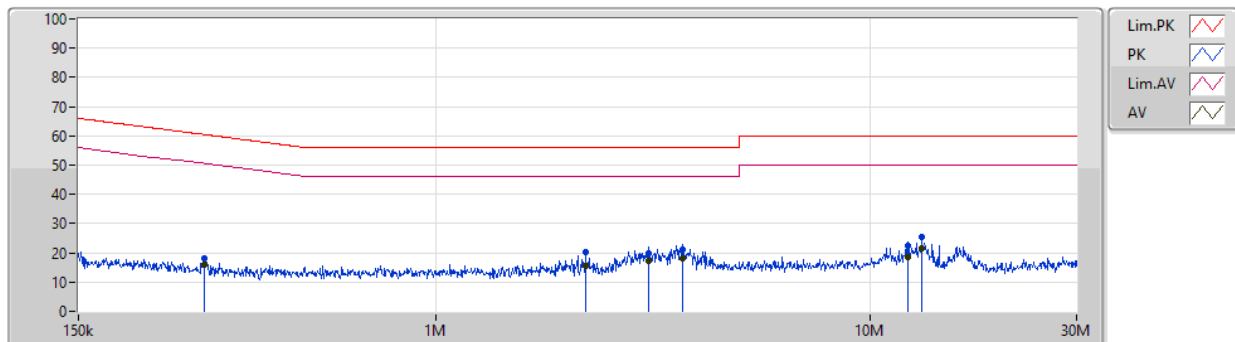
Type	Freq (Hz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Factor (dB)	Condition	Comment	Raw (dBuV)	LISN (dB)	CL (dB)	AT (dB)			
QP	292.16k	18.39	60.46	-42.07	19.48	Neutral	-	-1.09	9.59	0.01	9.88			
AV	292.16k	16.83	50.46	-33.63	19.48	Neutral	-	-2.65	9.59	0.01	9.88			
QP	2.247M	16.34	56.00	-39.66	19.54	Neutral	-	-3.20	9.61	0.04	9.89			
AV	2.247M	13.93	46.00	-32.07	19.54	Neutral	-	-5.61	9.61	0.04	9.89			
QP	2.843M	21.97	56.00	-34.03	19.54	Neutral	-	2.43	9.61	0.04	9.89			
AV	2.843M	19.18	46.00	-26.82	19.54	Neutral	-	-0.36	9.61	0.04	9.89			
QP	3.701M	24.45	56.00	-31.55	19.54	Neutral	-	4.91	9.61	0.04	9.89			
AV	3.701M	19.98	46.00	-26.02	19.54	Neutral	"Worst"	0.44	9.61	0.04	9.89			
QP	13.927M	24.86	60.00	-35.14	19.66	Neutral	-	5.20	9.67	0.09	9.90			
AV	13.927M	23.09	50.00	-26.91	19.66	Neutral	-	3.43	9.67	0.09	9.90			
QP	16.208M	23.15	60.00	-36.85	19.68	Neutral	-	3.47	9.68	0.10	9.90			
AV	16.208M	18.98	50.00	-31.02	19.68	Neutral	-	-0.70	9.68	0.10	9.90			

AC Power-line Conducted Emissions Result

Operating Mode	1	Power Phase	Line
Operating Function	DC Power Supply mode _RX		

AC Conduction

29/03/2019



Type	Freq (Hz)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Factor (dB)	Condition	Comment	Raw (dBuV)	LISN (dB)	CL (dB)	AT (dB)			
QP	293.329k	17.99	60.44	-42.45	19.48	Line	-	-1.49	9.59	0.01	9.88			
AV	293.329k	16.14	50.44	-34.30	19.48	Line	-	-3.34	9.59	0.01	9.88			
QP	2.211M	20.35	56.00	-35.65	19.54	Line	-	0.81	9.62	0.03	9.89			
AV	2.211M	15.50	46.00	-30.50	19.54	Line	-	-4.04	9.62	0.03	9.89			
QP	3.104M	19.99	56.00	-36.01	19.56	Line	-	0.43	9.63	0.04	9.89			
AV	3.104M	17.09	46.00	-28.91	19.56	Line	-	-2.47	9.63	0.04	9.89			
QP	3.715M	20.91	56.00	-35.09	19.56	Line	-	1.35	9.63	0.04	9.89			
AV	3.715M	17.98	46.00	-28.02	19.56	Line	"Worst"	-1.58	9.63	0.04	9.89			
QP	12.257M	22.60	60.00	-37.40	19.63	Line	-	2.97	9.66	0.08	9.89			
AV	12.257M	18.39	50.00	-31.61	19.63	Line	-	-1.24	9.66	0.08	9.89			
QP	13.223M	25.57	60.00	-34.43	19.63	Line	-	5.94	9.65	0.08	9.90			
AV	13.223M	21.64	50.00	-28.36	19.63	Line	-	2.01	9.65	0.08	9.90			

3.2 Emission Bandwidth

3.2.1 Emission Bandwidth Limit

20dB Bandwidth Limit	
☒	Intentional radiators must be designed to ensure that the 20 dB bandwidth of the emissions in the specific band (13.553 – 13.567 MHz).

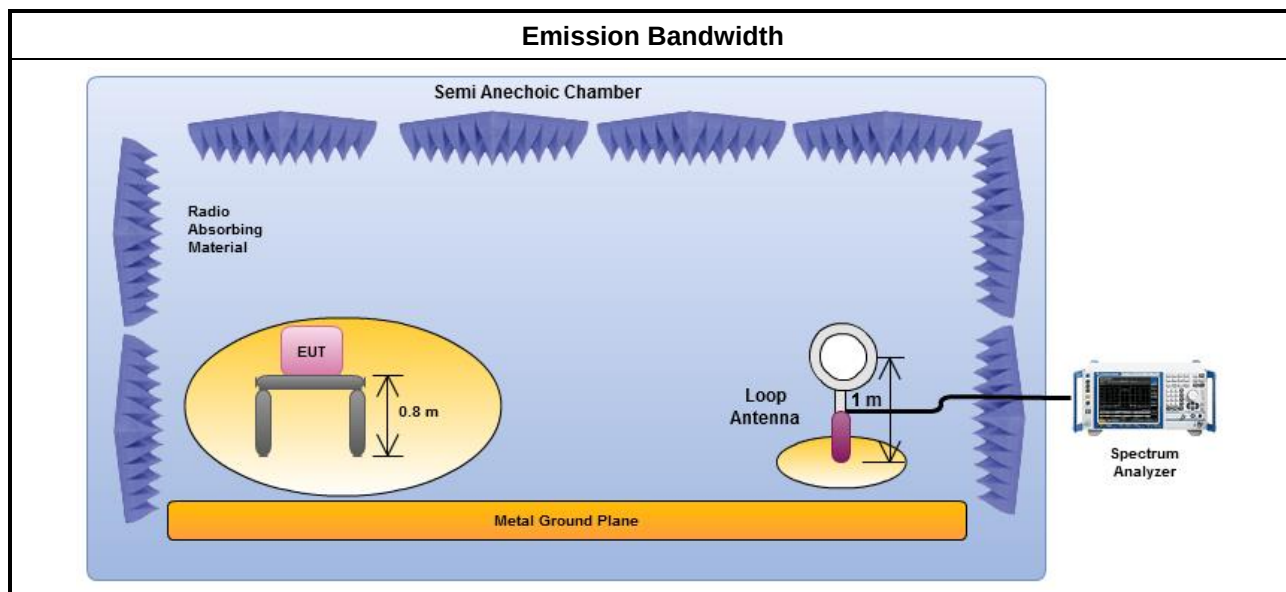
3.2.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

3.2.3 Test Procedures

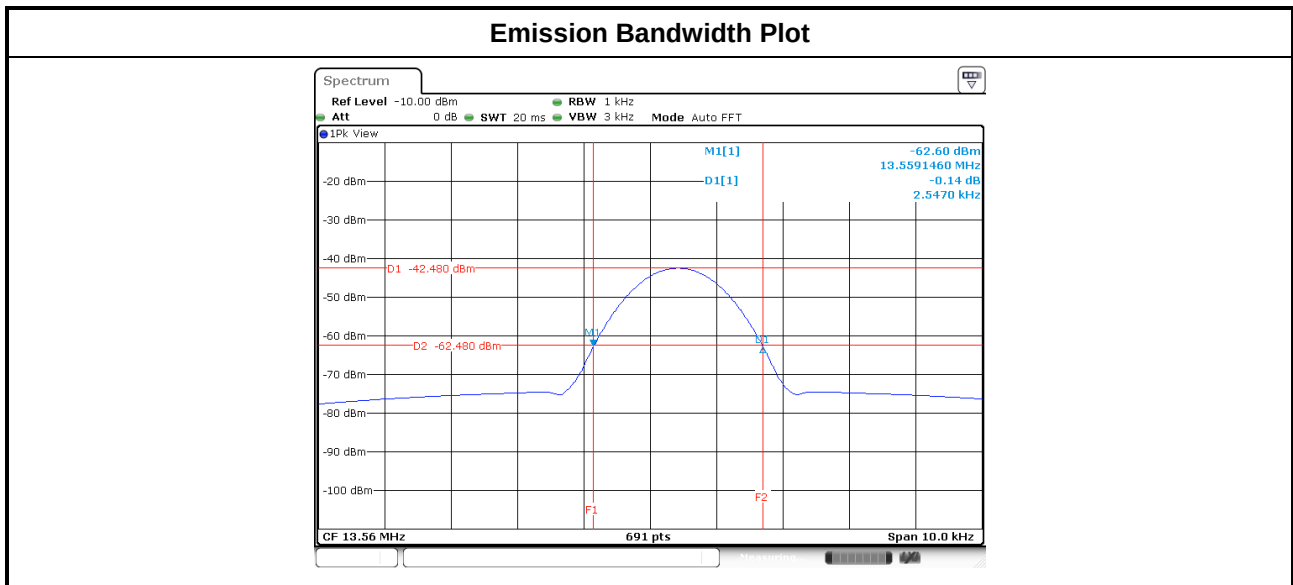
Test Method	
☒	For the emission bandwidth refer ANSI C63.10, clause 6.9.1 for occupied bandwidth testing.
☒	For radiated measurement. Loop antenna was rotated about the horizontal and vertical axis and the equipment to be measured and the test antenna shall be oriented to obtain the maximum emitted field strength level.

3.2.4 Test Setup



3.2.5 Test Result of Emission Bandwidth

Occupied Channel Bandwidth Result					
Modulation Mode	Frequency (MHz)	20dB Bandwidth (kHz)	F _L at 20dB BW (MHz)	F _H at 20dB BW (MHz)	99% Bandwidth (kHz)
NFC-Read/Write	13.56	2.54700	13.55914	13.56169	2.24312
Limit		N/A	13.553	13.567	N/A
Result		Complied			



3.3 Field Strength of Fundamental Emissions and Spectrum Mask

3.3.1 Field Strength of Fundamental Emissions and Spectrum Mask Limit

Field Strength of Fundamental Emissions For FCC					
Emissions	(uV/m)@30m	(dBuV/m)@30m	(dBuV/m)@10m	(dBuV/m)@3m	(dBuV/m)@1m
fundamental	15848	84.0	103.1	124.0	143.1
Quasi peak measurement of the fundamental.					

Spectrum Mask For FCC					
Freq. of Emission (MHz)	(uV/m)@30m	(dBuV/m)@30m	(dBuV/m)@10m	(dBuV/m)@3m	(dBuV/m)@1m
1.705~13.110	30	29.5	48.6	69.5	88.6
13.110~13.410	106	40.5	59.6	80.5	99.6
13.410~13.553	334	50.5	69.6	90.5	109.6
13.553~13.567	15848	84.0	103.1	124.0	143.1
13.567~13.710	334	50.5	69.6	90.5	109.6
13.710~14.010	106	40.5	59.6	80.5	99.6
14.010~30.000	30	29.5	48.6	69.5	88.6

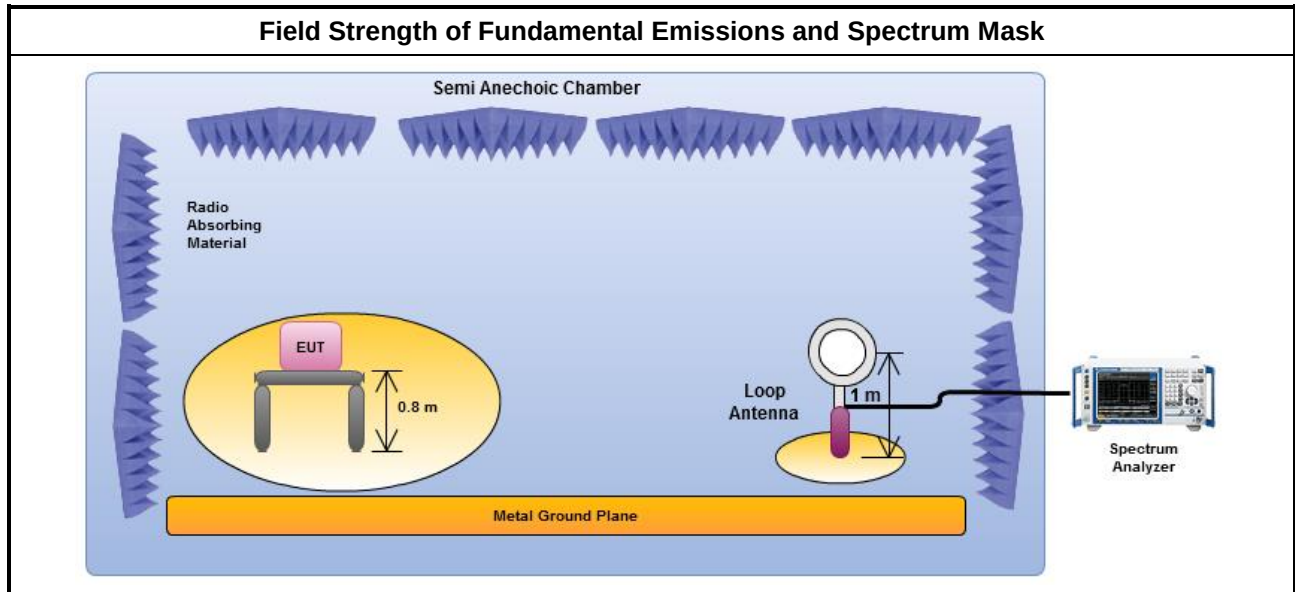
3.3.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

3.3.3 Test Procedures

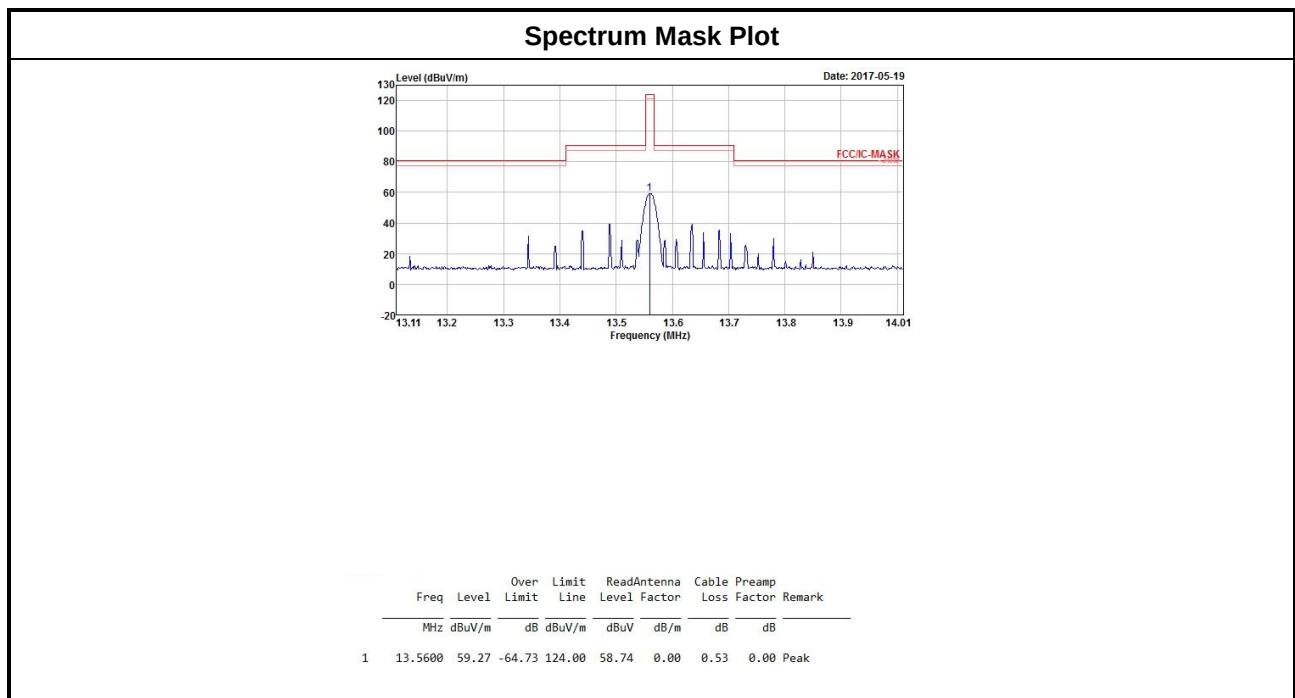
Test Method	
☒	Refer as ANSI C63.10, clause 6.4 for radiated emissions from below 30 MHz and test distance is 3m.
☒	At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the requirements; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be following below methods.
☐	The results shall be extrapolated to the specified distance by making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor.
☒	The results shall be by using the square of an inverse linear distance extrapolation factor (40 dB/decade).
☒	For radiated measurement. Loop antenna was rotated about the horizontal and vertical axis and the equipment to be measured and the test antenna shall be oriented to obtain the maximum emitted field strength level.

3.3.4 Test Setup



3.3.5 Test Result of Field Strength of Fundamental Emissions and Spectrum Mask

Field Strength of Fundamental Emissions Result					
Modulation Mode	Frequency (MHz)	Fundamental (dBuV/m)@3m	Polarization	Margin (dB)	Limit (dBuV/m)@3m
NFC-Read/Write	13.56	59.27	H	64.73	124.00
Result		Complied			
Note 1: Measurement worst emissions of receive antenna polarization: H(Horizontal).					



3.4 Transmitter Radiated Unwanted Emissions

3.4.1 Transmitter Radiated Unwanted Emissions Limit

Transmitter Radiated Unwanted Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1: Test distance for frequencies at or above 30 MHz, measurements may be performed at a distance other than the limit distance provided they are not performed in the near field and the emissions to be measured can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse of linear distance for field-strength measurements, inverse of linear distance-squared for power-density measurements).

Note 2: Test distance for frequencies at below 30 MHz, measurements may be performed at a distance closer than the EUT limit distance; however, an attempt should be made to avoid making measurements in the near field. When performing measurements below 30 MHz at a closer distance than the limit distance, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two or more distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). The test report shall specify the extrapolation method used to determine compliance of the EUT.

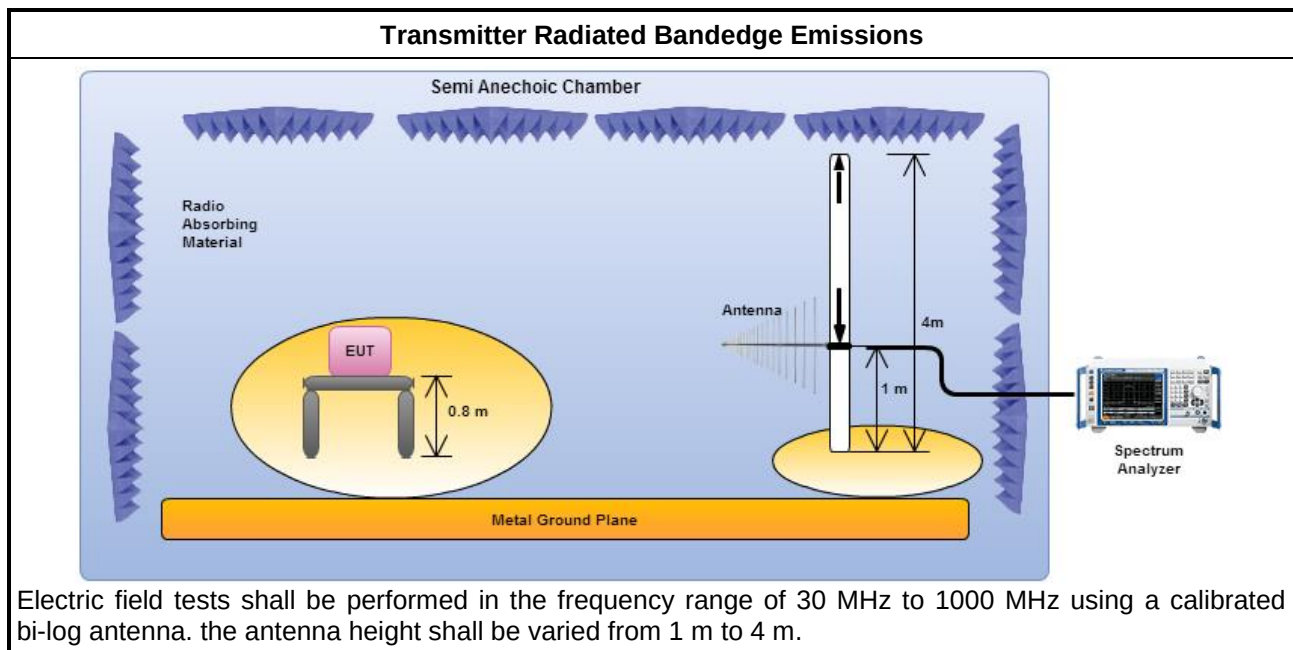
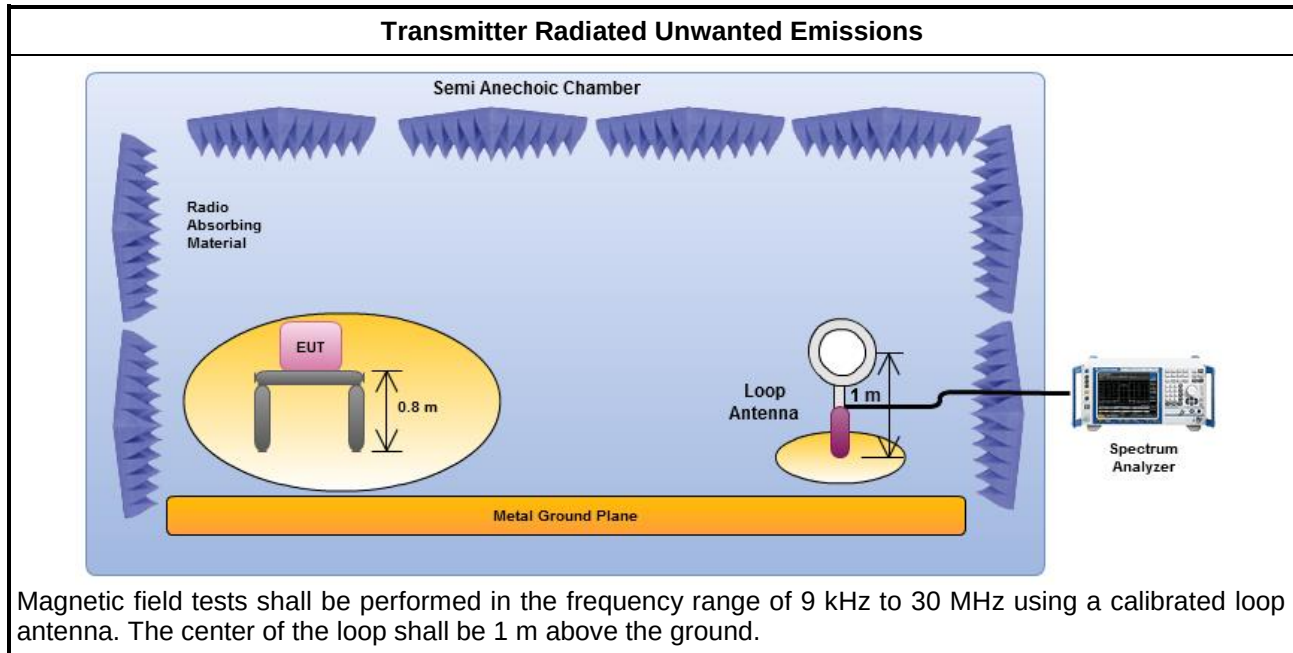
3.4.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

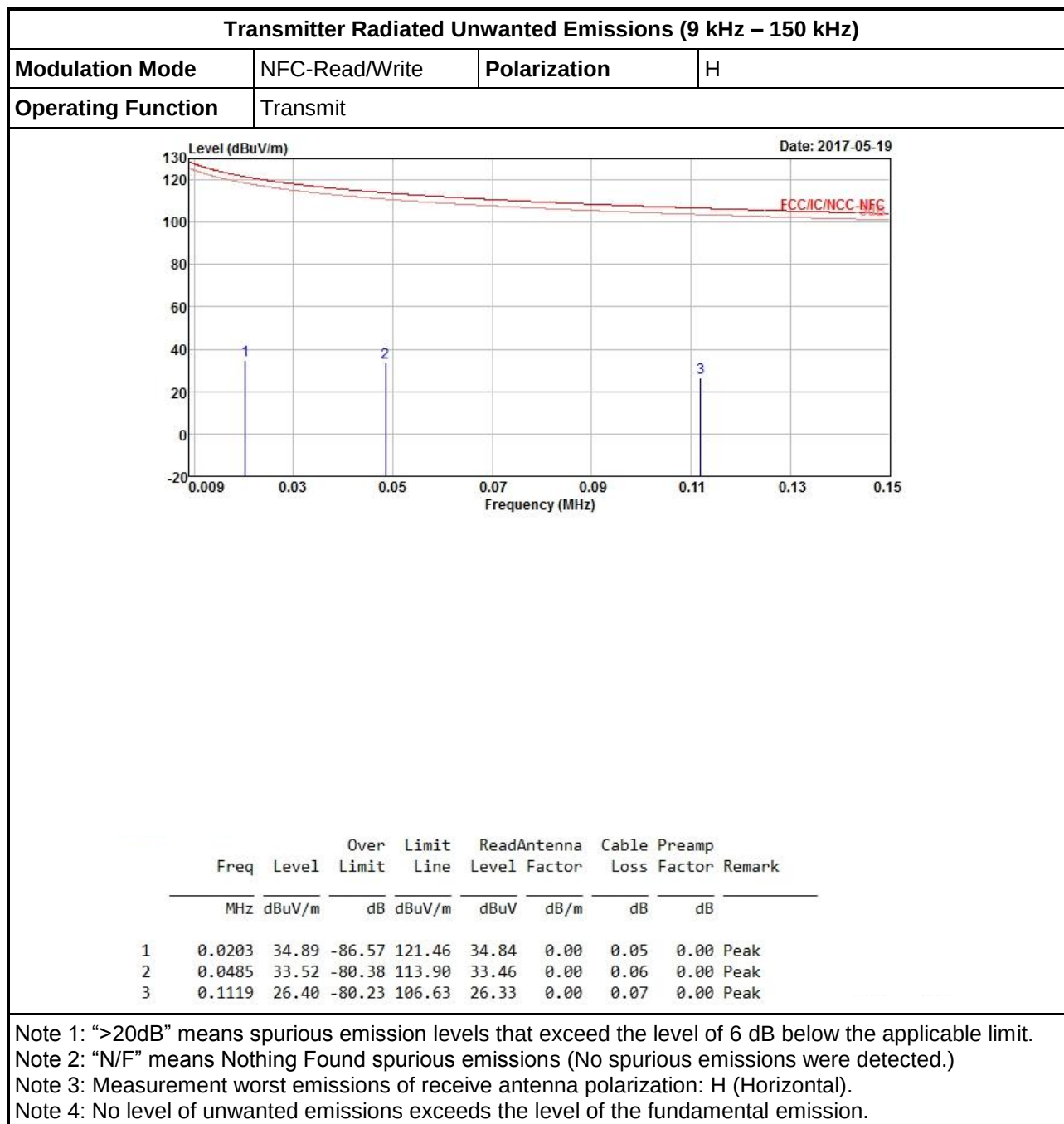
3.4.3 Test Procedures

Test Method	
☒	Refer as ANSI C63.10, clause 6.5 for radiated emissions from 30 MHz to 1 GHz and test distance is 3m.
☒	Refer as ANSI C63.10, clause 6.4 for radiated emissions from below 30 MHz and test distance is 3m.
☒	At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the requirements; however, an attempt should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be following below methods.
☐	The results shall be extrapolated to the specified distance by making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor.
☒	The results shall be by using the square of an inverse linear distance extrapolation factor (40 dB/decade).
☒	For radiated measurement. Loop antenna was rotated about the horizontal and vertical axis and the equipment to be measured and the test antenna shall be oriented to obtain the maximum emitted field strength level.
☒	The any unwanted emissions level shall not exceed the fundamental emission level.
☒	All amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

3.4.4 Test Setup

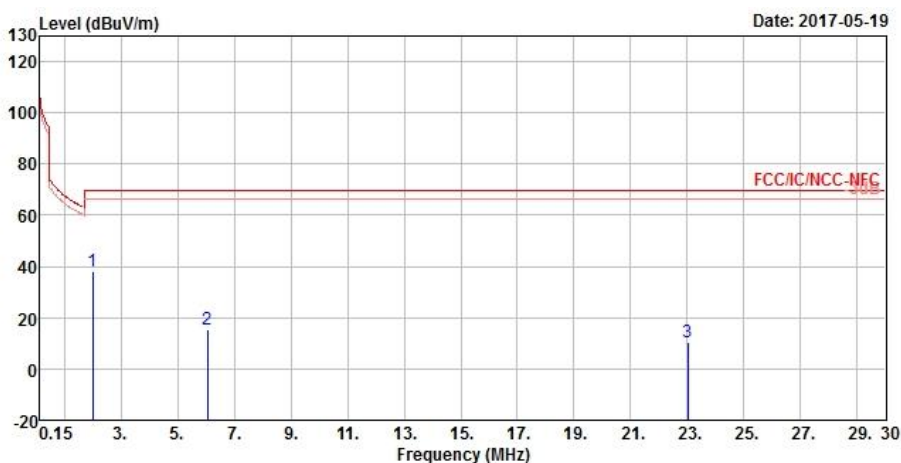


3.4.5 Transmitter Radiated Unwanted Emissions (Below 30MHz)



Transmitter Radiated Unwanted Emissions (150 kHz –30 MHz)

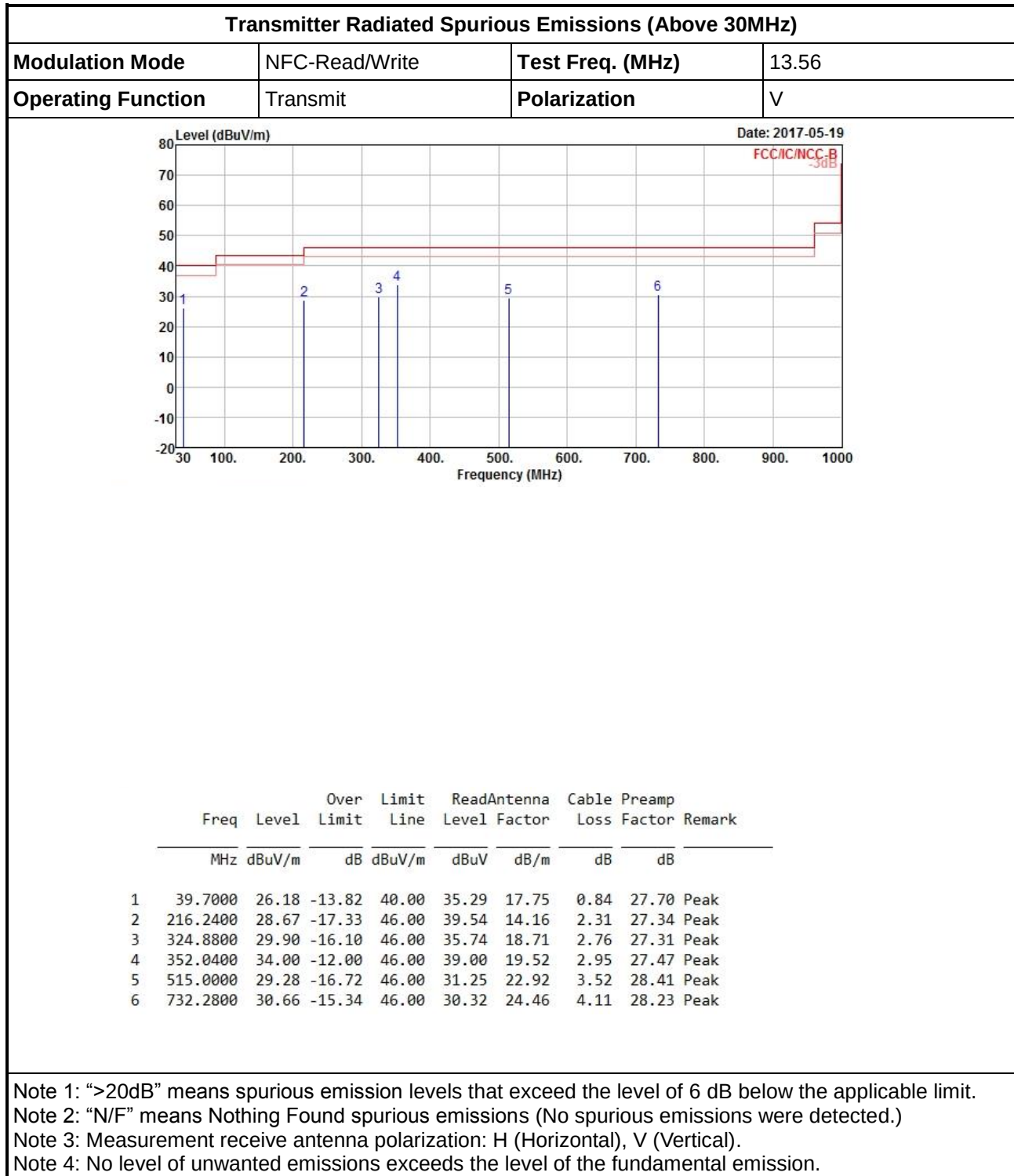
Modulation Mode	NFC-Read/Write	Polarization	H
Operating Function	Transmit		



	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Cable Loss	Preamp Factor	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB
1	2.0007	37.97	-31.57	69.54	37.72	0.00	0.25	0.00 Peak
2	6.0603	15.59	-53.95	69.54	15.16	0.00	0.43	0.00 Peak
3	23.0151	10.63	-58.91	69.54	10.00	0.00	0.63	0.00 Peak

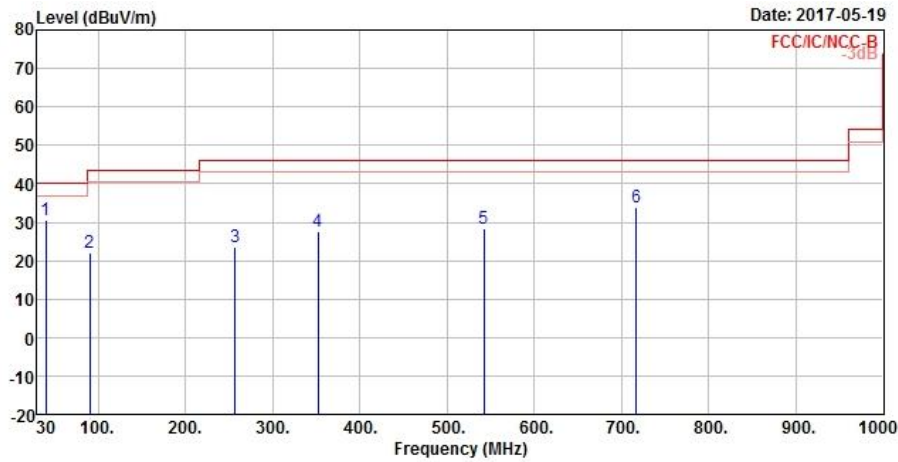
Note 1: ">20dB" means spurious emission levels that exceed the level of 6 dB below the applicable limit.
 Note 2: "N/F" means Nothing Found spurious emissions (No spurious emissions were detected.)
 Note 3: Measurement worst emissions of receive antenna polarization: H (Horizontal).
 Note 4: No level of unwanted emissions exceeds the level of the fundamental emission.

3.4.6 Transmitter Radiated Unwanted Emissions (Above 30MHz)



Transmitter Radiated Spurious Emissions (Above 30MHz)

Modulation Mode	NFC-Read/Write	Test Freq. (MHz)	13.56
Operating Function	Transmit	Polarization	H



	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Cable Loss	Preamp Factor	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB
1	39.7000	30.72	-9.28	40.00	39.83	17.75	0.84	27.70 Peak
2	90.1400	22.12	-21.38	43.50	34.64	13.92	1.36	27.80 Peak
3	256.9800	23.60	-22.40	46.00	29.93	18.29	2.47	27.09 Peak
4	352.0400	27.47	-18.53	46.00	32.47	19.52	2.95	27.47 Peak
5	542.1600	28.34	-17.66	46.00	29.46	23.62	3.62	28.36 Peak
6	716.7600	34.01	-11.99	46.00	34.06	24.21	4.05	28.31 Peak

Note 1: ">20dB" means spurious emission levels that exceed the level of 6 dB below the applicable limit.

Note 2: "N/F" means Nothing Found spurious emissions (No spurious emissions were detected.)

Note 3: Measurement receive antenna polarization: H (Horizontal), V (Vertical).

Note 4: No level of unwanted emissions exceeds the level of the fundamental emission.

3.5 Receiver Radiated Spurious Emissions

3.5.1 Receiver in Radiated Spurious Emissions Limit

Restricted Spurious Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1: Test distance for frequencies at or above 30 MHz, measurements may be performed at a distance other than the limit distance provided they are not performed in the near field and the emissions to be measured can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse of linear distance for field-strength measurements, inverse of linear distance-squared for power-density measurements).

Note 2: Test distance for frequencies at below 30 MHz, measurements may be performed at a distance closer than the EUT limit distance; however, an attempt should be made to avoid making measurements in the near field. When performing measurements below 30 MHz at a closer distance than the limit distance, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two or more distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade). The test report shall specify the extrapolation method used to determine compliance of the EUT.

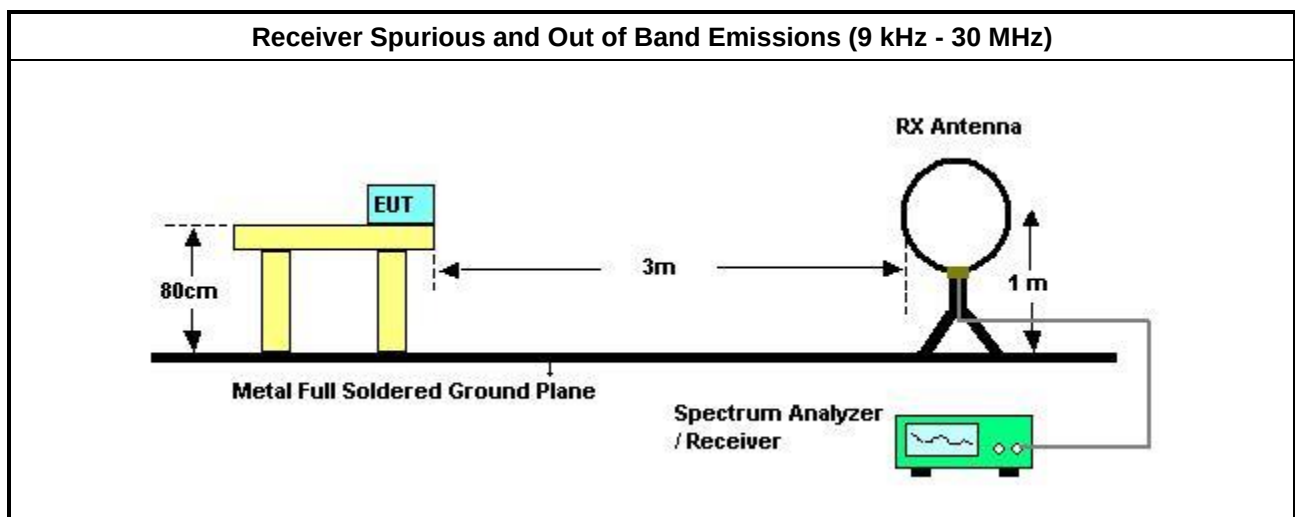
3.5.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

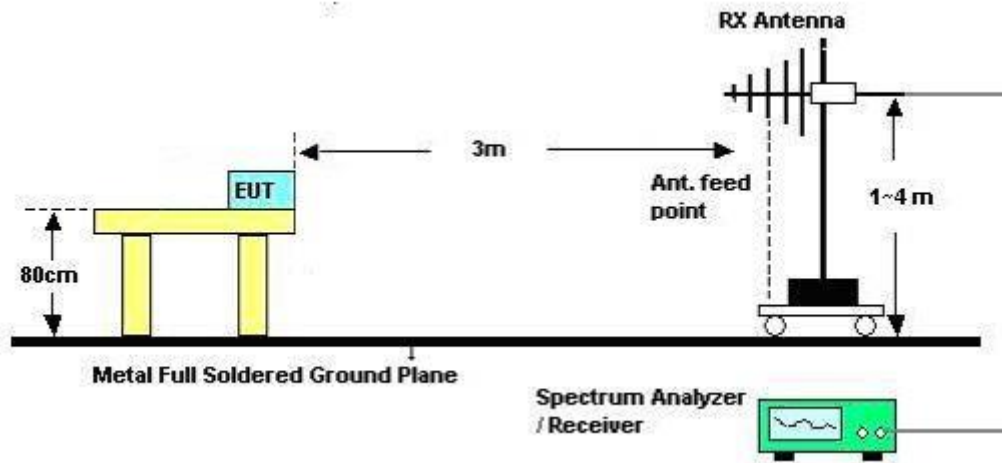
3.5.3 Test Procedures

Test Method	
☒	The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least 3 times the highest tuneable or local oscillator frequency, whichever is higher, without exceeding 40 GHz.
☒	Measurements may be performed at a distance other than the limit distance provided they are not performed in the near field and the emissions to be measured can be detected by the measurement equipment. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse of linear distance for field-strength measurements, inverse of linear distance-squared for power-density measurements).
☒	For radiated measurement, refer as ANSI C63.4, clause 8.3.
☒	Refer as ANSI C63.4, clause 8.3.1.1 and 8.3.2.1 for radiated emissions from below 30 MHz.
☒	Refer as ANSI C63.4, clause 8.3.1.1 and 8.3.2.1 for radiated emissions from 30 MHz-1 GHz. For the peak measurement is fully sufficient, as the max field strength as measured with the Peak-Detector meets the QP-Limit so that the QP level does not need to be reported in addition.
☒	Refer as ANSI C63.4, clause 8.3.1.2 and 8.3.2.2 for radiated emissions from above 1 GHz. For the peak measurement is fully sufficient, as the max field strength as measured with the Peak-Detector meets the AV-Limit so that the AV level does not need to be reported in addition.
☒	All amplitude of spurious emissions that are attenuated by more than 30 dB below the permissible value has no need to be reported.

3.5.4 Test Setup



Receiver Radiated Unwanted Emissions (30 MHz ~ 1 GHz)



3.5.5 Receiver Radiated Unwanted Emissions (Below 30MHz)

Summary

Mode	Result	Type	Freq (Hz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Factor (dB)	Dist (m)	Azimuth (°)	Height (m)	Comments
13.553-13.567MHz	-	-	-	-	-	-	-	-	-	-	-
NFC	Pass	PK	2.12M	56.46	69.50	-13.04	17.22	3	360	1.00	-

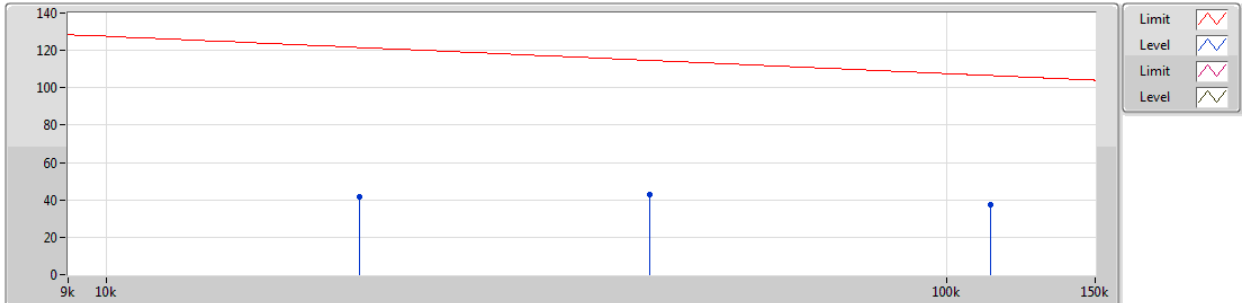
Result

Mode	Result	Type	Freq (Hz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Factor (dB)	Dist (m)	Azimuth (°)	Height (m)	Comments
NFC	-	-	-	-	-	-	-	-	-	-	-
13.56MHz_DC Power Supply	Pass	PK	19.998k	41.82	121.56	-79.74	12.22	3	0	1.00	-
13.56MHz_DC Power Supply	Pass	PK	44.25k	42.88	114.67	-71.79	13.49	3	0	1.00	-
13.56MHz_DC Power Supply	Pass	PK	112.494k	37.32	106.57	-69.25	13.62	3	0	1.00	-
13.56MHz_DC Power Supply	Pass	PK	209.7k	43.42	101.16	-57.74	14.62	3	360	1.00	-
13.56MHz_DC Power Supply	Pass	PK	388.8k	50.66	95.80	-45.14	15.55	3	360	1.00	-
13.56MHz_DC Power Supply	Pass	PK	2.12M	56.46	69.50	-13.04	17.22	3	360	1.00	-

NFC Standby below 30MHz

29/03/2019

13.56MHz_DC Power Supply

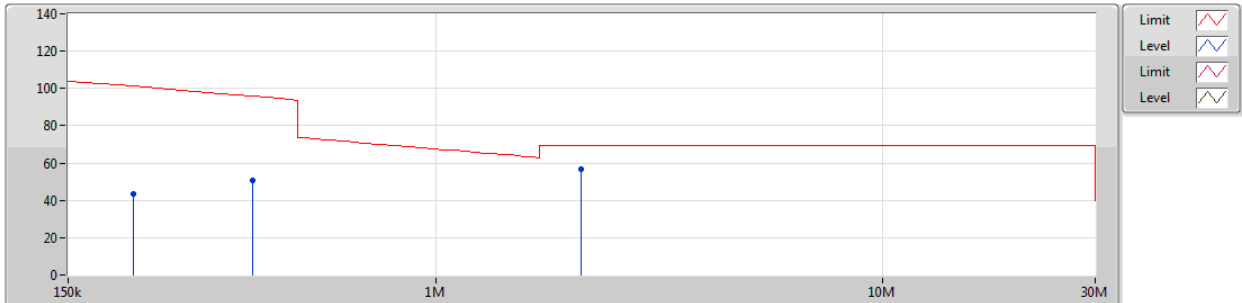


Type	Freq (Hz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Factor (dB)	Dist (m)	Condition	Azimuth (°)	Height (m)	Comments								
PK	19.998k	41.82	121.56	-79.74	12.22	3	Horizontal	0	1.00	-								
PK	44.25k	42.88	114.67	-71.79	13.49	3	Horizontal	0	1.00	-								
PK	112.494k	37.32	106.57	-69.25	13.62	3	Horizontal	0	1.00	-								

NFC Standby below 30MHz

29/03/2019

13.56MHz_DC Power Supply



Type	Freq (Hz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Factor (dB)	Dist (m)	Condition	Azimuth (°)	Height (m)	Comments						
PK	209.7k	43.42	101.16	-57.74	14.62	3	Horizontal	360	1.00	-						
PK	388.8k	50.66	95.80	-45.14	15.55	3	Horizontal	360	1.00	-						
PK	2.12M	56.46	69.50	-13.04	17.22	3	Horizontal	360	1.00	-						

3.5.6 Receiver Radiated Unwanted Emissions (Above 30MHz)

Summary

Mode	Result	Type	Freq (Hz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Factor (dB)	Dist (m)	Azimuth (°)	Height (m)	Comments
13.553-13.567MHz	-	-	-	-	-	-	-	-	-	-	-
NFC	Pass	PK	90.14M	34.92	43.50	-8.58	-12.55	3	0	1.00	-

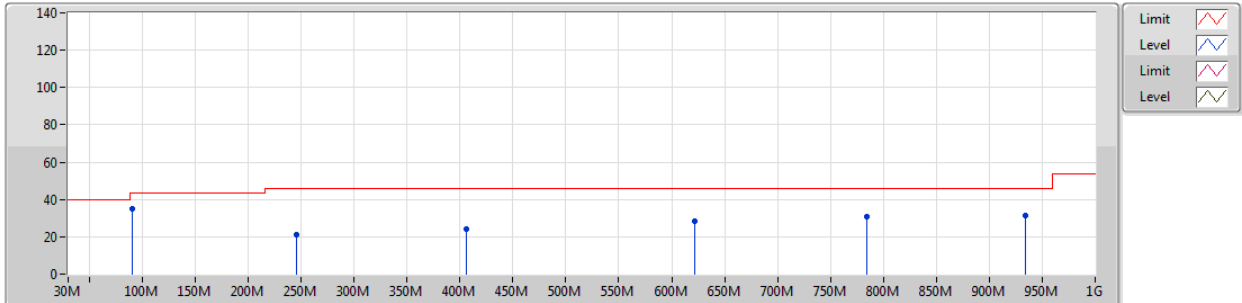
Result

Mode	Result	Type	Freq (Hz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Factor (dB)	Dist (m)	Azimuth (°)	Height (m)	Comments
NFC	-	-	-	-	-	-	-	-	-	-	-
13.56MHz_DC Power Supply	Pass	PK	90.14M	34.92	43.50	-8.58	-12.55	3	0	1.00	-
13.56MHz_DC Power Supply	Pass	PK	245.34M	21.13	46.00	-24.87	-7.52	3	0	1.00	-
13.56MHz_DC Power Supply	Pass	PK	406.36M	24.43	46.00	-21.57	-3.49	3	0	1.00	-
13.56MHz_DC Power Supply	Pass	PK	621.7M	28.45	46.00	-17.55	-0.46	3	0	1.00	-
13.56MHz_DC Power Supply	Pass	PK	784.66M	30.87	46.00	-15.13	1.19	3	0	1.00	-
13.56MHz_DC Power Supply	Pass	PK	934.04M	31.55	46.00	-14.45	3.15	3	0	1.00	-
13.56MHz_DC Power Supply	Pass	PK	30M	29.54	40.00	-10.46	-4.63	3	360	1.00	-
13.56MHz_DC Power Supply	Pass	PK	90.14M	28.24	43.50	-15.26	-12.55	3	360	1.00	-
13.56MHz_DC Power Supply	Pass	PK	315.18M	22.02	46.00	-23.98	-5.59	3	360	1.00	-
13.56MHz_DC Power Supply	Pass	PK	460.68M	25.71	46.00	-20.29	-2.75	3	360	1.00	-
13.56MHz_DC Power Supply	Pass	PK	726.46M	29.45	46.00	-16.55	0.40	3	360	1.00	-
13.56MHz_DC Power Supply	Pass	PK	924.34M	30.72	46.00	-15.28	2.95	3	360	1.00	-

NFC Standby above 30MHz

13.56MHz_DC Power Supply

29/03/2019

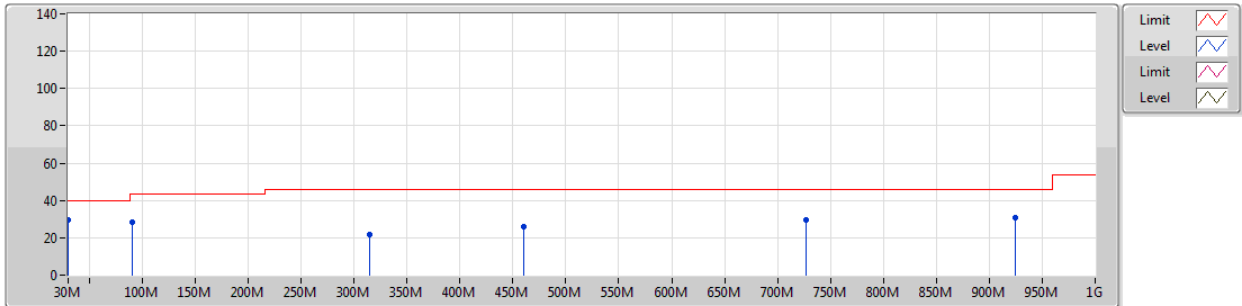


Type	Freq (Hz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Factor (dB)	Dist (m)	Condition	Azimuth (°)	Height (m)	Comments
PK	90.14M	34.92	43.50	-8.58	-12.55	3	Vertical	0	1.00	-
PK	245.34M	21.13	46.00	-24.87	-7.52	3	Vertical	0	1.00	-
PK	406.36M	24.43	46.00	-21.57	-3.49	3	Vertical	0	1.00	-
PK	621.7M	28.45	46.00	-17.55	-0.46	3	Vertical	0	1.00	-
PK	784.66M	30.87	46.00	-15.13	1.19	3	Vertical	0	1.00	-
PK	934.04M	31.55	46.00	-14.45	3.15	3	Vertical	0	1.00	-

NFC Standby above 30MHz

29/03/2019

13.56MHz_DC Power Supply



Type	Freq	Level	Limit	Margin	Factor	Dist	Condition	Azimuth	Height	Comments
	(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dB)	(m)		(°)	(m)	
PK	30M	29.54	40.00	-10.46	-4.63	3	Horizontal	360	1.00	-
PK	90.14M	28.24	43.50	-15.26	-12.55	3	Horizontal	360	1.00	-
PK	315.18M	22.02	46.00	-23.98	-5.59	3	Horizontal	360	1.00	-
PK	460.68M	25.71	46.00	-20.29	-2.75	3	Horizontal	360	1.00	-
PK	726.46M	29.45	46.00	-16.55	0.40	3	Horizontal	360	1.00	-
PK	924.34M	30.72	46.00	-15.28	2.95	3	Horizontal	360	1.00	-

3.6 Frequency Stability

3.6.1 Frequency Stability Limit

Frequency Stability Limit	
☒	Carrier frequency stability shall be maintained to $\pm 0.01\%$ (± 100 ppm).

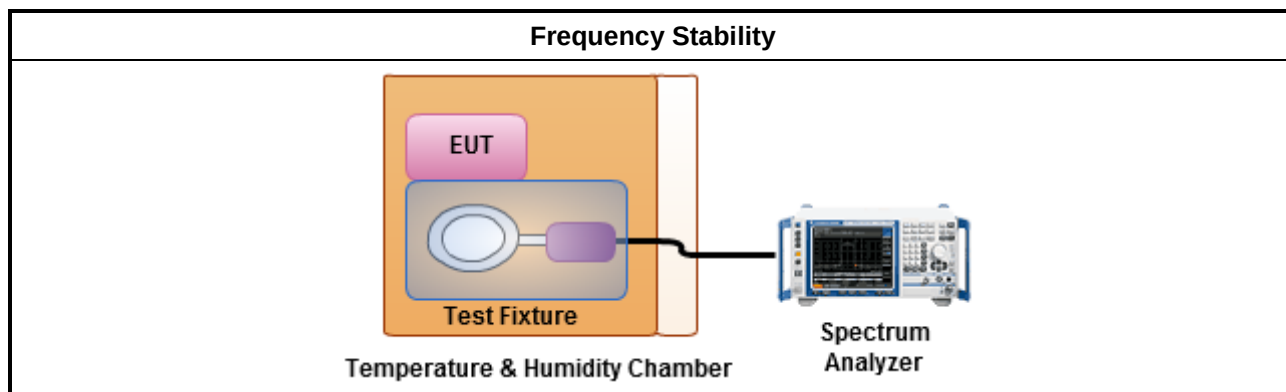
3.6.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

3.6.3 Test Procedures

Test Method	
☒	Refer as ANSI C63.10, clause 6.8 for frequency stability tests
☒	Frequency stability with respect to ambient temperature
☒	Frequency stability when varying supply voltage
☐	For conducted measurement.
☒	For radiated measurement. The equipment to be measured and the test antenna shall be oriented to obtain the maximum emitted power level.

3.6.4 Test Setup



3.6.5 Test Result of Frequency Stability

Frequency Stability Result									
Condition	Ch. Freq. (MHz)	Frequency Stability (ppm)							
		Test Frequency (MHz)				Frequency Stability (ppm)			
		0 min	2 min	5 min	10 min	0 min	2 min	5 min	10 min
T _{20°C} Vmax	13.56	13.56045	13.56045	13.56047	13.56048	33.19	33.19	34.66	35.40
T _{20°C} Vmin	13.56	13.56028	13.56028	13.56029	13.56029	20.65	20.65	21.39	21.39
T _{85°C} Vnom	13.56	13.56009	13.56010	13.56010	13.56010	6.64	7.37	7.37	7.37
T _{80°C} Vnom	13.56	13.56008	13.56007	13.56008	13.56007	5.90	5.16	5.90	5.16
T _{70°C} Vnom	13.56	13.56006	13.56006	13.56006	13.56006	4.42	4.42	4.42	4.42
T _{60°C} Vnom	13.56	13.56009	13.56009	13.56009	13.56009	6.64	6.64	6.64	6.64
T _{50°C} Vnom	13.56	13.56014	13.56015	13.56015	13.56015	10.32	11.06	11.06	11.06
T _{40°C} Vnom	13.56	13.56022	13.56022	13.56023	13.56023	16.22	16.22	16.96	16.96
T _{30°C} Vnom	13.56	13.56032	13.56030	13.56032	13.56033	23.60	22.12	23.60	24.34
T _{20°C} Vnom	13.56	13.56039	13.56039	13.56039	13.56039	28.76	28.76	28.76	28.76
T _{10°C} Vnom	13.56	13.56048	13.56048	13.56049	13.56048	35.40	35.40	36.14	35.40
T _{0°C} Vnom	13.56	13.56055	13.56055	13.56054	13.56054	40.56	40.56	39.82	39.82
T _{-10°C} Vnom	13.56	13.56061	13.56061	13.56061	13.56061	44.99	44.99	44.99	44.99
T _{-20°C} Vnom	13.56	13.56063	13.56063	13.56064	13.56063	46.46	46.46	47.20	46.46
T _{-30°C} Vnom	13.56	13.56063	13.56063	13.56064	13.56063	46.46	46.46	47.20	46.46
T _{-40°C} Vnom	13.56	13.56059	13.56059	13.56059	13.56059	43.51	43.51	43.51	43.51
Limit (ppm)		100							
Result		Complied							
Note 1: Measure at 85 % [Vmin] and 115 % [Vmax] of the nominal voltage [Vnom]. The nominal voltage refer test report clause 1.1.5 for EUT operational condition.									
Note 2: Measure maximum deviation frequency at operating frequency at startup and two, five, and ten min.									

4 Test Equipment and Calibration Data

Instrument for Conducted Test

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Next Calibration Date
Spectrum Analyzer	R&S	FSV 40	101500	9KHz~40GHz	12/May/2016	11/May/2017
Temp. and Humidity Chamber	Giant Force	GTH-225-40-CP-AR	MAA1611-005	-40~100℃	21/Nov/2016	20/Nov/2018
Loop Antenna	TESEQ	HLA 6120	31244	9 kHz~30 MHz	02/Mar/2017	01/Mar/2018

Instrument for Radiated Test - TX

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Next Calibration Date
3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH02-HY	9kHz ~ 1GHz 3m	05/Jun/2017	04/Jun/2018
RF Cable-R03m	Jye Bao	RG142	CB017	9kHz~1GHz	26/Jan/2017	25/Jan/2018
Spectrum Analyzer	R&S	FSP 40	100593	9kHz~40GHz	26/Oct/2016	25/Oct/2017
Loop Antenna	TESEQ	HLA 6120	31244	9 kHz~30 MHz	02/Mar/2017	01/Mar/2018

Instrument for Radiated Test - RX

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Next Calibration Date
3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	30MHz ~ 1GHz 3m	30/Oct/2018	29/Oct/2019
Amplifier	HP	8447D	2944A08033	10kHz ~ 1.3GHz	23/Apr/2018	19/Apr/2019
Signal Analyzer	R&S	FSV40	101500	10Hz ~ 40GHz	18/Jul/2018	17/Jul/2019
RF Cable-R03m	Jye Bao	RG142	CB021	9kHz ~ 1GHz	22/Mar/2019	21/Mar/2020
Bilog Antenna with 5dB Pad	ETS	3142B & MTJ6102-05	00022055	26 MHz - 3 GHz	19/Nov/2018	18/Nov/2019
EMI Test Receiver	R&S	ESR3	102052	9kHz ~ 3.6GHz	10/Apr/2018	09/Apr/2019
Loop Antenna	TESEQ	HLA 6120	31244	9k-30MHz	15/Mar/2019	14/Mar/2020

Instrument for AC Conduction

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Calibration Due Date
EMC Receiver	R&S	ESR	102051	9KHz ~ 3.6GHz	03/May/2018	02/May/2019
LISN	R&S	ENV216	101295	9kHz ~ 30MHz	08/Nov/2018	07/Nov/2019
RF Cable-CON	MTJ	RG142	CB002-CO	9kHz ~ 200MHz	17/Sep/2018	16/Sep/2019
AC POWER	APC	AFC-11005G	F310050055	47Hz~63Hz 5~300V	NCR	NCR
Impuls Begrenzer Pulse Limiter	SCHWARZBECK	VTSD 9561-F	9561-F041	9 kHz ~ 30 MHz	12/Oct/2018	11/Oct/2019