



Confidential Report

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FCC Designation Number	IE0002			
ISED CAB identifier:	IE0001			
Date	18 th Dec 2023			
EUT Description	Sensor			
FCC ID	2ANL3SPR433TA			
IC ID	23633-SPR433TA			
Authorised by	Paul Reilly			
Authorised Signature:	Part Ruly			

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)	RSS-210 A1.4	Duty Cycle	PASS
15.35	RSS-Gen 6.10		
15.231(e)	RSS-210 A1.4	Radiated Emissions	PASS
15.209	RSS-210 8.9		
15.231(c)	RSS-210 A1.3	20dB Bandwidth	PASS
		99% Bandwidth	

RSS 210 Issue	10 Dec 2019	(Amd Apr 2020)		
RSS-Gen Issue	5 Apr 2018	(Amd 1 Mar 2019)	(Amd 2	Feb 2021)

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Contents

1.	EUT	DESCRIPTION	4
	1.1. 1.2. 1.3. 1.4 1.5	EUT Operation Modifications Date of Test Measurement Uncertainty Special Test Software	5 5 5 6 6
2.	EMIS	SIONS MEASUREMENTS	7
	2.1. 2.2. 2.2. 2.2. 2.3.	Conducted Emissions Measurements Radiated Emissions Measurements 1. General 2. Measurements in Transmit mode Occupied Bandwidth	7 7 7 9
3.	MAX	IMUM MODULATION PERCENTAGE (M%)/DUTY CYCLE1	.1
4.	FIELD	STRENGTH OF RADIATED EMISSIONS	.3
	4.1. 4.1. 4.1.	 Fundamental Measurements (30MHz to 1GHz)	4 5 6
5.	LIST (DF TEST EQUIPMENT	7
AP	PENDIX	A: SCANS FOR RADIATED SPURIOUS EMISSIONS 433.4MHZ TRANSMITTER1	.8
AP	PENDIX	B: TEST CONFIGURATIONS:	3
AP	PENDIX	C: BLOCK DIAGRAMS OF TEST SETUP	4

1. EUT Description

Type of radio:	Standalone
Transmitter Type:	FSK
Operating Frequency Range(s):	433.4 MHz
Number of Channels:	1
Antenna:	Internal trace pcb antenna
Transmitter power configuration:	3V6
Classification:	DXX
HVIN:	WMVM
PMN:	WMVM
FVIN:	4.0
Test Methodology:	Measurements performed according to the
	procedures in ANSI C63.10-2013

The Hose/Spool Monitoring (WMVM) sensor is used to continuously monitor the condition of rubber hoses, within the mining industry, for the transferring of minerals. Wear of the hoses is detected using two copper wires placed within different construction layers of the hose section. Wear indicated remotely via RF and locally by an LED light.

The EUT was a sensor which communicated data via RF link in the 433MHz Band. It also contained a pre-certified BLE module for commissioning.

The EUT was powered from its 3.6V Lithium internal battery. The EUT was potted.

There are 2 mounting options

- a) a hose interface (supplied with sensor as a Hose Sensor Kit under order code WM-K0H)
- b) a spool interface (supplied with sensor as a Spool Sensor Kit under order code WM-K0P)

This report covers the 433.4 MHz radio operating on its own.

Ref report 23E10540-2a for testing with 433.4MHz and BLE operating together.

1.1. EUT Operation

Operating Conditions during Test:

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

The EUT was programmed to operate in test mode (un modulated CW mode) was used for all tests except duty cycle and bandwidth.

The duty cycle test was performed with test firmware programmed to operate at the highest duty cycle possible.

Note all tests were performed as radiated on EUT labelled "5bdecf" on both mounting options.

Worst case results are reported here.

The EUT was powered from battery and a new battery was used for tests.

433 Radio for transmission of data

:

2-FSK modulation 9600bps baud rate Forward error correction enabled Frame table (bits):

2 identical frames of information transmitted for redundancy

Preamble	Sync	Туре	Len	Payload	Diag
4	4	1	1	7	2

The host pcb controller

Environmental conditions:

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

Temperature:	+20 to +24 ° C
Humidity:	+38 to +43 %

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 28th ,29th ,30th Jun and 5th Jul 2023

1.4 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. Emissions Measurements

2.1. Conducted Emissions Measurements

Test not performed as EUT is powered from a 3.6V 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, and y 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 (orientation O1).

The EUT in a horizontal (orientation 2 O2) gave the highest emissions for horizontal polarization.

A full scan for radiated emission was performed in orientation O1 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

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 EUT is permanently attached.

*The EUT Complies with the requirement of 15.203.

2.3. 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

RESU	ILTS

Spectrum 3 (3) Receiver (3)					
RefLevel 80.00 dBµV					
😑 Att					
TDF					
O 1Pk Max					
70 dBul/					
60 dBuV					
40 dBuV					
30-46.0					
10 dBµV					
-10 dBµV					
Markan					
Tune Def Tre Vuelue Vuelue Curetien Countier Provide					
Type Ker Free Function Function Result M1 1 432.37000 MHz 60.04 dp./// Function Function Result					
MI I 433.37000 MHZ 00.04 uppy D2 M1 1 -13.53 kHz -21.10 dB					
D3 M1 1 53 76 kHz -21 29 dB					
Fig 1: Oppunied Bandwidth 20dP down					

Operating Frequency	20dB Bandwidth	Limit	Margin	Result
MHz	KHz	KHz	KHz	
433.4	67.15	1083.5	1066.15	Pass

Test Result Pass

Report Ref: 23E10540-1b



Operating Frequency	99% Bandwidth	Limit	Margin	Result
MHz	KHz	KHz	KHz	
433.4	65.12	1083.5	1018.38	Pass

Test Result Pass

3. 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 second 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.

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 100ms scan.

RESULTS

One Period(mS)	Pulse Width (mS)	No of Pulses	Duty Cycle	20 log duty cycle (dB)	Duty Cycle %	Test Result
100	40.58	1	0.4058	-7.83	40.6	Pass

MAXIMUM MODULATION PERCENTAGE/Duty Cycle

CALCULATION

Average Reading = Peak Reading $dB(\mu V/m) + 20\log (Duty Cycle)$, where Duty Cycle is (No of pulses*pulse width)/100 or T Note correction for pulse mode operation is:

20 log duty cycle (dB)
-7.83

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 = 81.16	SmS
Silent period between transmissions	15.94Secs

Limit <1sec Comply Limit >10secs Comply

Report Ref: 23E10540-1b Page 12 of 24

Ref Level 90.00 dB	spectrum 5	🔍 Re	ceiver 🖸	9				
	μV	🔵 RBW 1	00 kHz					
Att 20	dB 画 SWT 1 s	● VBW 3	00 kHz	Input 1 AC				
SGL TRG: VID PS PA	TDF							
OIPK Max								
80 авµv-								
70 dBµV		D4						
TRG 66.0	00 dBµV							
60 dBµV								
50 dBµV								
	DP							
Muran und	manutation	deal have	Murrellydo	and have been a second	normalized	mound	-untrentilised in the	montheather
30 dBµV								
20 авµv								
10 dBµV								
o doux								
о ивµv								
CE 433 4 MHz			601 nt	<u> </u>				100.0 ms/
Marker				-				
Type Ref Trc	X-value		Y-value	Function		Func	tion Result	
M1 1		0.0 s	68.74 dBµV					
D2 M1 1	40.5	58 ms	-0.39 dB					
D3 M1 1 D4 M1 1	278.2	26 ms	-0.33 dB					
		F	ig 3: Single P	ulse Train				
			0 0					
Spectrum	Spectrum 3	X Re	ceiver 0	จา				E
Spectrum S Ref Level 90.00 dB	Spectrum 3 µ∨	× Re	ceiver () 100 kHz	9				
Spectrum S Ref Level 90.00 dB Att 20	G pectrum 3 µ∨ dB ⊜ SWT 40 s	× Re RBW s • VBW	ceiver 0 100 kHz 300 kHz	Input 1 AC	2			
Spectrum Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA	G pectrum 3 µV dB ● SWT 40 s TDF	▼ Re RBW s ● VBW	ceiver () 100 kHz 300 kHz	Input 1 AC	:			
Spectrum Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA PIPK Max	Spectrum 3 µV dB • SWT 40 s TDF	Re RBW S VBW	ceiver () 100 kHz 300 kHz	Input 1 AC	:			
Spectrum Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA 1Pk Max	Spectrum 3 µV dB • SWT 40 s TDF	Rew RBW s ● VBW	ceiver () 100 kHz 300 kHz	Input 1 AC	:			
Spectrum Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA 1Pk Max 80 dBµV	Spectrum 3 µV dB • SWT 40 s TDF	Re RBW S VBW	ceiver () 100 kHz 300 kHz	Input 1 AC	:			
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG: VID PS ● 1Pk Max 80 dBµV 70 dBµV	Spectrum 3	× Re ● RBW s ● VBW	ceiver () 100 kHz 300 kHz	Input 1 AC				
Spectrum S Ref Level 90.00 dB, Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV TRG 66.0	Bpectrum 3 µV dB ● SWT 40 s TDF 00 dBµV	× Re ● RBW s ● VBW	ceiver () 100 kHz 300 kHz 04	Input 1 AC				₽5 •
Spectrum € Ref Level 90.00 dB, Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 60 dBµV	Bpectrum 3 µV dB ● SWT 40 s TDF 00 dBµV	RBW s ● VBW	Ceiver () 100 kHz 300 kHz 04	Input 1 AC				
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV TRG 60 dBµV 50 dBµV	Spectrum 3 µV dB • SWT 40 s TDF 00 dBµV	Rew RBW VBW	Ceiver () 100 kHz 300 kHz 04	Input 1 AC				D25
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG:VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 50 dBµV 50 dBµV 40 dBµV	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV	Re RBW VBW	ceiver () 100 kHz 300 kHz D4	Input 1 AC				
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG:VID PS PA ● 1Pk Max 80 dBµV 70 dBµV TRG 66.0 60 dBµV 50 dBµV 40 dBµV	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV	× Re • RBW • VBW	ceiver () 100 kHz 300 kHz D4	Input 1 AC			Start of the start	
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 50 dBµV 50 dBµV 40 dBµV 30 dBµV	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV	× Re • RBW • VBW	Ceiver () 100 kHz 300 kHz				ىرى مەرىپ كىلىكى بىرىكى بىرىكى بىر	
Spectrum € Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 50 dBµV 50 dBµV 30 dBµV 20 dBµV	Bpectrum 3 µV dB ● SWT 40 s TDF 00 dBµV	× Re • RBW • VBW	ceiver () 100 kHz 300 kHz 04	Input 1 AC			and the second second	
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG:VID PS PA 91Pk Max IPk Max 90 1Pk Max 90 0 dBµV 70 70 dBµV 70 50 dBµV 70 50 dBµV 70 40 dBµV 70 20 dBµV 10	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV	RBW VBW	ceiver () 100 kHz 300 kHz	Input 1 AC			207-y	
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG:VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 40 dBµV 30 dBµV 20 dBµV 10 dBµV	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV 00 dBµV	× Re • RBW • VBW	ceiver () 100 kHz 300 kHz D4	Input 1 AC				
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 40 dBµV 30 dBµV 20 dBµV 10 dBµV	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV 00 dBµV	× Re • RBW • VBW	Ceiver (2) 100 kHz 300 kHz 04	Input 1 AC				
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 30 dBµV 20 dBµV 10 dBµV	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV 00 dBµV	× Re • RBW • VBW	Ceiver ()	Input 1 AC				
Spectrum € Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 20 dBµV 30 dBµV 20 dBµV 10 dBµV 0 dBµV CF 433.4 MHz	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV 00 dBµV	× Rew • RBW • VBW	Ceiver () 100 kHz 300 kHz 04 04 04 04 04 04 04 04 04 04 04 04 04	Input 1 AC				₽5 ₽5 4.0 s/
Spectrum € Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 20 dBµV 30 dBµV 10 dBµV 10 dBµV CF 433.4 MHz Marker	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV 00 dBµV	× Rew • RBW • VBW	Ceiver ()	Input 1 AC				₽5
Spectrum € Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA • ● 1Pk Max • ● 1Pk Max • 80 dBµV • 70 dBµV • 70 dBµV • 50 dBµV • 40 dBµV • 30 dBµV • 20 dBµV • 10 dBµV • 0 dBµV •	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV 00 dBµV 00 dBµV	× Re • RBW • VBW	Ceiver () 100 kHz 300 kHz 04 04 04 04 04 04 04 04 04 04	Input 1 AC		Func	tion Result	€ 05 0 0 0 0 0 0 0 0 0 0 0 0 0
Spectrum S Ref Level 90.00 dB Att 20 SGL TRG:VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 40 dBµV 30 dBµV 20 dBµV 10 dBµV 10 dBµV CF 433.4 MHz Marker Type Ref M1 1 D2 M1	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV 00 dBµV 00 dBµV 00 dBµV 13 272	× Re • RBW s • VBW	Ceiver () 100 kHz 300 kHz 04 04 04 04 04 04 04 04 04 04	Input 1 AC		Func	tion Result	€ 05 05 0 0 0 0 0 0 0 0 0 0 0 0 0
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Spectrum € Ref Level 90.00 dB Att 20 SGL TRG: VID PS PA ● 1Pk Max 80 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 70 dBµV 20 dBµV 30 dBµV 20 dBµV 40 dBµV 20 dBµV 30 dBµV 20 dBµV 10 dBµV 0 dBµV 10 dBµV 10 dBµV 0 dBµV 10 dBµV 10 dBµV 0 dBµV 10 dBµV 11 D2 M1 1 12 M1 1 13 M1 1 14 M1 1 15 M1 1	Spectrum 3 µV dB ● SWT 40 s TDF 00 dBµV 00 dBµV 10 10 10 10 13 272. 16.2: 16.5: 32.4¢	RBW RBW S P VBW .9 as .5 ms 159 s 101 s 638 s :5 m 2	ceiver Σ 100 kHz 04 300 kHz 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 04 05 07 06 0.07 0.04 08 0.06 08 0.06 08 0.06 08	Input 1 AC		Func	tion Result	€ 05 1 4.0 s/

4. Field Strength of Radiated Emissions

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emission (microvolts/meter)
40.66-40.70	1,000	100
70-130	500	50
130-174	500 to 1,500 ¹	50 to 150 ¹
174-260	1,500	150
260-470	1,500 to 5,0001	150 to 500 ¹
Above 470	5,000	500

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

¹ Linear interpolations.

Interpolation Formula = 16.67 x Freq MHz - 2833.33

For operating frequency of 433.4 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
433.400	4391.778	72.853	439.178	52.853

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 -7.83dB** as per ANSI C63.10-2013 Section 7.5 **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.

4.1.1. Fundamental Measurements (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	Result
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
433.400	43.6	O1	Vertical	16.9	0	3.3	63.8	72.9	29.1	Pass
433.400	48.8	02	Horizontal	16.9	0	3.3	69.0	72.9	23.9	Pass

Calculation example Final Field Strength Peak (dBuV/m) =Reading Peak (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB) 69 = 48.8+16.9 – 0 + 3.3

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus - 7.83dB Duty Cycle factor)	Average Limit	Margin	Result
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB	P/F
433.400	63.8	01	Vertical	55.9	72.9	17	Pass
433.400	69.0	02	Horizontal	61.1	72.9	11.8	Pass

Calculation example

Average Level (dBuV/m)=Final Field Strength Peak (dBuV/m) + Duty cycle factor (dB) 61.1 = 69 - 7.8

Test Result: Pass

4.1.2. Harmonics Spurious Emissions Measurements (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	Result
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
866.800	2.1	01	Vertical	23.4	0	5.3	30.8	52.9	42.1	Pass
866.800	5.0	02	Horizontal	23.4	0	5.3	33.7	52.9	39.2	Pass

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

Calculation example

Final Field Strength Peak (dBuV/m) =Reading Peak (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB) 33.7 = 5+23.4+0+5.3

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus - 7.8dB Duty Cycle factor)	Average Limit	Margin	Result
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB	P/F
866.800	30.8	01	Vertical	23.0	52.9	29.9	Pass
866.800	33.7	02	Horizontal	25.9	52.9	27	Pass

Calculation example Average Level (dBuV/m)=Final Field Strength Peak (dBuV/m) + Duty cycle factor (dB) 25.9 =33.7 - 7.8

Test Result: Pass

4.1.3. Harmonics Spurious Emissions Measurements (above 1GHz)

	Reading	EUT	Antenna	Antenna	Preamp	Cable	Final Field Strength	Average	Margin for Peak V Average	
Frequency	Peak	Orientation	Polarity	Factor	Gain	loss	Peak	Limit	Limit +20dB	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
1.300	11.8	01	Vertical	25.3	0	3.5	40.6	52.9	32.3	Pass
1.734	10.1	01	Vertical	26.8	0	4	40.9	52.9	32.0	Pass
2.167	11.4	01	Vertical	27.9	0	4.6	43.9	52.9	29.0	Pass
2.600	13.1	01	Vertical	29	0	5.1	47.2	52.9	25.7	Pass
3.034	13.1	01	Vertical	30.3	0	5.4	48.8	52.9	24.1	Pass
3.467	15.3	01	Vertical	31.3	0	6	52.6	52.9	20.3	Pass
3.901	46.2	01	Vertical	32.9	38.3	6.1	46.9	52.9	26.0	Pass
4.334	46.6	01	Vertical	32.2	38.3	6.6	47.1	52.9	25.8	Pass
1.300	17.8	02	Horizontal	25.3	0	3.5	46.6	52.9	26.3	Pass
1.734	11.2	O2	Horizontal	26.8	0	4	42.0	52.9	30.9	Pass
2.167	12.2	O2	Horizontal	27.9	0	4.6	44.7	52.9	28.2	Pass
2.600	13.7	02	Horizontal	29	0	5.1	47.8	52.9	25.1	Pass
3.034	13.1	O2	Horizontal	30.3	0	5.4	48.8	52.9	24.1	Pass
3.467	15.8	O2	Horizontal	31.3	0	6	53.1	52.9	19.8	Pass
3.901	47.1	02	Horizontal	32.9	38.3	6.1	47.8	52.9	25.1	Pass
4.334	44.9	02	Horizontal	32.2	38.3	6.6	45.4	52.9	27.5	Pass

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

Calculation example

Final Field Strength Peak (dBuV/m) =Reading Peak (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB) 45.4 =44.9+32.2-38.3+6.6

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus - 7.8dB Duty Cycle factor)	Average Limit	Margin	Result
GHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB	P/F
3.467	53.1	02	Horizontal	45.3	52.9	7.6	Pass

The Average level was not computed for peaks where the peak level was below the average limit (52.9 dBuV/m)

Calculation example Average Level (dBuV/m)=Final Field Strength Peak (dBuV/m) + Duty cycle factor (dB) 45.3 =53.1 - 7.8

Test Result: Pass

5. List of Test Equipment

Instrument	Manufacturer	Model	Serial Num	CEI Ref	Cal Date	Cal Interval Months
Microwave Preamplifier	Hewlett Packard	83017A	3123A00175	805	30-Sep-22	12
Spectrum Analyser 30Hz-40GHz	Rohde& Schwarz	FSP40	100053	850	10-Dec-21	36
Test Receiver 3.6GHz	Rohde& Schwarz	ESR	1316.3003k03- 101625-s	869	23-May-23	36
LISN	Rohde & Schwarz	ESH3-Z5	825460/003	604	09-Mar-22	36
Antenna Horn	EMCO	3115	9905-5809	655	21-Jan-22	24
Fully Anechoic Chamber	CEI	FAR 3M	906	906	23-Jul-22	36
Anechoic Chamber	CEI	SAR 10M	845	845	12-Sep-22	36
Antenna Biconical	Schwarzbeck	VHBB 9124	9124 667	871	06-Oct-21	36
Antenna Log Periodic	Chase	UPA6108	1072	609	09-Sep-21	36
Cable Ntype 20m				1213	15-May-23	12
Cable purple Ktype 1.8m				917	29-Jul-22	12
Cable Ntype 10m				914	29-Jul-22	12
Cable HF Ktype 1.5m				705	29-Jul-22	12

Report Ref: 23E10540-1b Page 19 of 24

Spectrum Receiver 🛞	₽
RBW (QPK) 120 kHz MT 100 ms 871_3mx	
Input 1 AC Att 0 dB Preamp ON Step TD Scan	
Scan 👴1Pk Max●2QP Max	
100 MHz	
80 dBµV	-
70 dBµV	
ED HDW	
50 dBµV	-
40 dBµV	_
an drug	
30 UBHV	
20 dBµV	
mand and the second a	~
10 dBµV	_
La a b a a a b a b a b a b a b a b a b a	-
D dBIN	
	TE
Start 30.0 MHz Stop 300.0 MH	-IZ

Fig A1: Radiated Emissions 30MHz - 300MHz, Vertical, 3metres

Spectrum Receiver 🛞
RBW (QPK) 120 kHz MT 100 ms 871_3mx
Input 1 AC Att O dB Preamp ON Step TD Scan
Scan Olpk MaxO2QP Max
1UU MHZ
80 dBµV
70 dBµV
60 dBµV
50 dвµV
40 dBµV
30 dвµV
20 dBµV
10 dBpV
0 dBuV
ATT
Start 30.0 MHz Stop 300.0 MHz
Fig A2: Radiated Emissions 30MHz - 300MHz, Horizontal, 3metres

Report Ref: 23E10540-1b Page 20 of 24

Spectrum Receiver 🗵		
RBW (QPK) 120 kHz MT	100 ms 609_3mx	
Input 1 AC 👄 Att 0 dB Pre	amp ON Step TD Scan	
Scan 😑 1Pk Max 🕒 2QP Max		
an druke		
80 aBhA		
70 dBµV		
60 dBµV		
50 dBµV		
40 dBµV		
30 dBµV		
	and an and a second when the second when the	and
20 dBuV	mandenter	
and a start with the start of t		mannen
10 dBuV	and the second s	
D dBuild		
		т
Start 300.0 MHz	· · ·	Stop 1.0 GHz

Spectrum Receiver	×)	
RBW (QPK) 120 kHz	MT 100 ms	609_3mx
Input 1 AC 👄 Att 0 dB	Preamp ON Step TD Scan	
Scan O1Pk MaxO2QP Max		
80 dBµV		
70 dBµV		
60 dBµV		
50 dBµV		
40 dBµV		
30 dBµV		And Annothing the second se
	and a man a hundren man	demand and and and the second second
20 dBµV	An and a second and a second a	
10 dBµV	and the second s	
о авру-		
		ТЕ
Start 300.0 MHz		Stop 1.0 GHz
Fig A4: R	adiated Emissions 300MHz - 1GHz,	Horizontal, 3metres

Report Ref: 23E10540-1b Page 21 of 24

Spectrum Receiver 🗵		
RBW 1 MHz MT 100 ms	655_ESRG	
Scan O1Pk Max		
90 dBµV		
80 dBµV		
70 dBµV		
60 dBµV		
50 dBµV	through hand to	
and an advantage	and an Washer White mark and	
40 dBUV-		
30 dBµV		
20 dBµV		
10 dBuV		
		TF
Start 1.0 GHz	Stop 3	.6 GHz
Marker		

Fig A5: Radiated Emissions 1GHz - 3.6GHz, Vertical, 3metres

Spectrum Receiver 🛞	
RBW 1 MHz MT 100 ms 655_ESRG	
Scan 👴 1 Pk Max	
90 dBµV	
80 dBµV	
70 dBµV	
60 dBµV	
50 dBµV	had a surface have card as
where we have been and the second sec	
40 dBUV	
30 dBµV	
20 dвµV	
10 dBuV	
	TF
Start 1.0 GHz	Stop 3.6 GHz
Marker]
Fig A6: Radiated Emissions 1GHz - 3.6GHz, Horizontal, 3n	netres

Report Ref: 23E10540-1b

			P	age ZZ of Z4	
		Det	MA Trd	655_805	
V	Att 0 dB AUTO	ResBW	1 MHz		
	Preamp INPUT 1	Meas T	100 ms Unit	dBµV	
90					
80					
7.0					
,0					
					1MA
60					280
50]				
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	mon	mark have and more and the comments of the second s			
40					
2.0		and another and another			
30	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~				
20	I				
10					
0				6 CT-	
	J.O GHZ			6 GHZ	
		Fig A7: Radiated Emissions 3.6GHz - 6GHz,	Vertical, 3metre		
			-		
		Det	MA Trd	655_805	
	Att 0 dB AUTO	Det ResBW	MA Trd 1 MHz	655_805	
	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	
9 O C	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBμV	
90	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	
90 80	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	
90 80	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	
90 80	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	
90 80 70	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	
90 80 70	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA
90 80 70	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50 40	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50 40	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50 40 30	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 90 80 70 60 50 40 30	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 90 80 70 60 50 40 30	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 90 80 70 60 50 40 30 20	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50 40 30 20	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50 40 30 20	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50 40 30 20 10	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 80 70 60 50 40 30 20 10	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 90 80 70 60 50 40 30 20 10	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 90 80 70 60 50 40 30 20 10	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV
90 90 80 70 60 50 40 30 20 10 0	Att 0 dB AUTO Preamp INPUT 1	Det ResBW Meas T	MA Trd 1 MHz 100 ms Unit	655_805 dBµV	1MA 2AV

Appendix B: Test Configurations:

 Fig B1: EUT orientation "O1"
 Fig B2: EUT orientation "O2"

Orientations for Radiated Emissions



Appendix C: Block Diagrams of Test Setup

End of Report