



FCC LISTED, REGISTRATION
NUMBER: 2764.01

ISED LISTED REGISTRATION
NUMBER: 23595-1

Test report No:
4046ERM.006

Test report

USA FCC Part 15.225 and Part 15.209

CANADA RSS-210, RSS-Gen

(*) Identification of item tested	Wireless Charging Module
(*) Trademark	Aptiv
(*) Model and /or type reference	WCM_tx2
(*) Other identification of the product	FCC: L2C0092TR IC ID: 3432A-0092TR
(*) Features	NFC, PLA FOD
Manufacturer	APTIV SERVICES US, LLC. 5725 Innovation Drive, Troy, Michigan 48098, USA
Test method requested, standard	USA FCC Part 15.225 (10–1–21 Edition): Operation within the band 13.110 -14.010 USA FCC Part 15.209 (10–1–21 Edition): Radiated emission limits, general requirements. CANADA RSS-210 Issue 10 (Dec 2019). CANADA RSS-Gen Issue 5 (March 2019). ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Domingo Galvez EMC&RF Lab Manager
Date of issue	02-12-2024
Report template No	FDT08_23 (*) "Data provided by the client"

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Competences and guarantees

DEKRA Certification Inc. is a testing laboratory accredited by A2LA (The American Association for Laboratory Accreditation), to perform the tests indicated in the Certificate 2764.01

DEKRA Certification Inc. is a testing laboratory competent to carry out the tests described in this report.

In order to assure the traceability to other national and international laboratories, DEKRA Certification Inc. has a calibration and maintenance program for its measurement equipment.

DEKRA Certification Inc. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Certification at the time of performance of the test.

DEKRA Certification Inc. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

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General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Certification Inc.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Certification Inc. and the Accreditation Bodies.

Uncertainty

Uncertainty (factor $k=2$) was calculated according to the DEKRA Certification internal document PODT000.

Test case	Frequency (MHz)	U(k=2)	Units
Radiated Spurious Emission	0,009 - 30	2.69	dB
	30-180	3.82	dB
	180-1000	2.61	dB
	1000-18000	2.92	dB
	18000-40000	2.15	dB

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample consists of the Wireless Charging Module version 3.1 (WCM3.1), Model A & B charges consumer electronics (CE) devices wirelessly by supplying power under the Wireless Power Consortium (WPC) Qi v1.3 charging standard. The power source to the WCM is 12V vehicle battery. CAN bus is the communication interface to the vehicle. WCM3.1 is a non-terminating CAN node with output pins provisioned for a daisy-chain connection to additional downstream CAN nodes. The WCM supports functionality for detecting foreign objects, such as coins, keys, or RFID tags; and halting or prohibiting charging while the foreign object remains present on the interface surface. The WCM is capable of delivering up to 15W to the compatible CE device.

DEKRA declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples used for test have been selected by: The client.

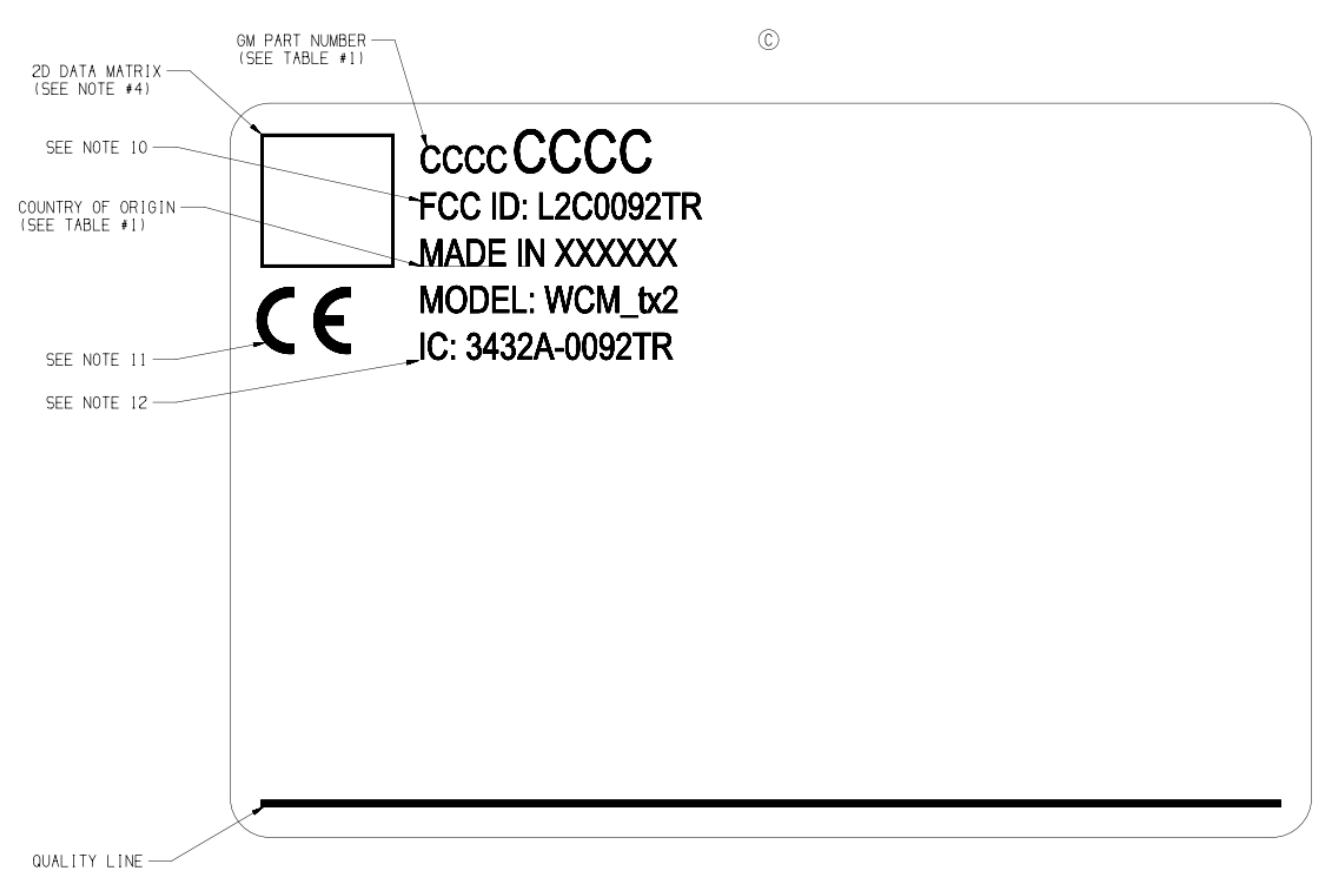
Sample S/01 is composed of the following elements:

Id	Control N°	Description	Model	Serial N°	Date of reception	Application
S/01	4046/08	WCM-B (NFC)	WCM_tx2	-	11/29/2023	Element Under Test
S/01	4046/05	Harness	-	-	11/29/2023	Accessory

Sample S/01 was used for the following test(s): All conducted and radiated tests indicated in appendix A.

Test sample description

Ports..... :	Port name and description		Cable				
			Specified length [m]	Attached during test	Shielded		
	Product connector		N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/>	<input type="checkbox"/>		
				<input type="checkbox"/>	<input type="checkbox"/>		
				<input type="checkbox"/>	<input type="checkbox"/>		
				<input type="checkbox"/>	<input type="checkbox"/>		
Supplementary information to the ports..... :							
Rated power supply :	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	<input type="checkbox"/>	AC:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	AC:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	DC: DC: 13.5V DC, 1.5A					
<input type="checkbox"/>	DC:						
Rated Power :	15W						
Clock frequencies..... :	27.12 MHz, 40 MHz						
Other parameters..... :	No data provided						
Software version :	Qi module: WCM2_C_CERT_SW2, NFC module: WCM2_C_CERT_SW1						
Hardware version..... :	PV1						
Dimensions in cm (L x W x D)..... :	No data provided						
Mounting position..... :	<input checked="" type="checkbox"/>	Table top equipment					
	<input type="checkbox"/>	Wall/Ceiling mounted equipment					
	<input type="checkbox"/>	Floor standing equipment					
	<input type="checkbox"/>	Hand-held equipment					
	<input type="checkbox"/>	Other: Automotive centre console					
Modules/parts..... :	Module/parts of test item		Type		Manufacturer		
	Aptiv Test Receivers		Receivers		Aptiv		
	Harness-2 meters long (6)		Harness		Aptiv		
	WCM module A- (4 Qi) (4 NFC)		WCM modules		Aptiv		
	WCM module B- (2 Qi) (2 NFC)		WCM modules		Aptiv		
Accessories (not part of the test item)..... :	Description		Type		Manufacturer		
	NA						

Documents as provided by the applicant..... :	Description	File name	Issue date
	Aptiv Receiver test instruction ppt document	Aptiv WCM setup instructions_3-Nov-2023	11/22/2023
	Declaration Equipment Data	FDT30_19 Declaration Equipment Data_ModelB	12/19/2023
Copy of marking plate:			
 <p>The marking plate contains the following information: <ul style="list-style-type: none"> 2D DATA MATRIX (SEE NOTE #4): A square matrix code. GM PART NUMBER (SEE TABLE #1): A line pointing to the top right of the matrix. SEE NOTE 10: A line pointing to the bottom left of the matrix. COUNTRY OF ORIGIN (SEE TABLE #1): A line pointing to the bottom right of the matrix. CE: The CE mark. SEE NOTE 11: A line pointing to the CE mark. SEE NOTE 12: A line pointing to the text 'MADE IN XXXXXX'. Text on plate: ccccCCCC, FCC ID: L2C0092TR, MADE IN XXXXXX, MODEL: WCM_tx2, IC: 3432A-0092TR. QUALITY LINE: A horizontal line at the bottom of the plate. </p>			

Identification of the client

APTIV SERVICES US, LLC.
5725 Innovation Drive,
Troy, Michigan 48098,
USA

Testing period and place

Test Location	DEKRA Certification Inc.
Date (start)	12-06-2023
Date (finish)	12-06-2023

Document history

Report number	Date	Description
4030ERM.006	02-12-2024	First release

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 30 % Max. = 60 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Remarks and comments

The tests have been performed by the technical personnel: Ivy Yousuf Moutushi, Qi Zhang, and Koji Nishimoto.

Testing verdicts

Not applicable :	N/A
Pass :	P
Fail :	F
Not measured :	N/M

Summary

FCC PART 15 PARAGRAPH / RSS-210					
Report Section	15.225 Spec Clause	RSS Spec Clause	Test Description	Verdict	Remark
A.1		RSS-Gen 6.7	99% Occupied Bandwidth	P	N/A
A.2	§ 15.225 (a)	RSS-210 Clause B.6 (a).	Field Strength of emissions within the band 13.553 MHz – 13.567 MHz	P	N/A
A.3	§ 15.225 (b)	RSS-210 Clause B.6 (b).	Field Strength of emissions within the band 13.410 MHz – 13.553 MHz and 13.567 – 13.710 MHz	P	N/A
A.4	§ 15.225 (c)	RSS-210 Clause B.6 (c).	Field Strength of emissions within the band 13.110 MHz – 13.410 MHz and 13.710 – 14.010 MHz	P	N/A
A.5	§ 15.225 (d)	RSS-210 Clause B.6 (d).	Field Strength of emissions outside of the band 13.110 MHz – 14.010 MHz	P	N/A
A.6	§ 15.225 (e)	RSS-210 Clause B.6	Frequency Tolerance of the carrier signal.	P	N/A

List of equipment used during the test

Conducted Measurements

Control Number	Description	Manufacturer	Serial	Model	Next Calibration
1107	Ethernet SNMP Thermometer	Hw Group	60038026952	HWg-STE Plain	2024/10
1391	Signal analyzer	Rohde & Schwarz	101281	FSW50	2024/01
1387	Power supply 0-30V, 0-3A	GWINSTEK	GEV875134	GPS3030D	N/A
1497	ESPEC CHMBER UNIT	ESPEC NORTH AMERICA	R21868-04	T20RC	2024/12

Radiated Measurements

Control Num	Equipment	Manufacturer	Serial	Model	Next calibration
878	DC Power supply	Ametek Prog	1707A01783	PROG-DC-PS	N/A
1012	ESR26 EMI Test Receiver	Rohde & Schwarz	101478	ESR26	2025/01
1014	FSV40 Signal Analyzer 40GHz	Rhode & Schwarz	101626	FSV40	2024/08
1062	Active loop Antenna	ETS Lindgren	208517	6502	2026/07
1064	3142E Biconilog Antenna	ETS Lindgren	208600	3142E	2024/12
1108	Ethernet SNMP Thermometer-CR Room	Hw Group	60038026954	HWg-STE Plain	2024/10
1111	Ethernet SNMP Thermometer-SAC	Hw Group	60038026577	HWg-STE Plain	2024/10
1179	Semi-Anechoic Chamber	Frankonia	F169021	SAC 3plus 'L'	N/A
1314	Wireless Measurement Software R&S EMC32	Rohde & Schwarz	1040-OT102236	-	N/A

Appendix A: Test results

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PRODUCT INFORMATION

The following information is provided by the client:

Information	Description
Operating Frequency Band or Bands	13.56 MHz
Operating Frequency or Frequencies	13.56 MHz
Channel Bandwidth	46k-1.7MHz
Extreme operating conditions	
- Temperature range	-20 °C to +50 °C
Nominal Voltage	
- Supply Voltage	13.5V DC
- Voltage range	4.5Vdc to 26.5Vdc

Test modes available:

- Nominal Operating Frequency: 13.56 MHz

DESCRIPTION OF TEST CONDITIONS

TEST CONDITIONS	DESCRIPTION
TC#01	<p><u>Power supply (V):</u></p> <p>$V_{\text{nom}} = 13.5 \text{ V}$</p> <p>$V_{\text{min}} = 4.5 \text{ V}$</p> <p>$V_{\text{max}} = 26.5 \text{ V}$</p> <p><u>Temperature (°C):</u></p> <p>Temperature range: -20°C to +50 °C</p> <p>The subscript nom indicates normal test conditions.</p> <p>The subscripts min and max indicate extreme test conditions (minimum and maximum respectively).</p> <p><u>Test Frequencies for Conducted and Radiated tests:</u></p> <p>13.56 MHz</p>

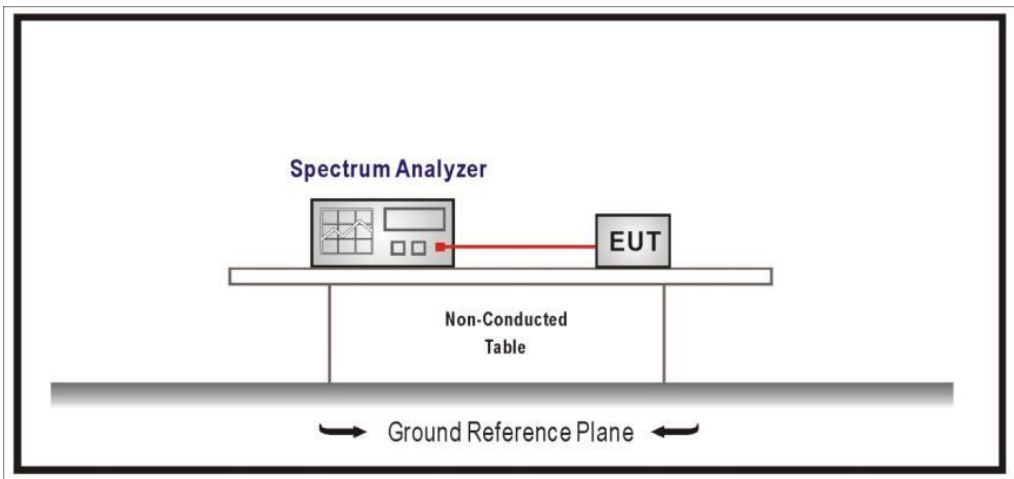
TEST A.1: 99% OCCUPIED BANDWIDTH

LIMITS:	Product standard:	RSS-Gen
	Test standard:	RSS-Gen 6.7

LIMITS

The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs

TEST SETUP

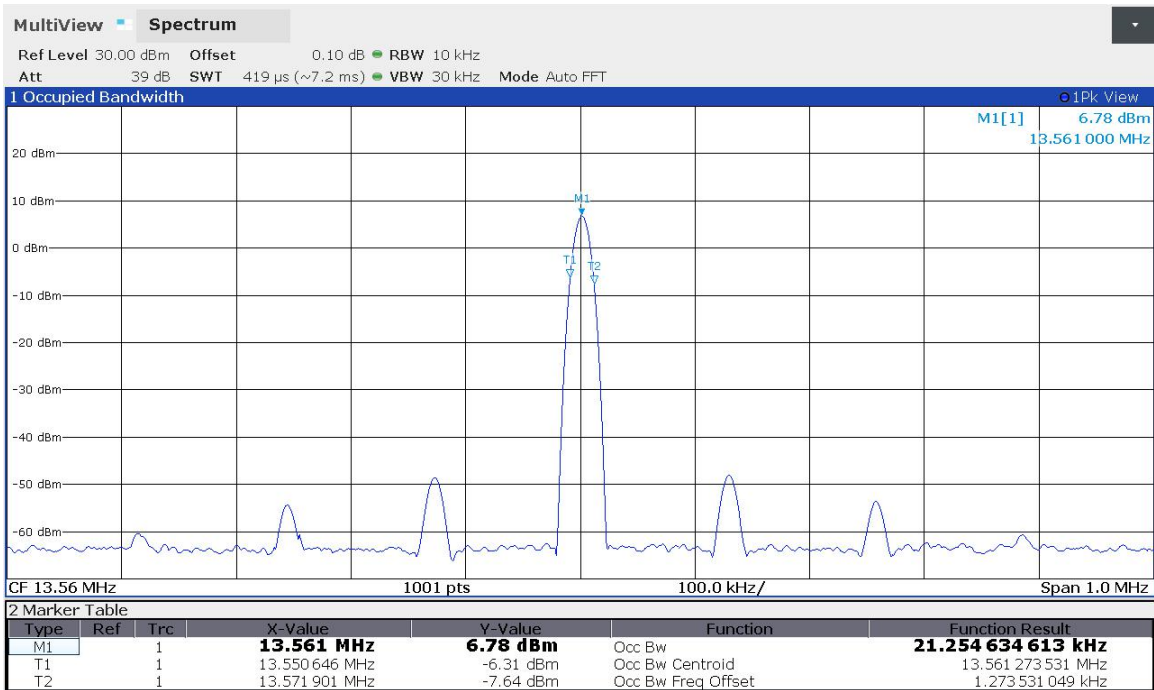


TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC#01
TEST RESULTS:	PASS

NFC Operating Frequency: 13.56MHz

Center Frequency (MHz)	13.561
99% bandwidth (KHz)	21.254

TEST RESULTS (Cont.):



TEST A.2: FIELD STRENGTH OF EMISSIONS WITHIN THE BAND 13.553 MHZ – 13.567 MHZ

LIMITS:	Product standard:	Part 15 Subpart C §15.225 and RSS-210
	Test standard:	Part 15 Subpart C §15.225(a) and RSS-210 clause B.6 (a)

LIMITS

The field strength of any emissions within the band 13.553 – 13.567 MHz shall not exceed 15,848 microvolts/meter (84 dBμV/m) at 30 meters.

TEST SETUP

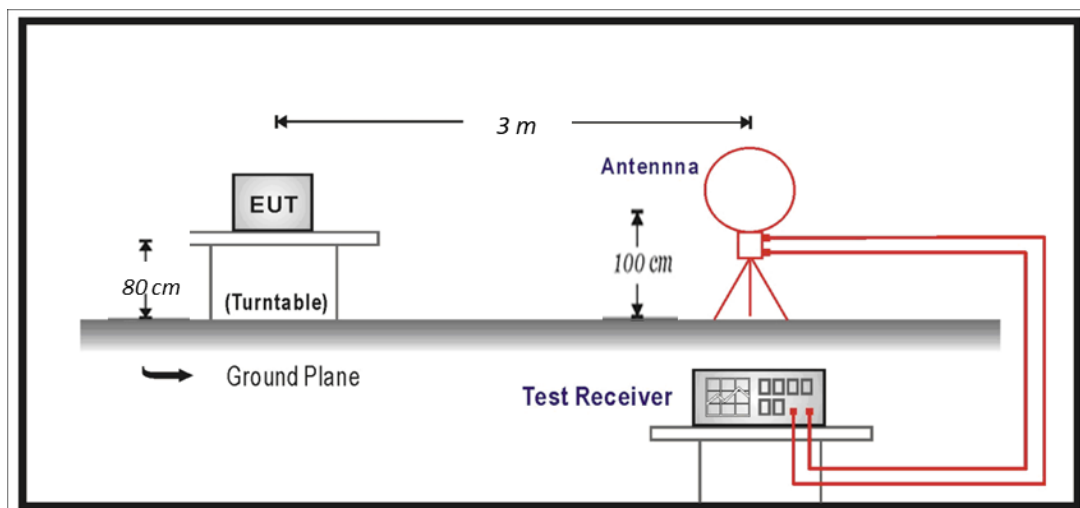
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Loop antenna for the range between 9 kHz to 30 MHz) is situated at a distance of 3 m.

For radiated emissions in the range 9 kHz to 30 MHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 40 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° to find the maximum radiated emission.

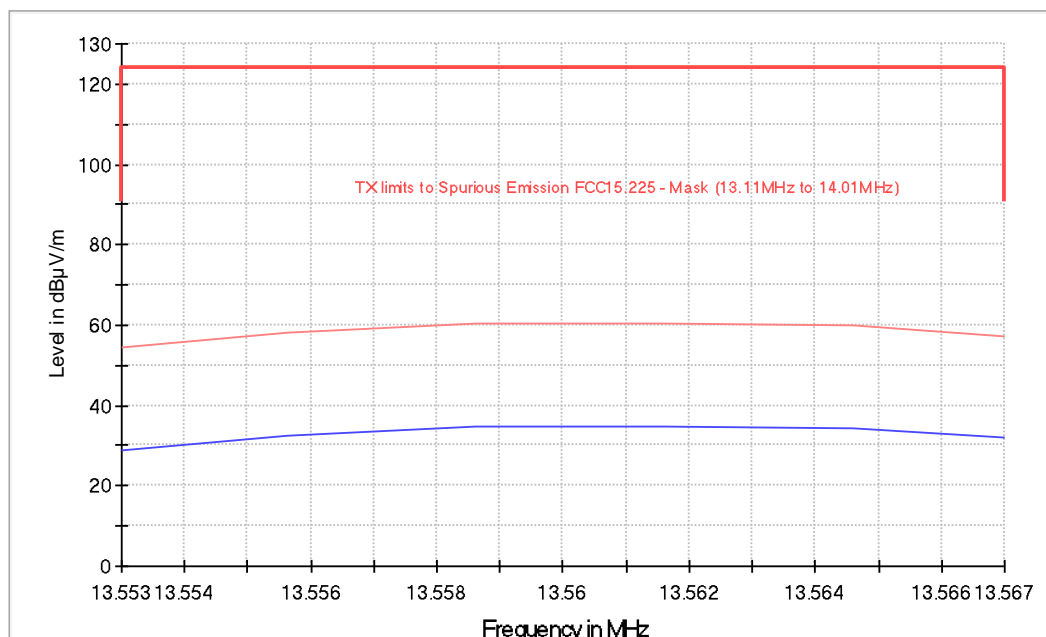
Three different orientations (X, Y, and Z) of receiving loop antenna orientation were tested to determine the worst case shown in the following test results.

Radiated measurements setup 9 kHz to 30 MHz.



TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC#01
TEST RESULTS:	PASS

Band 13.553 MHz – 13.567 MHz



- PK+_CLRWR
- TX limits to Spurious Emission FCC15.225 - Mask (13.11MHz to 14.01MHz)
- PK+_MAXH

Limit and Margin

Frequency (MHz)	PK+_CLRWR (dBµV/m)	PK+_MAXH (dBµV/m)	Pol	Margin - PK+ (dB)	Limit - PK+ (dBµV/m)
13.561605	35.0	60.5	H	63.5	124.0

TEST A.3: FIELD STRENGTH OF EMISSIONS WITHIN THE BAND 13.410 MHZ – 13.553 MHZ AND 13.567 – 13.710 MHZ

LIMITS:	Product standard:	Part 15 Subpart C §15.225 and RSS-210
	Test standard:	Part 15 Subpart C §15.225(b) and RSS-210 clause B.6 (b)

LIMITS

Within the bands 13.410–13.553 MHz and 13.567–13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter (50.47 dBμV/m) at 30 meters.

TEST SETUP

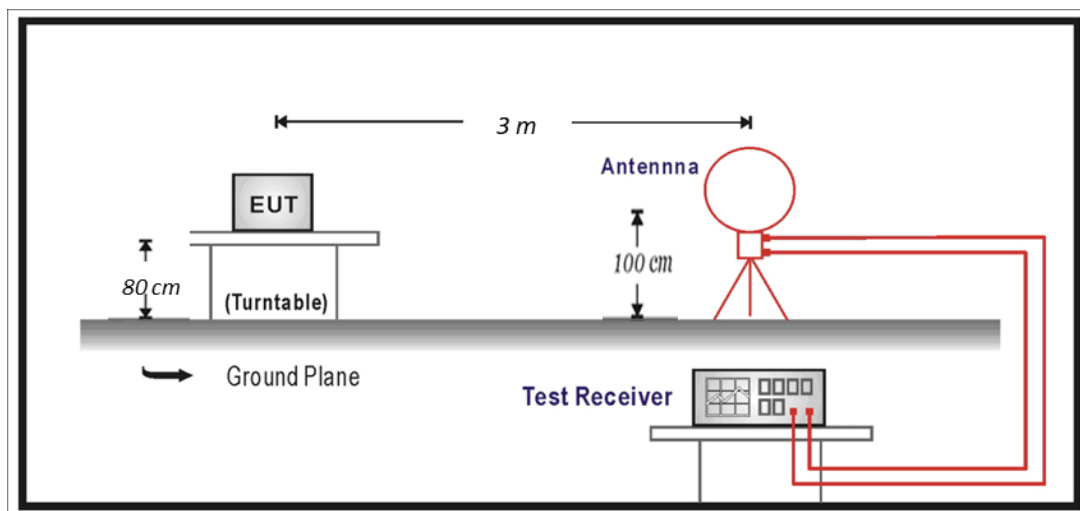
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Loop antenna for the range between 9 kHz to 30 MHz) is situated at a distance of 3 m.

For radiated emissions in the range 9 kHz to 30 MHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 40 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° to find the maximum radiated emission.

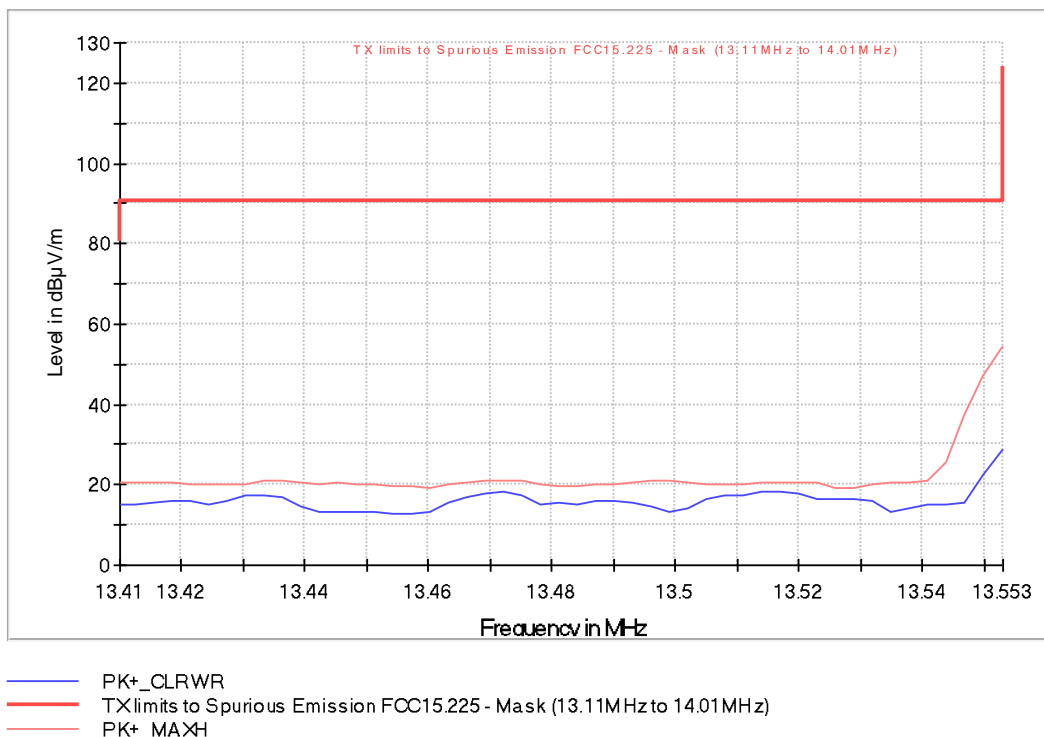
Three different orientations (X, Y, and Z) of receiving loop antenna orientation were tested to determine the worst case shown in the following test results.

Radiated measurements setup 9 kHz to 30 MHz.



TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC#01
TEST RESULTS:	PASS

Band 13.410 MHz – 13.553 MHz

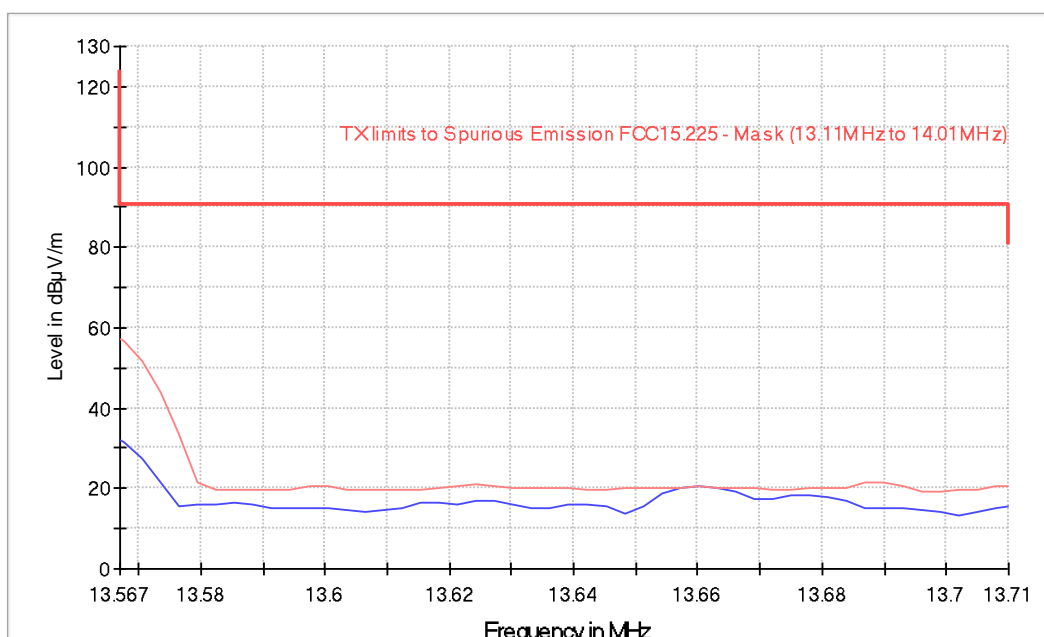


Limit and Margin

Frequency (MHz)	PK+_CLRWR (dBµV/m)	PK+_MAXH (dBµV/m)	Pol	Margin - PK+ (dB)	Limit - PK+ (dBµV/m)
13.552650	28.4	53.8	H	36.7	90.5

TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC#01
TEST RESULTS:	PASS

Band 13.567 MHz – 13.710 MHz



PK+_CLRWR
 TXlimits to Spurious Emission FCC15.225 - Mask (13.11MHz to 14.01MHz)
 PK+_MAXH

Limit and Margin

Frequency (MHz)	PK+_CLRWR (dBμV/m)	PK+_MAXH (dBμV/m)	Pol	Margin - PK+ (dB)	Limit - PK+ (dBμV/m)
13.567575	31.7	56.9	H	33.6	90.5

TEST A.4: FIELD STRENGTH OF EMISSIONS WITHIN THE BAND 13.110 MHZ – 13.410 MHZ AND 13.710 – 14.010 MHZ

LIMITS:	Product standard:	Part 15 Subpart C §15.225 and RSS-210
	Test standard:	Part 15 Subpart C §15.225(c) and RSS-210 clause B.6 (c)

LIMITS

Within the bands 13.110–13.410 MHz and 13.710–14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter (40.51 dB μ V/m) at 30 meters

TEST SETUP

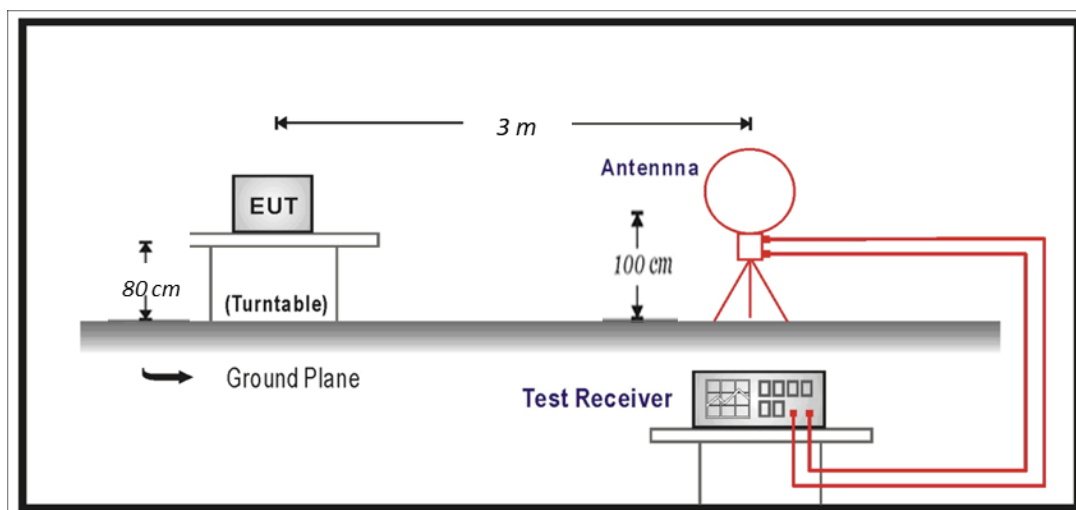
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Loop antenna for the range between 9 kHz to 30 MHz) is situated at a distance of 3 m.

For radiated emissions in the range 9 kHz to 30 MHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 40 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° to find the maximum radiated emission.

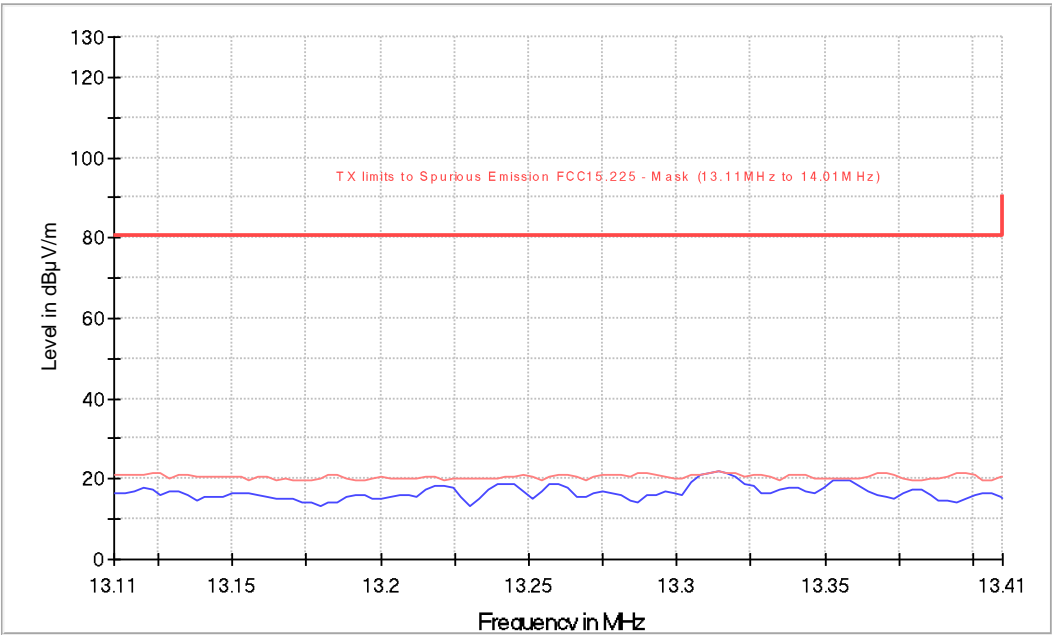
Three different orientations (X, Y, and Z) of receiving loop antenna orientation were tested to determine the worst case shown in the following test results.

Radiated measurements setup 9 kHz to 30 MHz.



TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC#01
TEST RESULTS:	PASS

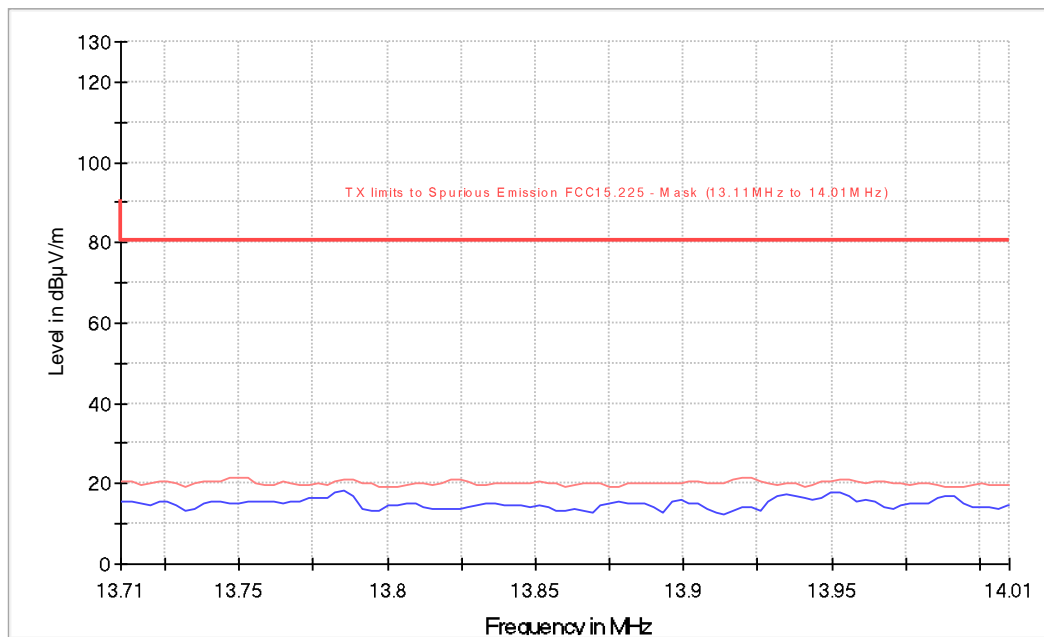
Band 13.110 MHz – 13.410 MHz



 PK+_CLRWR
 TX limits to Spurious Emission FCC15.225 - Mask (13.11MHz to 14.01MHz)
 PK+_MAXH

Frequency (MHz)	PK+_CLRWR (dBµV/m)	PK+_MAXH (dBµV/m)	Pol	Margin - PK+ (dB)	Limit - PK+ (dBµV/m)
13.313850	21.8	21.8	H	58.7	80.5

Band 13.710 MHz – 14.010 MHz



— PK+_CLRWR
 — TX limits to Spurious Emission FCC15.225 - Mask (13.11MHz to 14.01MHz)
 — PK+_MAXH

Frequency (MHz)	PK+_CLRWR (dBμV/m)	PK+_MAXH (dBμV/m)	Pol	Margin - PK+ (dB)	Limit - PK+ (dBμV/m)
13.919805	14.1	21.5	H	59.0	80.5

TEST A.5: FIELD STRENGTH OF EMISSIONS OUTSIDE OF THE BAND 13.110 MHZ – 14.010 MHZ

LIMITS:	Product standard:	Part 15 Subpart C §15.225 and RSS-210
	Test standard:	Part 15 Subpart C §15.225(d) and RSS-210 clause B.6 (d)

LIMITS

Frequency Range (MHz)	Field strength (μV/m)	Field strength (dBμV/m)	Measurement distance (m)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	29.54	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

TEST SETUP

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Loop antenna for the range between 9 kHz to 30 MHz and Bilog antenna for the range between 30 MHz to 1 GHz) is situated at a distance of 3 m.

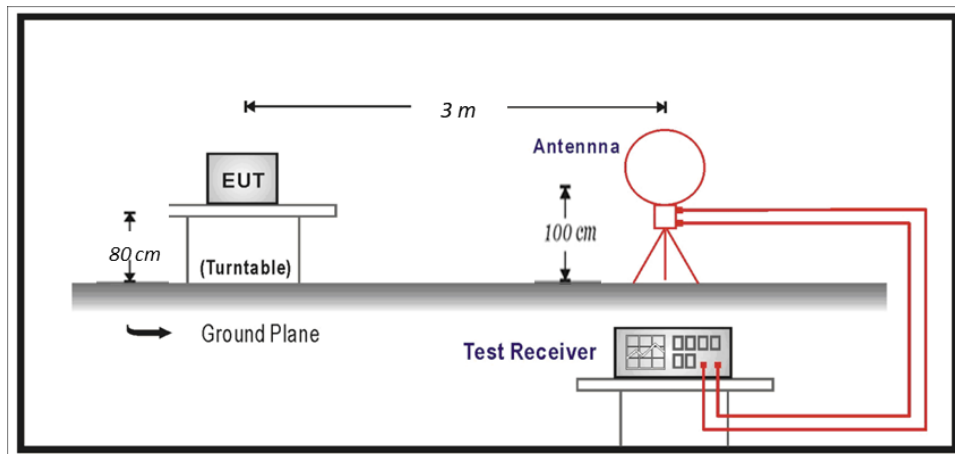
For radiated emissions in the range 9 kHz to 30 MHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 40 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and in the range between 30 MHz and 200 MHz the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

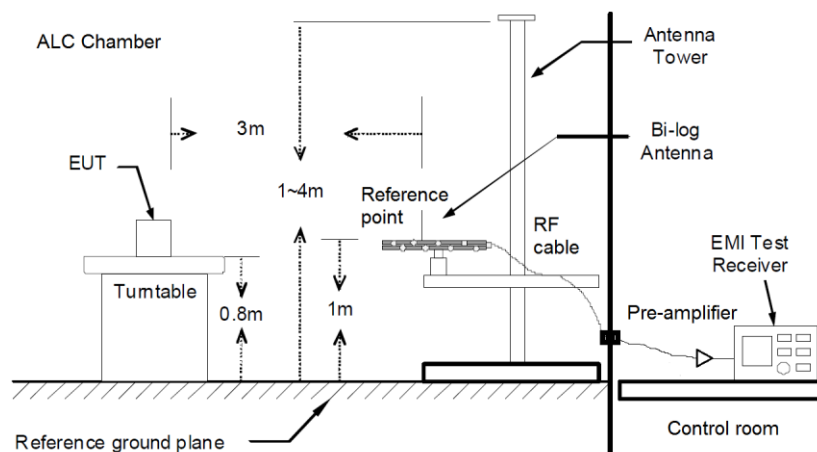
In the range between 9 kHz and 30 MHz three different orientations (X, Y, and Z) of receiving loop antenna were tested to determine the worst case shown in the following test results.

TEST SETUP (cont.):

Radiated measurements setup 9 kHz to 30 MHz

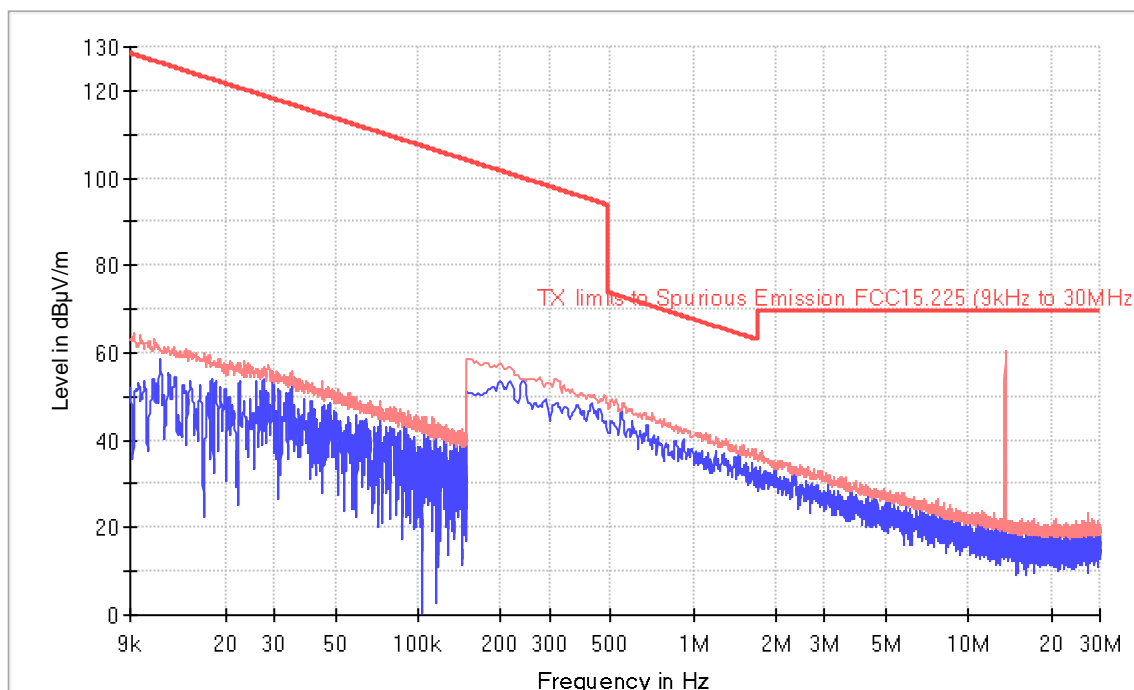


Radiated measurements setup 30 MHz to 200 MHz



TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC#01
TEST RESULTS:	PASS

Frequency Range: 9 kHz – 30 MHz



PK+_CLRWR
 PK+_MAXH
 TX limits to Spurious Emission FCC15.225 (9kHz to 30MHz)

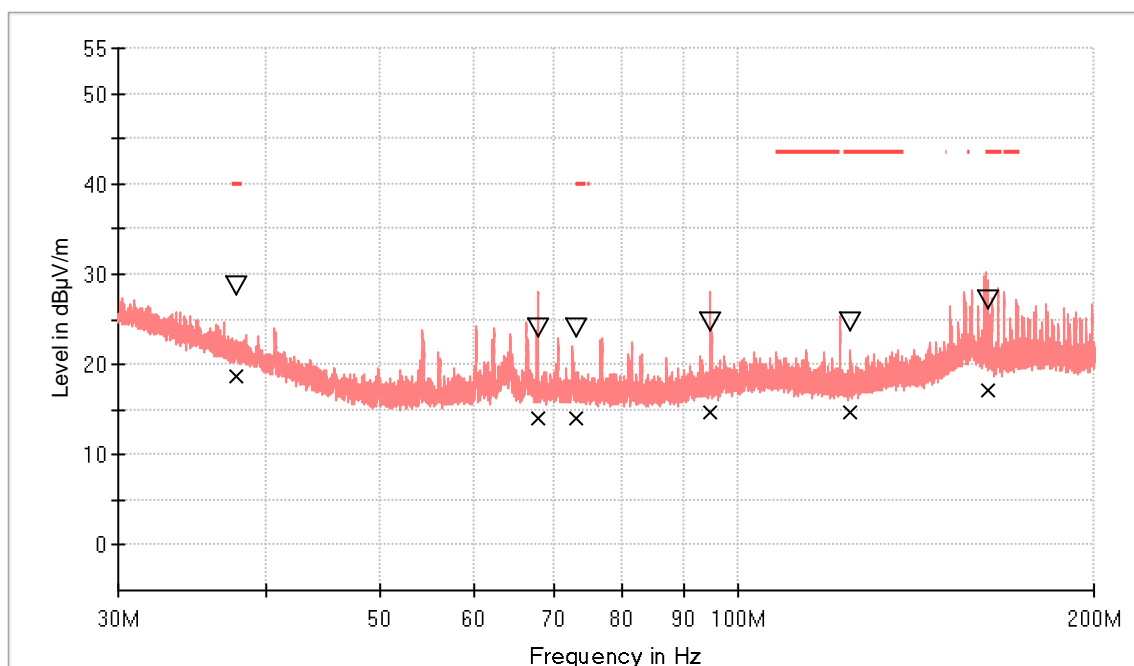
Maximizations

Frequency (MHz)	PK+_CLRWR (dBµV/m)	PK+_MAXH (dBµV/m)	PoI	Margin - PK+ (dB)	Limit - PK+ (dBµV/m)	Comment
0.009282	45.0	64.4	H	63.8	128.2	
0.200745	52.9	57.4	H	44.1	101.5	
7.728915	18.2	26.7	H	42.8	69.5	
13.561605	35.0	60.5	H	-	-	Fundamental
27.122460	22.1	23.3	H	46.2	69.5	

TEST RESULTS:

PASS

Frequency Range: 30 MHz – 200 MHz



- PK+_MAXH
- TX limits to Spurious Emission FCC15.225 (30MHz to 1GHz) Restricted Bands QPK Limit
- ▽ MaxPeak-PK+ (Single)
- × QuasiPeak-QPK (Single)

Maximizations

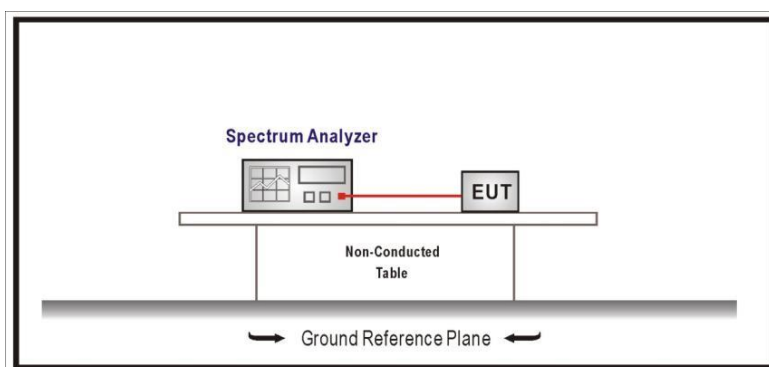
Frequency (MHz)	MaxPeak (dBμV/m)	QuasiPeak (dBμV/m)	Pol	Margin - QPK (dB)	Limit - QPK (dBμV/m)
37.743500	28.6	18.7	V	21.3	40.0
67.799500	24.0	14.1	V	26.4	40.5
73.018500	24.0	14.1	V	25.9	40.0
94.914500	24.7	14.8	V	25.7	40.5
124.401000	24.6	14.7	V	28.8	43.5
162.736000	27.0	17.1	V	26.4	43.5

TEST A.6: FREQUENCY TOLERANCE OF THE CARRIER SIGNAL

LIMITS:	Product standard:	Part 15 Subpart C §15.225 and RSS-210
	Test standard:	Part 15 Subpart C §15.225(e) and RSS-210 clause B.6

The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

TEST SETUP



TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC#01
TEST RESULTS:	PASS

Nominal Operating Frequency: 13.56 MHz

Frequency stability over temperature variations.

Temperature (°C)	Frequency Error (kHz)	Frequency Error (%)
+50	-0.29	-0.0021
+40	-0.26	-0.0019
+30	-0.24	-0.0018
+20	0.02	0.0001
+10	-0.23	-0.0017
0	-0.25	-0.0018
-10	-0.22	-0.0016
-20	0.45	0.0033

Frequency stability over voltage variations.

AC Supply voltage	Voltage (V)	Frequency Error (kHz)	Frequency Error (%)
Vmin	11.5	-0.28	-0.0021
Vmax	15.5	0.45	0.0033