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Confidential Report

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Quotation	Q19-1110-1
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FCC Test Firm Registration	409640
IC Site Registration	IE0001
Date	6th Apr 2020
EUT Description	Tyre Pressure and Temperature Monitor
FCC ID	MRXAHMPD4
IC ID	2546A-AHMPD4
Authorised by	**Paul Reilly**
Authorised Signature:	

TEST SUMMARY

The equipment complies with the requirements according to the following standards.

FCC Part Section(s)	Industry Canada	TEST PARAMETERS	Test Result
15.231(e) 15.35	RSS-210 A1.4 RSS-Gen 6.10	Duty Cycle	PASS
15.231(e) 15.209	RSS-210 A.1.4 RSS-210 8.9	RADIATED EMISSIONS	PASS
15.231(c)	RSS-210 A1.3	20dB BANDWIDTH 99% Bandwidth	PASS

RSS 210 Issue 10 Dec 2019
RSS-Gen Issue 5 Mar 2019

Exhibit A – Technical Report

Table of Contents

1.0 EUT Description

The EUT was monitor using a short range 433.914 MHz band transmitter for reporting of tyre pressure and temperature in cars/trucks.

Model:	AHMPD4
Type:	Tyre Pressure and Temperature Monitor
Type of radio:	Stand-alone
Transmitter Type:	FSK
Operating Frequency Range(s):	433.914 MHz
Number of Channels:	One
Antenna:	Integral
Transmitter power configuration:	3 VDC Internal Battery.
Operating. Temp Range:	-40° C to +85° C
Classification:	DSC
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2013

1.1 EUT Operation

Operating Conditions during Test:
The equipment under test was operated during the measurement under the following conditions:

A sample of EUT which was programmed to operate in test mode (CW mode) was used for all tests except duty cycle and bandwidth.

The duty cycle test was performed on a sample of EUT programmed to operate at the highest duty cycle possible.

Environmental conditions
During the measurement the environmental conditions were within the listed ranges:

☒ Normal

Temperature:	+15 to +35 ° C
Humidity:	20-75 %

1.2 Modifications

No modifications were required in order to pass the test specifications.

1.3 Date of Test

The tests were carried out on one sample of the EUT on 26th and 27th of Nov 2019 and 23rd Jan 2020.

1.4 Electromagnetic Emissions Testing

The guidelines of CISPR 16-4 were used for all uncertainty calculations, estimates and expressions thereof for EMC testing. A copy of Compliance Engineering Ireland Ltd.'s policy for EMC Measurement Uncertainty is available on request.
RF Requirements: Spurious emissions in accordance with FCC CFR 15.107, 15.109 and 15.209. Tests were carried out to the requirements of CISPR 16-4 and ANSI C63.4-2014 and C63.10-2013.

1.4.1 Measurement Uncertainty

The measurement uncertainty (with a 95% confidence level) for the conducted emissions test was ±3.5 dB.
The measurement uncertainty (with a 95% confidence level) for the radiated emissions test was ±5.3 dB (from 30 to 100 MHz), ±4.7 dB (from 100 to 300 MHz),
±3.9 dB (from 300 to 1000 MHz) and ±3.8 dB (from 1 GHz to 40 GHz).

1.5 Special Test Software

Tests were performed manually and no special test software was used

2.0 Emissions Measurements

2.1 Conducted Emissions Measurements

Test not performed as EUT is powered from battery.

2.2 Radiated Emissions Measurements

Radiated Power measurements were made at the Compliance Engineering Ireland Ltd anechoic chamber located in Dunshaughlin, Co. Meath, Ireland to determine the radio noise radiated from the EUT. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.

2.2.1 General

Emissions below 1GHz were measured using resolution bandwidth 100kHz at a measurement distance of 3 metres with EUT on a motorised turntable which allowed 360 degrees rotation.

Emissions above 1GHz were measured with resolution bandwidth of 1MHz at a measurement distance of 3 metres with EUT on a motorised turntable which allowed 360 degrees rotation.

2.2.2 Measurements in Transmit mode

A Radiated Emission pre-scan was performed which covered the x, y and z orientations in horizontal and vertical polarizations. In each case the emission was maximised.
The result of this pre-scan showed that the highest emission for vertical polarization was with the EUT vertical (orientation3 O3)
The EUT in a vertical orientation (orientation2 O2) gave the highest emissions for horizontal polarization.
A full scan for radiated emission was performed in orientation O3 for vertical polarization and in orientation O2 for horizontal polarization.

The radiated emissions were maximised by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 metres.
Significant peaks from the EUT were then recorded to determine margin to the limits.

Tests were carried out as per Ansi C63.10 -2013

2.3 Antenna Requirements

According to FCC 47 CFR 15.203:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

* The antenna of this E.U.T is permanently attached.

*The E.U.T Complies with the requirement of 15.203

2.4 Occupied Bandwidth

Requirement -15.231 (c) & IC RSS-210 A1.3

The bandwidth of the emission shall be no wider than 0.25% of the centre frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz. the emission shall be no wider than 0.5% of the centre frequency. Bandwidth is determined at the points 20dB down from the modulated carrier.

TEST PROCEDURE

RESULTS

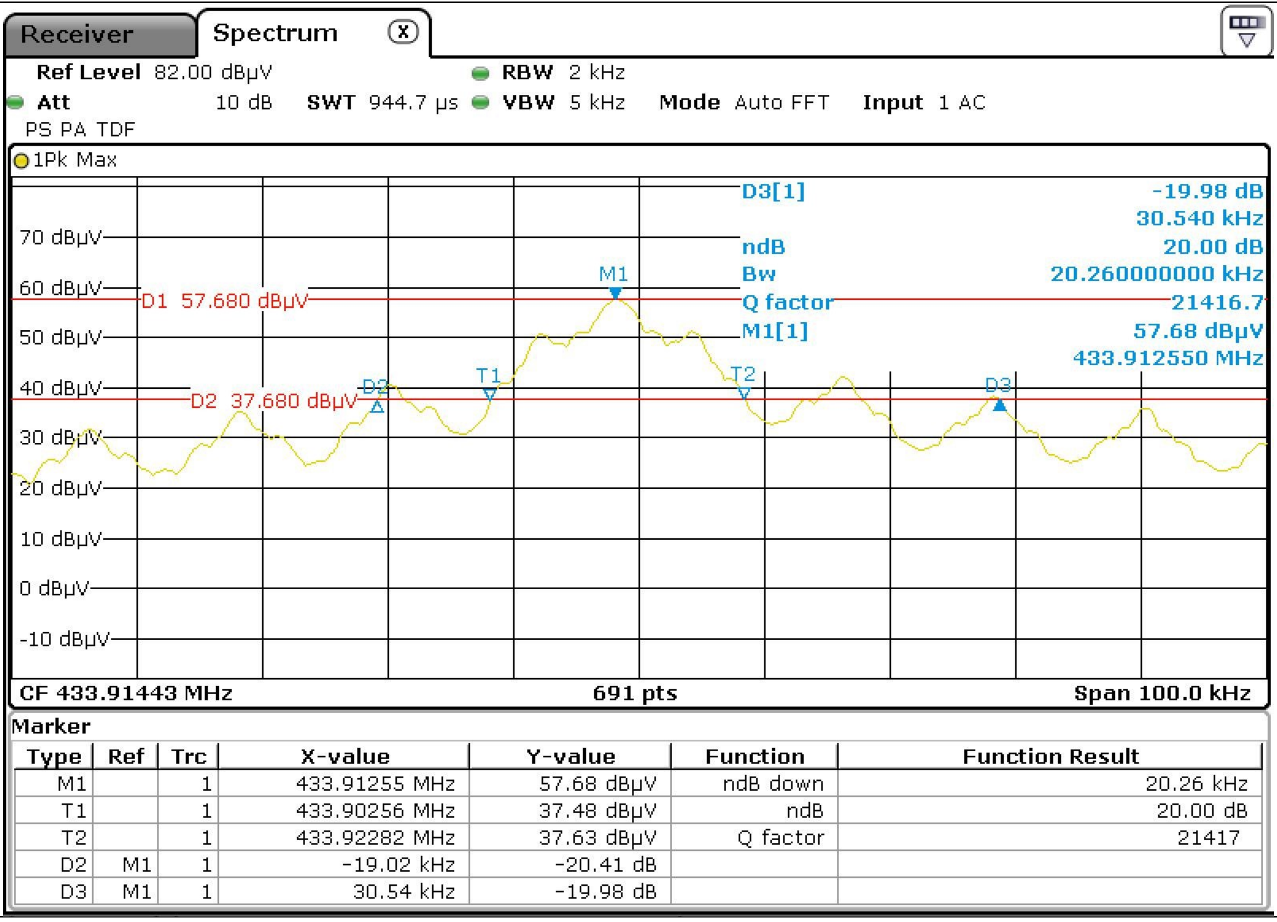


Fig 1 Occupied Bandwidth 20dB down

Operating Frequency (MHz)	20dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
433.914	49.56	1084.785	1035.225	Pass

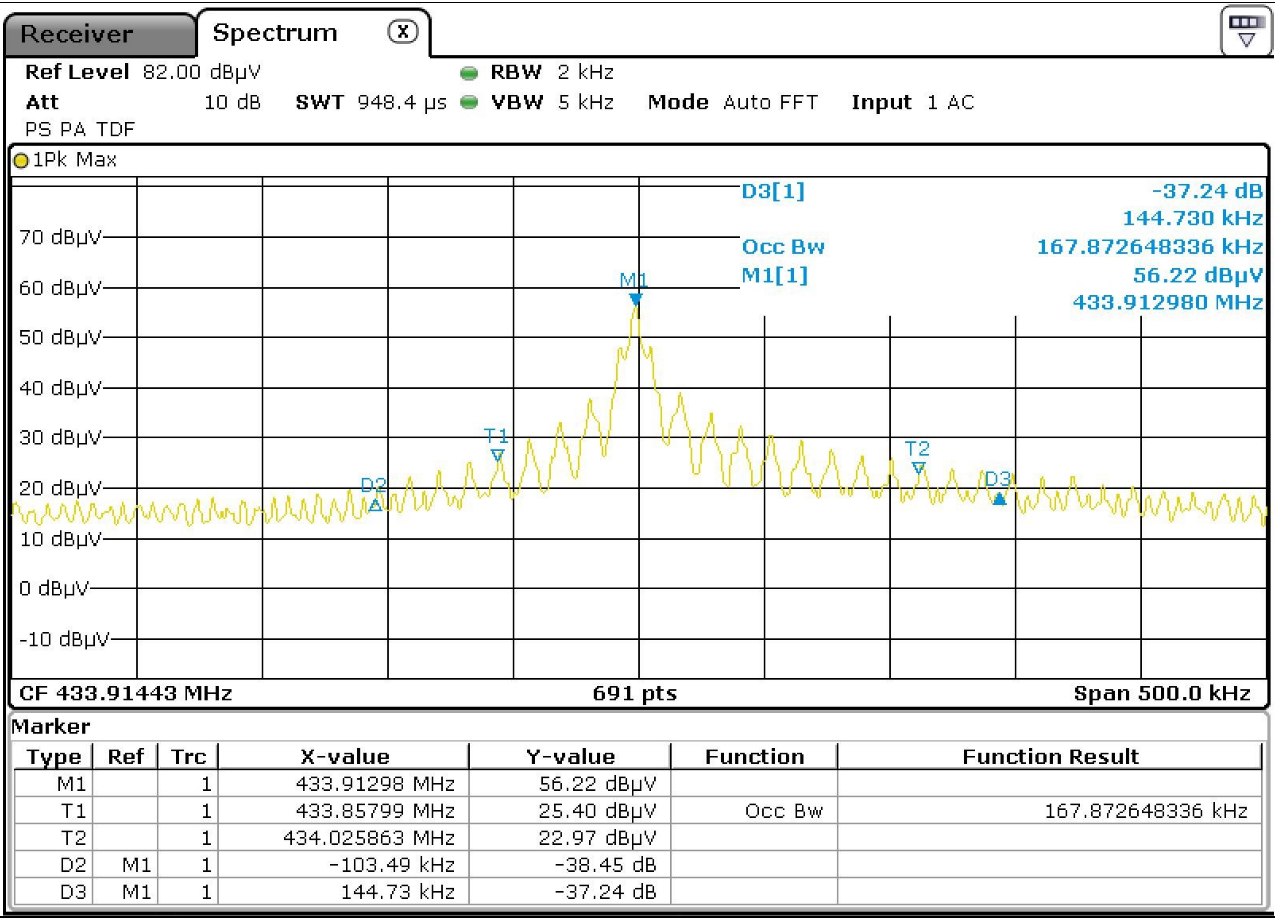


Fig 2 99% Occupied Bandwidth

Operating Frequency	99% Bandwidth	Limit	Margin	Result
MHz	KHz	KHz	KHz	
433.914	167.87	1084.785	916.915	Pass

3.0 MAXIMUM MODULATION PERCENTAGE (M%) / Duty cycle

LIMIT

Requirement 15.35 (c) 15.231(e) IC RSS210 A1.4 IC RSS-Gen 6.10

The measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative(provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 seconds interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

TEST PROCEDURE

The transmitter output was connected to a spectrum analyzer or radiated field strength. The RBW was set to 100 kHz and the VBW is set to 300KHz. The sweep time was coupled and the span was set to 0 Hz. The number of pulses was measured and calculated in a 100 ms scan.

RESULTS

MAXIMUM MODULATION PERCENTAGE /Duty Cycle

One Period(mS)	Pulse Width (mS)	No of Pulses	Duty Cycle	Duty Cycle %	Test Result
100	**17.39**	**1**	**0.1739**	**17.4**	**Pass**

CALCULATION

Average Reading = Peak Reading dB(µV/m) +20log (Duty Cycle),
*where Duty Cycle is (No of pulses*pulse width)/100 or T*

Note correction for pulse mode operation is

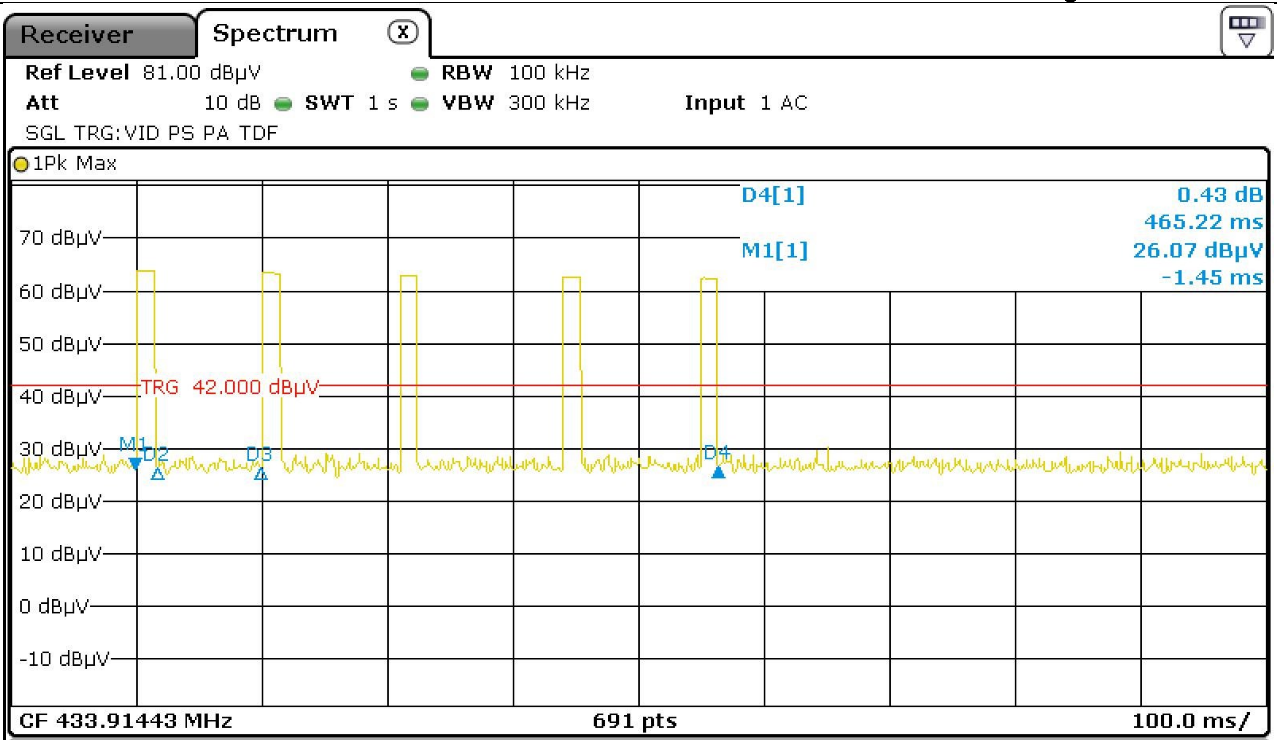
20 log duty cycle (dB)
-15.2

15.231e duty cycle limits

The duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds

Result

Duration of each transmission = 465.22mS	Limit 1sec	Comply
Silent period between transmissions >32Secs	Limit 13.95secs	Comply



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	-1.45 ms	26.07 dBµV		
D2	M1	1	17.39 ms	0.14 dB		
D3	M1	1	100.0 ms	0.35 dB		
D4	M1	1	465.22 ms	0.43 dB		

Fig 3 Single pulse train

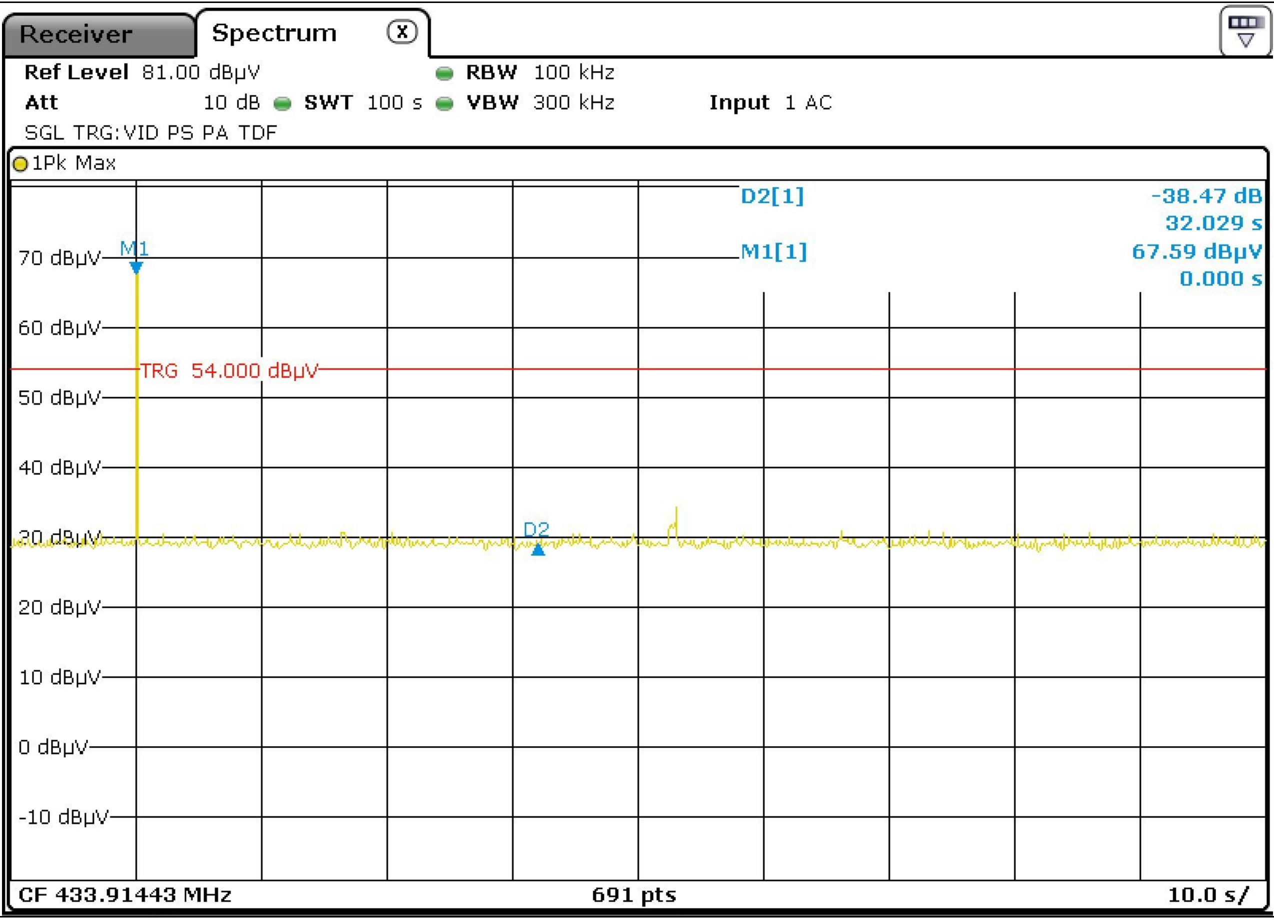


Fig 4 Pulse repetition rate Transmitted Pulses

4.0 Field Strength of Radiated Emissions

Test Specification: FCC 15.231(e) and RSS-210 A1.4

Fundamental Frequency (MHz)	Field Strength of fundamental (µV/m)	Strength of Spurious Emissions (µV/m).
40.66 ~ 40.70	22.50	225
70 ~ 130	1250	125
130 ~ 174	1250 to 3750 **	125 to 375 **
174 ~ 260	3750	375
260 ~ 470	3750 to 12500 **	375 to 1250 **
Above 470	12500	1250

**** Linear interpolations**
Interpolation Formula = 16.67 x Freq MHz - 2833.33

For operating frequency of 433.948 MHz the following limits apply (using interpolation formula above)

Fundamental Frequency	Field Strength of fundamental	Field Strength of fundamental	Field Strength of Spurious Emissions	Field Strength of Spurious Emissions
MHz	µV/m	dBµV/m	µV/m	dBµV/m
433.948	4400.913	72.871	440.091	52.871

Test Specification: FCC PART 15, SECTION 47 CFR 15.209 , RSS Gen 8.9

Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
Above 960	500	54.0

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., Sections 15.231 and 15.241

Duty cycle correction =20Log (duty cycle) dB
Duty Cycle correction for Average measurement of pulsed signal =Peak -15.3dB
as per ANSI C63.10-2013 Section 7.5

4.1 Results for Radiated emissions

Test Specification: FCC 15.231(e) and RSS-210 A1.4

Appendix A shows the results of the scans in the anechoic chamber.
Ref Appendix B for EUT orientation

4.1.1 Fundamental Measurements with Trilog Antenna (30MHz to 1GHz)

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB
433.948	54.5	O3	Vertical	16.1	0	1.2	71.8	72.9	21.1
433.948	54.0	O2	Horizontal	16.1	0	1.2	71.3	72.9	21.6

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus -15.2dB Duty Cycle factor)	Average Limit	Margin
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
433.948	71.8	O3	Vertical	56.6	72.9	16.3
433.948	71.3	O2	Horizontal	56.1	72.9	16.8

4.1.2 Harmonics Measurements in the range (30MHz to 1GHz)

Test Specification: FCC 15.231(e) and RSS-210 A1.1.5

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB
867.900	6.9	O3	Vertical	22.2	0	1.4	30.5	52.9	42.4
867.900	6.8	O2	Vertical	22.2	0	1.4	30.4	52.9	42.5

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus -15.2dB Duty Cycle factor)	Average Limit	Margin
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
867.900	30.5	O3	Vertical	15.2	52.9	37.6
867.900	30.4	O2	Vertical	15.2	52.9	37.7

Result: Pass

4.1.3 Spurious Emissions Measurements above 1GHz (1GHz – 6 GHz)

Test Specification: FCC 15.231(e) and RSS-210 A1.4

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB
1.301	52.4	O3	Vertical	23.6	39.8	3.8	40.0	52.9	32.9
1.734	55.2	O3	Vertical	24.8	39.3	2.8	43.5	52.9	29.4
2.170	49.8	O3	Vertical	28	39	3.2	42.0	52.9	30.9
1.301	52.1	O2	Horizontal	23.6	39.8	3.8	39.7	52.9	33.2
1.734	60.5	O2	Horizontal	24.8	39.3	2.8	48.8	52.9	24.1
2.170	50.0	O2	Horizontal	28	39	3.2	42.2	52.9	30.7

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus - 15.2dB Duty Cycle factor)	Average Limit	Margin
GHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
1.301	40.0	O3	Vertical	24.8	52.9	28.1
1.734	43.5	O3	Vertical	28.3	52.9	24.6
2.170	42.0	O3	Vertical	26.8	52.9	26.1
1.301	39.7	O2	Horizontal	24.5	52.9	28.4
1.734	48.8	O2	Horizontal	33.6	52.9	19.3
2.170	42.2	O2	Horizontal	27.0	52.9	25.9

Duty cycle correction =20Log (duty cycle) dB
Duty Cycle correction for Average measurement of pulsed signal =Peak -15.2dB
as per ANSI C63.10-2013 Section 7.5

Result: Pass

5 List of Test Equipment

Instrument	Manufacturer	Model	Serial Num	CEI Ref	Cal Due Date	Cal Interval Months
Microwave Preamplifier	Hewlett Packard	83017A	3123A00175	805	30-Sep-20	12
Spectrum Analyser 30Hz-40GHz	Rohde& Schwarz	FSP40	100053	850	11-Dec-21	36
Test Receiver 3.6GHz	Rohde& Schwarz	ESR	1316.3003k03-101625-s	869	07-Jun-20	36
LISN	Rohde& Schwarz	ESH3-Z5	825460/003	604	16-Feb-22	36
Antenna Horn	AH Systems	SAS-200/571	373	839	14-Mar-21	36
Fully Anechoic Chamber	CEI	FAR 3M	906	906	23-Jul-22	36
Anechoic Chamber	CEI	SAR 10M	845	845	16-May-22	36
Antenna Biconical	Schwarzbeck	VHBB 9124	9124 667	871	03-Sep-21	36
Antenna Log Periodic	Chase	UPA6108	1072	609	03-Sep-21	36

Appendix A
Additional Test Results

Transmitter Spurious Emissions

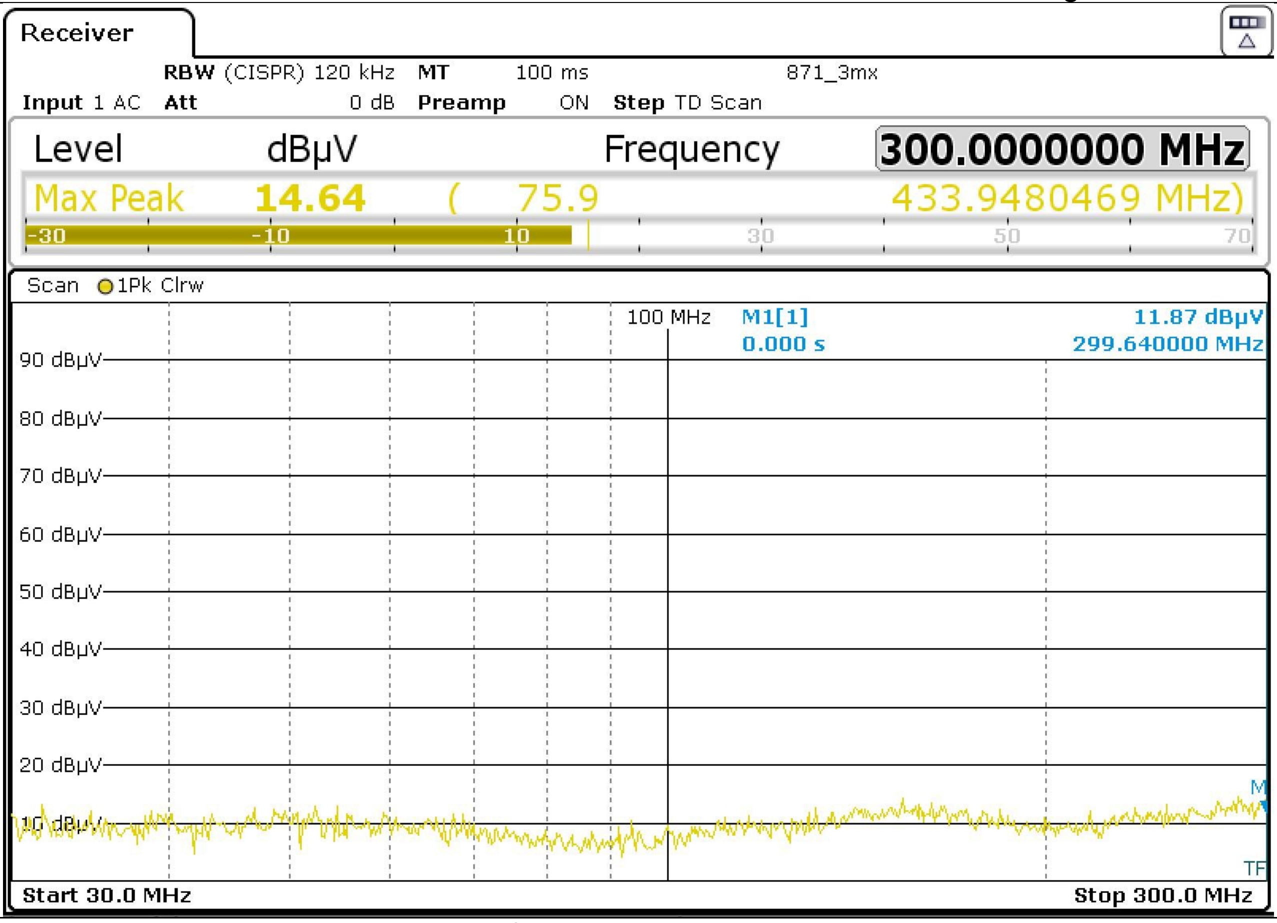


Fig A1 Scan 30MHz – 300MHz Vertical

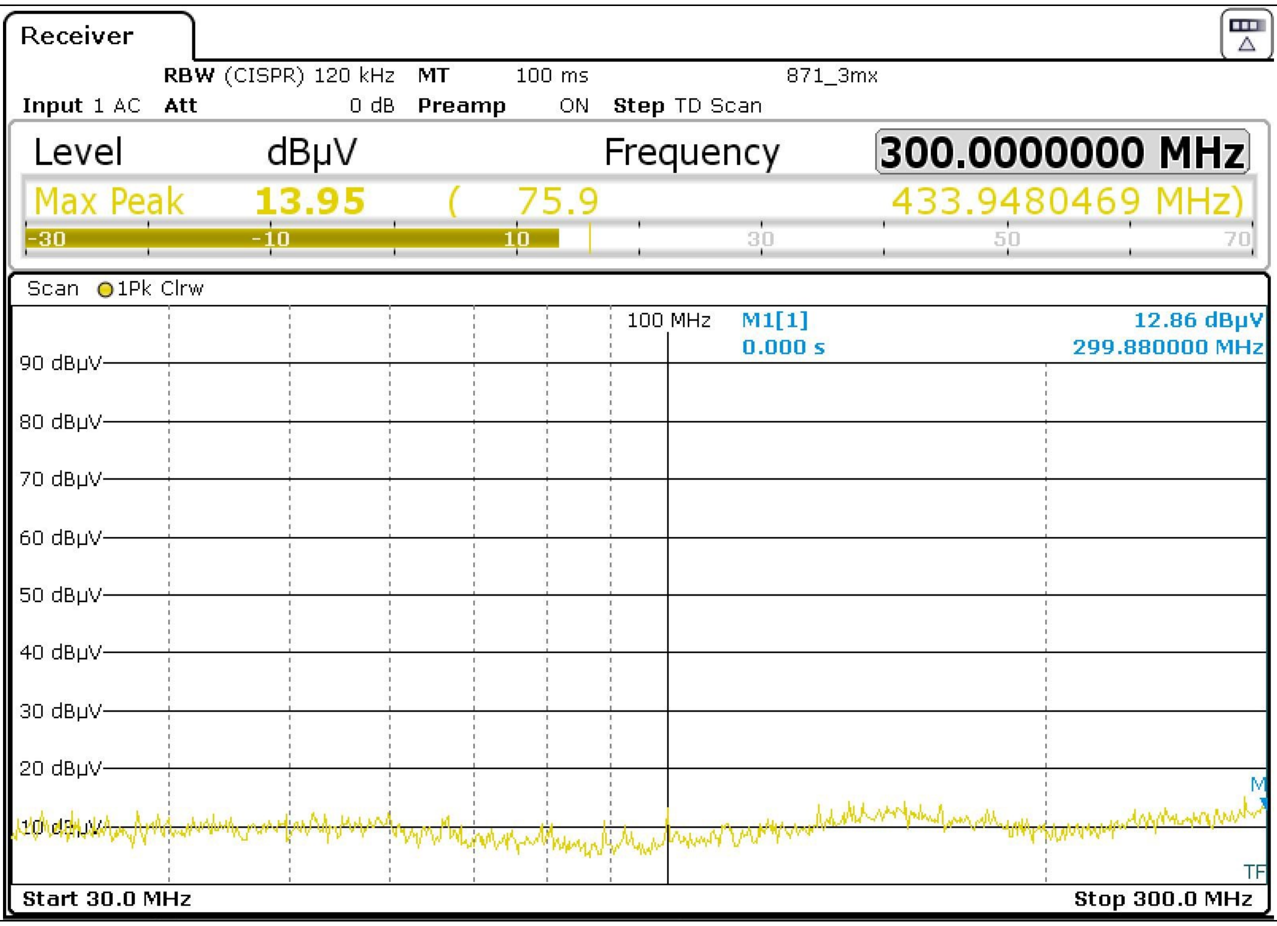


Fig A2 Scan 30MHz – 300MHz Horizontal

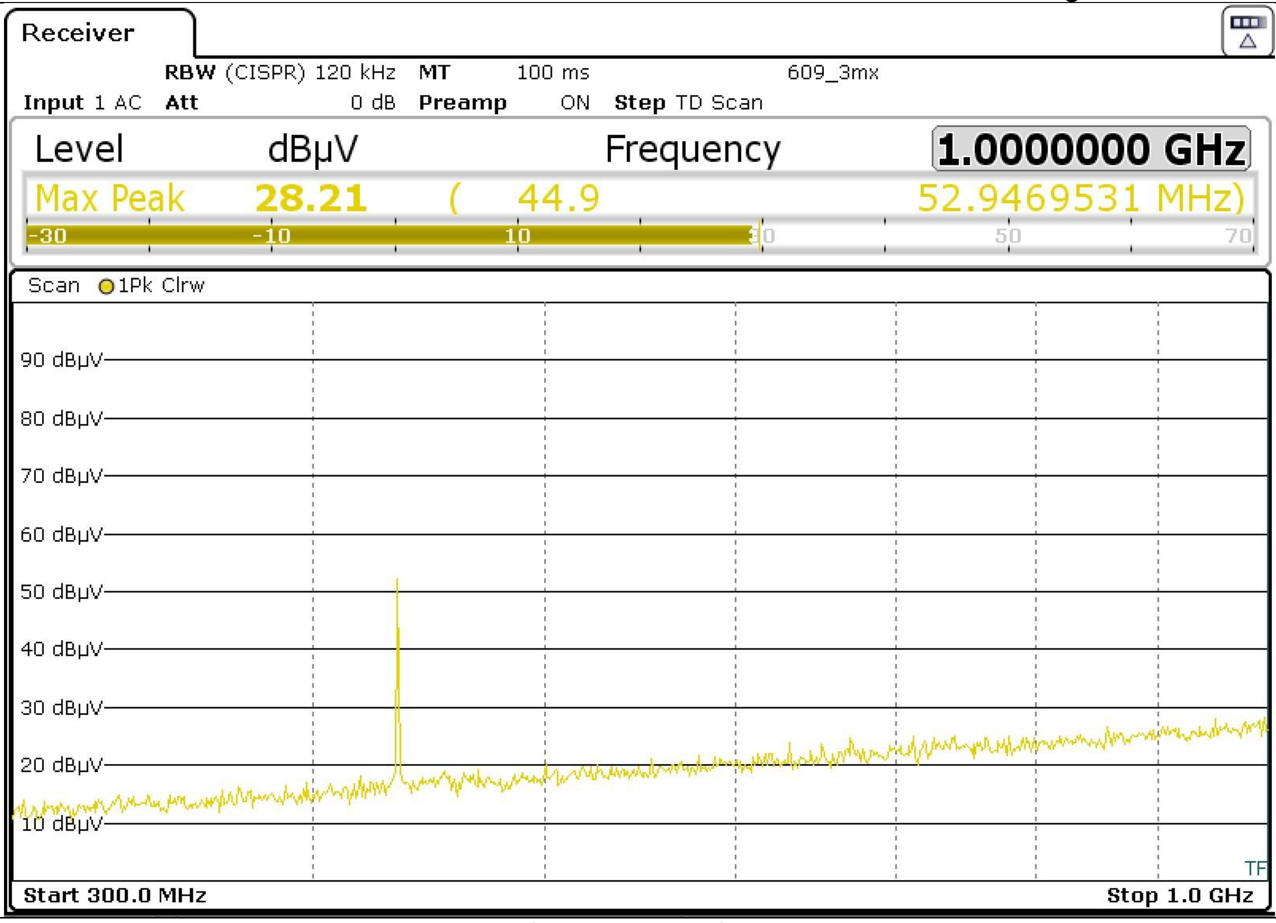


Fig A3 Scan 300MHz - 1GHz Vertical

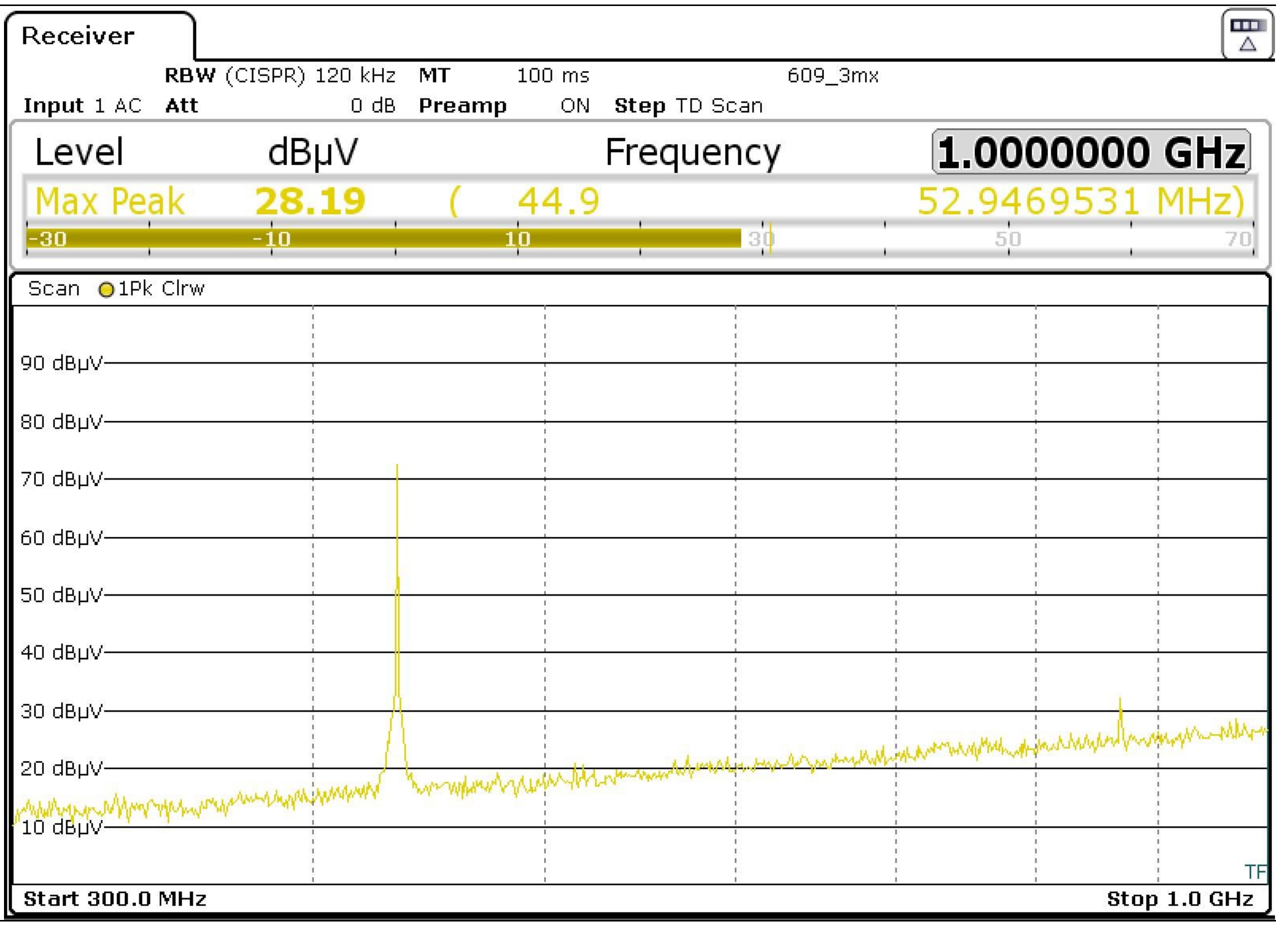


Fig A4 Scan 300MHz - 1GHz Horizontal

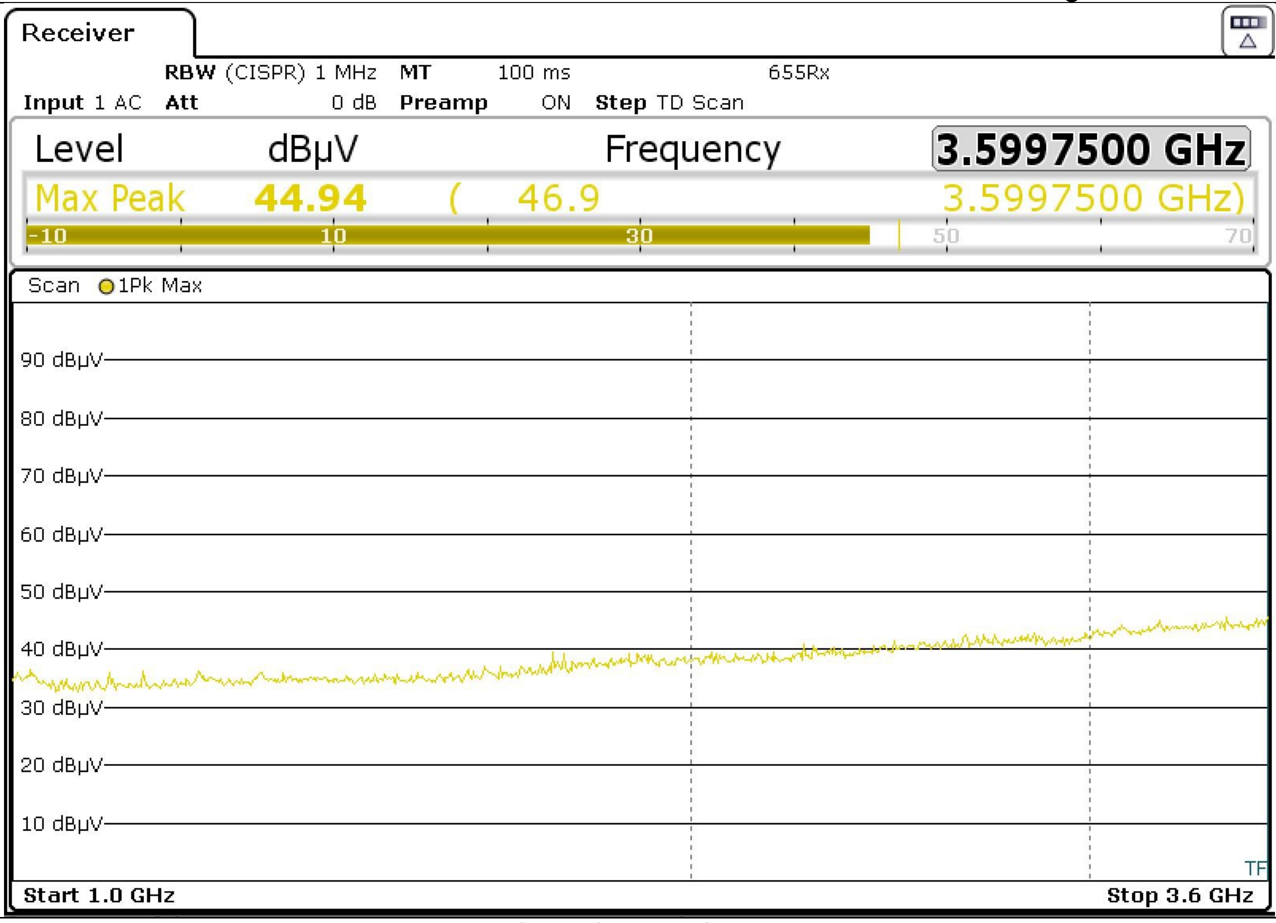


Fig A5 Scan 1GHz – 3.6GHz Vertical I

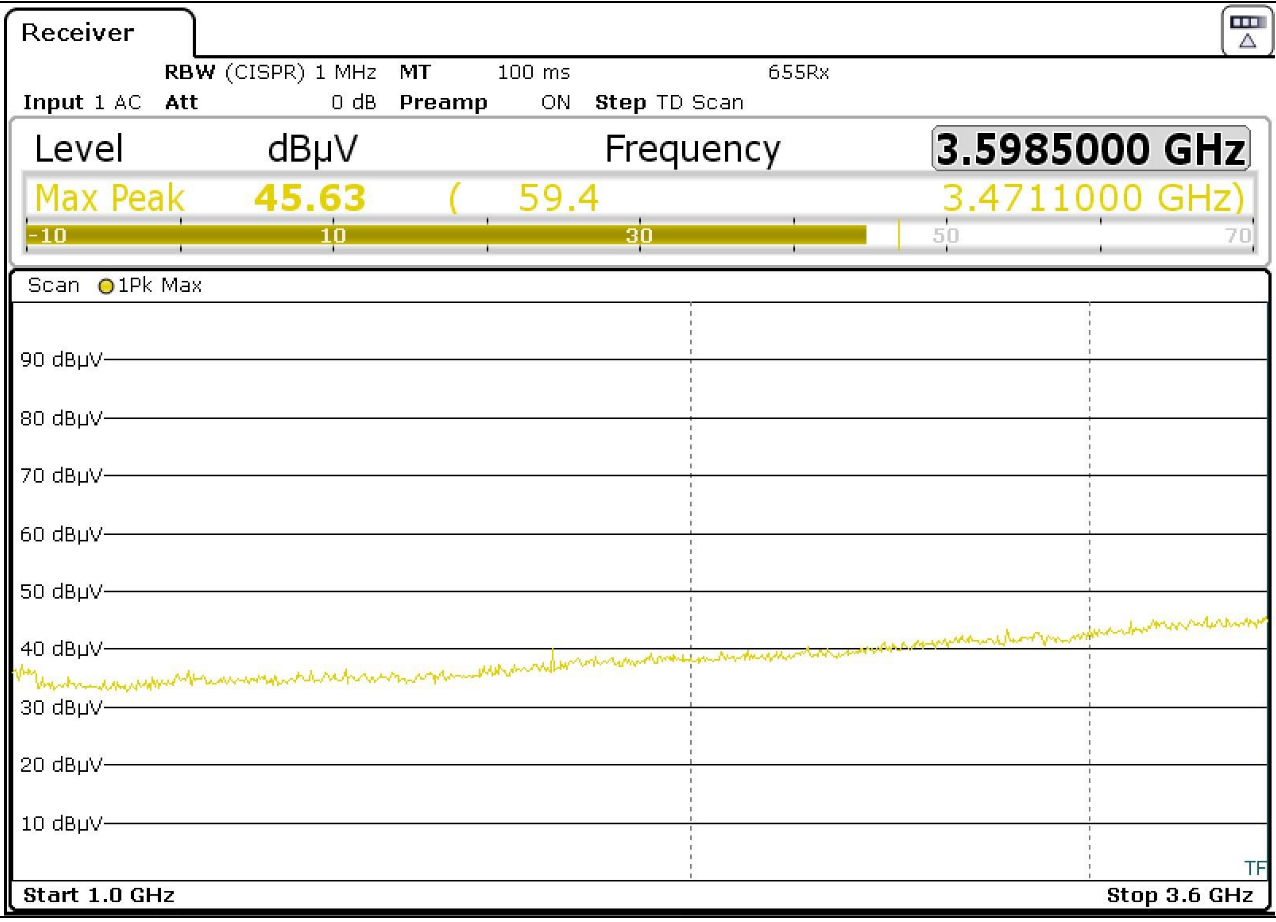
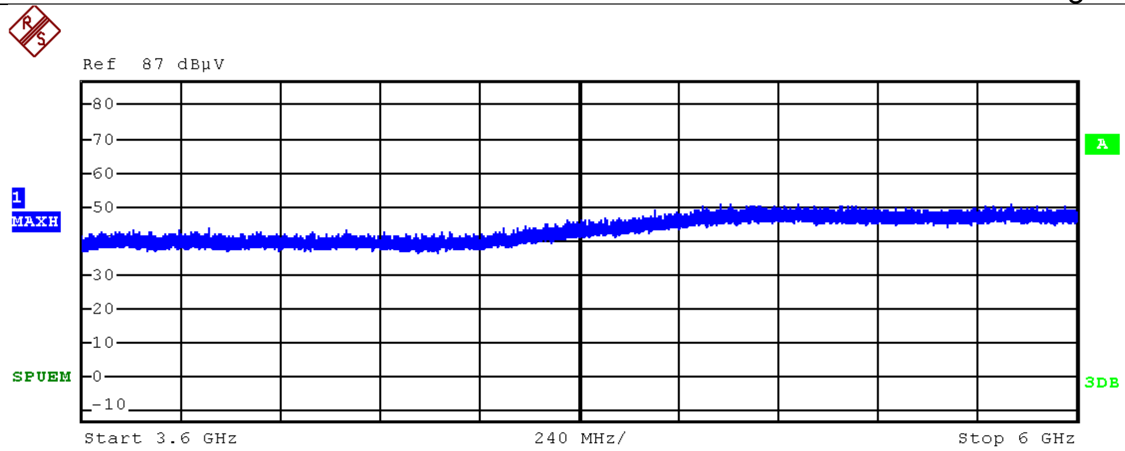
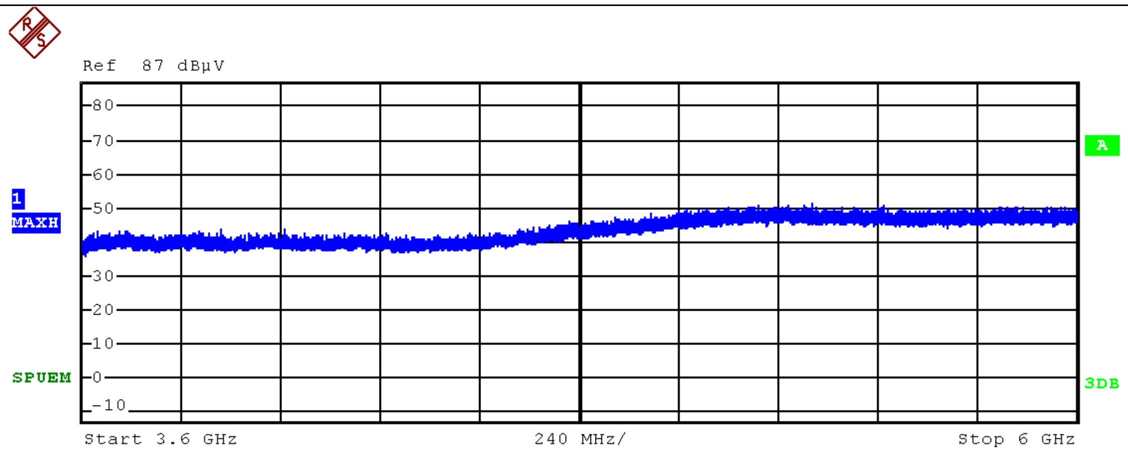


Fig A6 Scan 1GHz – 3.6GHz Horizontal



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
3.600 G	4.000 G	1.00 M	3.905900 G	-62.88	-200.00
4.000 G	4.700 G	1.00 M	4.669900 G	-62.27	-200.00
4.700 G	5.100 G	1.00 M	5.095800 G	-56.55	-200.00
5.100 G	5.500 G	1.00 M	5.142100 G	-55.68	-200.00
5.500 G	6.000 G	1.00 M	5.840438 G	-56.03	-200.00

Fig A5 Scan 3.6GHz –6GHz Vertical l



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
3.600 G	4.000 G	1.00 M	3.935800 G	-62.77	-200.00
4.000 G	4.700 G	1.00 M	4.687138 G	-62.66	-200.00
4.700 G	5.100 G	1.00 M	5.061450 G	-57.22	-200.00
5.100 G	5.500 G	1.00 M	5.360750 G	-55.43	-200.00
5.500 G	6.000 G	1.00 M	5.532750 G	-55.88	-200.00

Fig A6 Scan 3.6GHz – 6GHz Horizontal

Appendix B

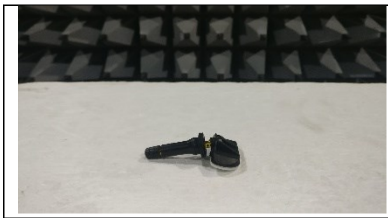


Fig B1 EUT orientation O1”	Fig B2 EUT orientation “O2”	Fig B3 EUT orientation “O3”

Orientations for Radiated Emissions

End of Report