



# Compliance Engineering Ireland Ltd Clonross Lane, Derrockstown, Dunshaughlin Co. Meath, Ireland A85 XN59

Ph +353 1 8017000 , 8256722

### **Confidential Report**

Project Num	21E9185-1b					
Quotation	Q21-1401-1					
Prepared For	Alps Electric (Ireland) Limited					
Company Address	Clara Road,					
	Millstreet, Cork , Ireland					
Contact	Donal O'Shea					
Contact Email	Donal.oshea-1@alps.ie					
Contact Phone	+ 353(29)70677					
Prepared By	Compliance Engineering Ireland					
Test Lab Address	Clonross Lane, Derrockstown,					
	Dunshaughlin, Co. Meath, Ireland					
Tested By	Michael Kirby / Joy Dalayap					
Test Report By	Michael Kirby					
FCC Test Firm Registration	409640					
ISED CAB identifier:	IE0001					
Date	6 <sup>th</sup> Sept 2021					
EUT Description	Asset Tracker					
FCC ID	2AT4VSKALLI1RM					
IC ID	26629-SKALLI1RM					
Authorised by	Paul Reilly					
Authorised Signature:	Part Rug					

### **TEST SUMMARY**

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

15247 Section	RSS-247 Section	TEST PARAMETERS	Test Result
15.247(a)	5.1(a)	20dB bandwidth of hopping Channel	Pass
15.247(a)	5.1(b)	Hopping Frequency Separation	Pass
1.247(a)	5.1(c)	Number of Hopping Channels	Pass
15.247(a)	5.1(c)	Average Time of Occupancy	Pass
15.247(b)	5.4	Output power	Pass
15.247(d)	5.5	Conducted Spurious Emissions	Pass
	RSS Gen 6.7	99% bandwidth	Pass
15.205 15.209 RSS Gen 8.9 and 8.10		Radiated Spurious Emissions for restricted bands	Pass

RSS 247 Issue 2 Mar16 2017 RSS-Gen Issue 5 Amd2 Feb 2021

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- Appendix D Appendix E Block Diagrams of the test setup Summary of Antennas and EUT Samples

### 1.0 EUT Description

FCC ID	2AT4VSKALLI1RM
IC ID	26629-SKALLI1RM
Model:	2EE-02707AB
HVIN:	2EE-02707AB
PMN:	Skalli1RM
Туре:	Asset Tracker
Type of radio:	Stand-alone
Power configuration:	3.6 VDC Internal Battery (non rechargeable)

### Sigfox

Transmitter Type:	D-BPSK
Classification:	DSS
Operating Frequency Range(s):	902.138MHz -904.663 MHz
Number of Channels:	Hopping on 54 channels (902.138 – 904.663 MHz)
Antenna:	Integral
Test Standards:	15.247 RSS-247
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2013 KDB 558074 V5 R02

### BLE

Type of radio:	Stand-alone
Transmitter Type:	BLE
Operating Frequency Range(s):	2.402 GHz - 2.480GHz
Number of Channels:	40
Ports:	None
Classification:	DTS
Antenna:	Integral
Test Standards:	15.247 RSS-247
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2013 KDB 558074 V5 R02

The EUT was an asset tracker reporting on the 915 MHz band over the Sigfox network The EUT also contained a custom BLE radio.

This report details test carried out on the Sigfox transmitter.

### 1.1 EUT Operation

### **Operating Conditions during Test:**

Conducted measurements were carried out on a sample where the antenna was replaced by cable and SMA.

The EUT was operated in test mode where the channel and modulation was set via USB connection from the EUT to a laptop.

Radiated measurements were performed on a sample with standard internal antenna.

The EUT was powered from its internal battery for all tests (and a new battery was used).

### **Environmental conditions**

	Temperature	Relative Humidity
Test	°C	%
Conducted Emissions	21.2	49
Radiated Emissions <1GHz	18	42
Radiated Emissions >1GHz	19	47

### 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 7<sup>th</sup>,8<sup>th</sup>, 27<sup>th</sup> Jul, 13<sup>th</sup> Aug and 6<sup>th</sup> Sept 2021.

### 1.4 Special Test Software

Tests were performed manually and no special test software was used

### 2.0 Emissions Measurements

### 2.1 Conducted Emissions Measurements

Conducted emissions were performed on a sample where the antenna was replaced by a cable and SMA connector.

### 2.2 Radiated Emissions Measurements

### 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.

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

### 2.2.2 Measurements in Transmit mode

A radiated emissions 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 (orientation2 O2)

The EUT in a horizontal orientation (orientation1 O1) gave the highest emissions for vertical polarization.

A full scan for radiated emission was performed in orientation O2 for vertical polarization and in orientation O3 for horizontal polarization.

Ref Appendix C for Orientations

### 3. Conducted Emissions on the fundamental

#### **Occupied Bandwidth** 3.1

### 3.1.1 20dB Bandwidth

Requirement FCC 15.247(a) IC RSS-247 5.1a The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz

Spectrum	R	eceiver 🗴 🤅	Spectrum 2	🗴 Spe	ctrum	3 X	Spectrum 4	× 🖫
Ref Level 3	0.00 dBm	1 .	<b>RBW</b> 50 Hz					
Att	50 dE	5 🛛 <b>SWT</b> 37.8 ms 🖷	<b>VBW</b> 200 Hz	Mode Auto	FFT	Input 1 /	٨C	
TDF						20		
⊖1Pk View								
			м	1 M	1[1]			20.60 dBm
20 dBm							904.671	58930 MHz
				no	IB			20.00 dB
10 dBm				B	N		955.099	9999905 Hz
		11			factor	T2		947163.7
0 dBm		N N		M	2[1]	×		-16.11 dBm
-10 dBm		1 Star					904.670	70650 MHz
	M2					1	~~~~~	~
-20 dBm						~		
$\checkmark$	$\vee$						$\vee$	$\sim$
-30 dBm								
-40 dBm								
-50 dBm								
-50 abiii								
-60 dBm								
CF 904.6718	5929 MH	z	691	pts		<u>I</u>	 Sp	an 2.5 kHz
Marker				-			· · · · ·	1
Type   Ref	Trc	X-value	Y-value	Funct	tion	1	Function Resul	t 1
M1	1	904.6715893 MHz	20.60 dB	m ndB	down		955.099	9999905 Hz
T1	1	904.6711045 MHz	0.36 dB	m	ndB			20.00 dB
T2	1	904.6720596 MHz	0.64 dB	m Qʻ	factor			947164
M2	1	904.6707065 MHz	-16.11 dB					
МЗ	1	904.6726457 MHz	-13.71 dB	m				
			Fig 1 20dB	Bandwidth				

Frequency	20dB Bandwidth	Limit Min	Margin
GHz	Hz	KHz	MHz
902.147	973.2	500	499.03
903.388	995.7	500	499
904.663	955.099	500	499.04

**Test Result Pass** 

### 3.1.2 99% Bandwidth

Test Method

As per Ansi 63.10 Section 6.9.3

#### Ansi63.10 Section 6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

The following procedure shall be used for measuring 99% power bandwidth:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

### TEST PROCEDURE The test was performed as a conducted measurement

RESULTS

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Spectrum		Receiver	🗴 Sp	ectrum 2	X	Spectrum	3 (	) Sp	ectrum 4	× 4
Ref Level 3	30.00 de	m	🖷 RBW	50 Hz		-				
Att		 HB 🖷 SWT 1 :			oho	Auto FFT In	put 1 A	c		
PS TDF				200 KH2 H	ouc		put 1A	<u> </u>		
) 1Pk Max										
						M1[1]				19.87 dBn
20 dBm				M	<u>H</u>				904.671	56900 MH
20 uBm					2	Occ Bw			875.542	2691827 H
10 dBm						M2[1]	TO			17.80 dBn
			V				T2 V			32620 MH
0 dBm			1				1		+	
		1	1							
-10 dBm	<b>N</b> 200						7	8	-	
	-	1 dest						V		
-20 dBm-+		6								
-30 dBm	177				2				~	
-30 ubiii										
-40 dBm										
-50 dBm										
-60 dBm										
CF 904.671	5762 M	Hz	9. <sup>2</sup>	691	pts				Spa	an 2.5 kHz
Marker										
Type   Ref	Trc	X-value	э	Y-value		Function		Fun	nction Result	
M1	1	904.6715	69 MHz	19.87 dE	Sm 🗌					
T1	1	904.671142	05 MHz	4.13 dE	Sm 🗌	Occ Bw	875.542691827 H		691827 Hz	
T2	1	904.672017		3.85 dE						
M2	1	904.67032		-17.80 dE						
M3	1	904.67032	62 MHz	-17.80 dE	Sm 🗌					
			F	ig 2 99% Occu	Jpied	Bandwidth				

Frequency	99% Bandwidth
GHz	Hz
902.147	859.624
903.388	871.925
904.663	875.543

No Limit

**Test Result Pass** 

#### 3.2 **Hopping Frequency Separation**

**Requirement FCC 15.247(a)** IC RSS-247 5.1b FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Number of hopping channels =

9 macro channels containing 6 micro channels each.

 $\Rightarrow$  Total of 54 micro channels

Each micro channel is active for 300mS per 20sec window

Receiv	ver	s	pectrum	×					
Ref Le Att PS TDF		0.00 de 50 i		● RB ms ● VB	WI kHz W3 kHz M	ode Auto F	FT Inj	put 1 AC	
O1Pk Ma	ах								
20 dBm·				D2	D3	~~~ ~~ ~~~	1[1] 2[1]		21.16 dBm 902 <sub>1</sub> 146910 MHz -0.07 dB
10 dBm· 0 dBm—					¥		-		25.550 kHz
-10 dBm -20 dBm		7		U		V			
<mark>,-30_dBm</mark> -40 dBm	$\vee$	~~							- Wh
-50 dBm -60 dBm									
Start 9	02.1	MHz	1	1	501	pts	1	<u>I</u> I	Stop 902.3 MHz
Marker									
Туре	Ref	Trc	X-value	e	Y-value	Func	tion	Functi	on Result
M1		1	902.146		21.16 dB				
D2	M1	1		.55 kHz	-0.07 c	1111211			
D3	M1	1		.53 kHz	-0.01 c				
D4	M1	1		.38 kHz	0.02 0				
D5	M1	1		10.0 Hz	0.00 c				
				Fig 3 M	icro Channel F	Frequency S	Separatio	n	

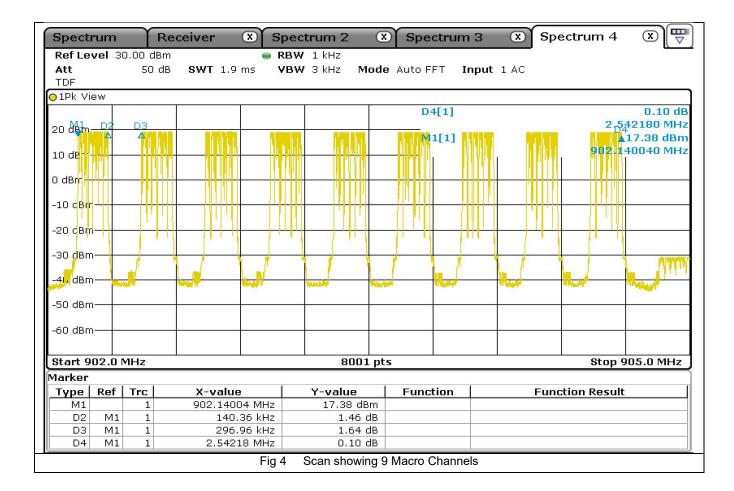
Micro Channel Separation (measured from channel centres) =25.55KHz

**Test Result Pass** 

### 3.3 Number of Hopping Channels

### Requirement FCC 15.247(a) IC RSS-247 5.1c

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz



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				1	
Spectrum	Spectrum 4 🛛 🛞				
Ref Level 30.00 a	dBm 🛛 👄 F	RBW 1 kHz			
<b>Att</b> 50	)dB SWT 1.9 ms 👄 🛚	/BW 3 kHz Mod	le Auto FFT 🛛 In	nput 1 AC	
TDF				-	
⊖1AP Max					
	M1		D3[1]		-0.49 dB
20 dBm	▼D2				1483710 kHz
20 ubiii	1 41		M1[1]	11 811	21.05 dBm
10 dBm			1	11 11	902.136930 MHz
10 dbiii		11		11 11 11	4
0 dBm				U V	
o abiii	1	U	$\langle \rangle$		
-10 dBm					
10 0.011	1				
-20 dBm	1				
-30 dBm					
a del					5
-40 dBm					
-50 dBm					
-60 dBm					
Start 902.1 MHz	I	501 pt	ts		Stop 902.3 MHz
Marker					
Type   Ref   Trc	X-value	Y-value	Function	Funct	ion Result
M1 1	902.13693 MHz	21.05 dBm	NOT TRACT REPORT OF		
D2 M1 1	20.76 kHz	-0.64 dB			
D3 M1 1	145.71 kHz	-0.49 dB			
	Fig 5 Scan show	/ing 1 macro chanr	el containing 6 m	icro channels	,

Number of hopping channels =

9 macro channels containing 6 micro channels each.

⇒ Total of 54 micro channels

Limit = Min 50 channels

**Test Result Pass** 

### 3.4 Occupancy

### Requirement FCC 15.247(a) IC RSS-247 5.1c

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 second period. The system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The

### Results

Spectrum	Spectrum	4 🕱					
Ref Level 30.00	dBm	👄 R	BW 5 kHz				
Att 5	0 dB 🥃 SWT	500 ms 👄 🗸	' <b>BW</b> 10 kHz	Input	t 1 AC		
SGL TRG: VID TDF							
⊖1AP Max							
				M	1[1]		11.22 dBm
20 dBm							0.000000 s
ZU UDIII M1				D	2[1]		-2.21 dB
10 dBm						<u>D</u> 2	300.000 ms
	000 dD-						
0 dBm	.000 dBm		╾┥┫╾╸╴╴╴╴╴╴╴				
		1111111			111		
-10 dBm <del></del>	╈╪╋╌	╶╂┼╋╏┨╢╏┼┼╾┼╴	╶╫╫╴╢┼╴┦╴╴╫┼╏┨┼	┝╾┾┼┝┼╏┼╾╾┥	╋╌┾╾╾┠╼╏┿┿┿┿	╈╋	
22.001	213121 (A. 1333)	activities of a	the second second	1.076.267	C. COLD	2.2.5	
-20 dBm							
-30 dBm							
-30 0011							
-40 dBm							
						~	100 100 100 100
450 d8m -#						a la faire de la serie	Anarolin line to ball a str
						1.1.1.1.1.1.1.1	A T
						di and a	ditta de des la colda
CF 902.2 MHz	•		501	ots			50.0 ms/
Marker							
Type   Ref   Tro	: X-va	lue	Y-value	Func	tion	Fund	ction Result
		-227.2 as	11.22 dBr				
	1	300.0 ms	-2.21 d				
D3 M1	1	423.0 ms	-65.01 d				
		F	ig 6 Micro chan	nel pulse w	/idth		

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Spectru	ım	S	pectrum 4 🛛 🗴						
Ref Leve	el 30.0	)0 dBm	n 🖷 RB	W 1 kHz					
Att		50 dB	🛯 🔵 SWT 25 s 🔵 VB	<b>W</b> 10 kHz	Input 1	AC			
SGL TRG	VID TI	DF							
O1AP Ma≻	(								
					D	2[1]			-59.63 dB
20 dBm—								19	9.999834 s
20 ubiii—	M1[1] 15.05 dBn								15.05 dBm
10 dBm—	TRG	13.00	0 dBm					(	0.000000 s
10 dbm	П								
0 dBm									
-10 dBm-									
-20 dBm-									
-30 dBm—								+	-
					D3				
-40 dBm		-		10	<b>A</b>			Di Di	2 14
								4	
-50 dBm	Con to	former.	the first second	ener second fille	J.	dist.	and the second descent	L L MARK	
edites to other	A. ALM	and by	a standard plan diana dia amang ang		and arreading	and the block tage	A STREET AND A STREET	a hall the partition	ing the man
CF 902.2	2 MHz			32000	pts				2.5 s/
Marker									
Type   F	Ref   T	rc	X-value	Y-value	Func	tion	Fun	ction Result	1
M1		1	-227.2 as	15.05 dBm					
D2	M1	1	19.999834 s	-59.63 dB					
D3	M1	1	11.320997 s	-55.35 dB					
			Fig 7 Av	erage Time of Oc	cupancy I	ow Channe			

The scans show that each micro channel on-time is 0.3 secs and the occupancy is less than 0.4 secs per 20 sec window.

**Test Result Pass** 

### 3.5 Output Power Conducted

### Requirement FCC 15.247(b) IC RSS-247 5.4

For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

3.5.1 Test Method As per Ansi 63.10 Section 11.9..1.1

#### Ansi63.10 Section 11.9.1.1 RBW ≥ DTS bandwidth

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

- a) Set the RBW  $\geq$  DTS bandwidth.
- b) Set VBW ≥ [3 × RBW].
- c) Set span ≥ [3 × RBW].
- d) Sweep time = auto couple.
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.

h) Use peak marker function to determine the peak amplitude level.

Test The test was performed as a conducted measurement

### Results

The maximum antenna gain is less than 6dBi therefore the limit is 30dBm

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							Faye IU	JI JU
Spectrum	Receiver		trum 2	Spect	rum 3	×s	pectrum 4	8 🕎
Ref Level 30.0		🔵 RBW						
	50 dB <b>SWT</b>	19 µs <b>VBW</b>	300 kHz	Mode Auto FF	T Input	1 AC		
●1Pk Max			T					
				M1	1]			21.07 dBm 96870 MHz
20 dBm				M1			903.3	90070 MHZ
10 dBm								
0 dBm					X			
					$\mathbf{X}$			
-10 dBm								
					$\sim$			
-20 dBm								
-30 dBm-								
-40 dBm								
-50 dBm								
oo abiii								
-60 dBm								
CF 903.388 MH	lz .	•	800	1 pts			Spa	n 1.0 MHz
		Fig	3 8 Output p	ower Conducte	d			
		-						

Frequency	Measurement	Limit	Margin
MHz	dBm	dBm	dB
902.147	21.04	30	8.93
903.388	21.07	30	8.93
904.663	21.17	30	8.83

**Test Result Pass** 

### 4. Spurious Emissions Measurements

### 4.1 Conducted Emissions Requirement FCC 15.247(d) IC RSS-247 5.5

4.1.1 Test Method As per Ansi63.10 Section 11.11.1 and 6.10.4

#### Ansi63.10 Section 11.11.1 General

Typical regulatory requirements specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions<sup>89:</sup> a) If the maximum peak conducted output power procedure was used to determine compliance as described in 11.9.1, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).

Ansi63.10 Section **6.10.4 Authorized-band band-edge measurements (relative method)** These procedures are applicable for determining compliance at authorized-band band-edges where the requirements are expressed as a value relative to the in-band signal level. Procedures for determining compliance with field strength limits at or close to the band-edges are given in 6.10.6 (see also Table A.2).

Test Specification: FCC 15.247(d) IC RSS-247 5.5

### 4.1.2 Results

	Peak 100KHz			
Frequency	RBW	Measured	Limit Min	Margin
GHz	dBm	dBc	dBc	dB
0.902138	21.04	0	20	-
1.804275	-34.7	55.74	20	35.74
2.7064	-63.1	84.14	20	64.14
3.6086	-74.13	95.17	20	75.17
4.51076	-74.13	95.17	20	75.17
5.41288	-68.73	89.77	20	69.77
6.31504	-68.2	89.24	20	69.24
7.2172	-63.3	84.34	20	64.34
8.11932	-56.88	77.92	20	57.92

	Peak 100KHz			
Frequency	RBW	Measured	Limit Min	Margin
GHz	dBm	dBc	dBc	dB
0.903388	21.07	0	20	-
1.807	-36.57	57.64	20	37.64
2.71	-74.12	95.19	20	75.19
3.6135	-76.5	97.57	20	77.57
4.517	-75.2	96.27	20	76.27
5.42	-67.3	88.37	20	68.37
6.323	-72	93.07	20	73.07
7.227	-63	84.07	20	64.07
8.13	-58.5	79.57	20	59.57
9.034	-61	82.07	20	62.07

	Peak 100KHz			
Frequency	RBW	Measured	Limit Min	Margin
GHz	dBm	dBc	dBc	dB
0.904675	21.17	0	20	-
1.80935	-34.9	56.07	20	36.07
2.7139	-62.9	84.07	20	64.07
3.61864	-74.59	95.76	20	75.76
4.52332	-78.41	99.58	20	79.58
5.42796	-70.24	91.41	20	71.41
7.23728	-63.96	85.13	20	65.13
8.14196	-57.46	78.63	20	58.63

## Ref scans in Appendix B

Result Pass

### 4.2 Radiated Spurious Emissions in Restricted bands

#### 4.2.1 Test Method

As per Ansi63.10 Section 11.12.1 and 6.10.5

#### Ansi63.10 Section 11.12.1 Radiated emission measurements

Because the typical emission requirements are specified in terms of radiated field strength levels, measurements performed to determine compliance have traditionally relied on a radiated test configuration.<sup>92</sup> Radiated measurements remain the principal method for determining compliance to the specified requirements; however antenna-port conducted measurements are also now acceptable to determine compliance (see 11.12.2 for details). When radiated measurements are utilized, test site requirements and procedures for maximizing and measuring radiated emissions that are described in 6.3, 6.5, and 6.6 shall be followed

### 6.10.5 Restricted-band band-edge measurements

These procedures are applicable for determining compliance at band edges of restricted bands. **6.10.5.1 Test setup** 

Restricted-band band-edge tests shall be performed as radiated measurements, on a test site meeting the specifications in 5.2 at the measurement distances specified in 5.3.57

The instrumentation shall meet the requirements in 4.1.1 using the bandwidths and detectors specified in 4.1.4.2. Considering the requirements of 5.8, the antenna(s) shall be connected to the antenna ports. When performing radiated measurements, the measurement antenna(s) shall meet the specifications in 4.3. The EUT shall be connected to an antenna and operated at the highest power settings following procedures in 6.3, and the relevant procedure in 6.4, 6.5, or 6.6

#### Spurious Emissions restricted bands

### Test Specification: FCC 15.205 15.209 RSS Gen 8.9 and 8.10

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
2.706	55.4	28.7	38.4	3.8	Vertical	0.00	49.5	74	24.5
3.608	47.7	31.3	37.6	4.6	Vertical	0.00	46.0	74	28.0
4.511	46.4	32.4	37	5.0	Vertical	0.00	46.8	74	27.2
5.412	48.4	33.5	37.5	5.6	Vertical	0.00	50.0	74	24.0
8.119	41.0	37.3	37.5	6.8	Vertical	0.00	47.6	74	26.4
9.021	43.0	37.9	37.1	7.5	Vertical	0.00	51.3	74	22.7
2.706	55.6	28.7	38.4	3.8	Horizontal	0.00	49.7	74	24.3
3.608	49.4	31.3	37.6	4.6	Horizontal	0.00	47.7	74	26.3
4.511	49.5	32.4	37	5.0	Horizontal	0.00	49.9	74	24.1
5.412	49.1	33.5	37.5	5.6	Horizontal	0.00	50.7	74	23.3
8.119	42.4	37.3	37.5	6.8	Horizontal	0.00	49.0	74	25.0
9.021	43.4	37.9	37.1	7.5	Horizontal	0.00	51.7	74	22.3

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
2.710	55.7	28.7	38.4	3.8	Vertical	0.00	49.8	74	24.2
3.614	48.2	31.3	37.6	4.6	Vertical	0.00	46.5	74	27.5
4.517	46.0	32.4	37	5.0	Vertical	0.00	46.4	74	27.6
5.420	48.6	33.5	37.5	5.6	Vertical	0.00	50.2	74	23.8
8.130	41.2	37.3	37.5	6.8	Vertical	0.00	47.8	74	26.3
9.033	43.6	37.9	37.1	7.5	Vertical	0.00	51.9	74	22.1
2.710	55.6	28.7	38.4	3.8	Horizontal	0.00	49.7	74	24.3
3.614	49.1	31.3	37.6	4.6	Horizontal	0.00	47.4	74	26.6
4.517	49.3	32.4	37	5.0	Horizontal	0.00	49.7	74	24.3
5.420	48.9	33.5	37.5	5.6	Horizontal	0.00	50.5	74	23.5
8.130	41.4	37.3	37.5	6.8	Horizontal	0.00	48.0	74	26.0
9.033	42.9	37.9	37.1	7.5	Horizontal	0.00	51.2	74	22.8

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
2.713	56.4	28.7	38.4	3.8	Vertical	0.00	50.5	74	23.5
3.618	47.8	31.3	37.6	4.6	Vertical	0.00	46.1	74	27.9
4.523	45.6	32.4	37	5.0	Vertical	0.00	46.0	74	28.0
5.428	48.3	33.5	37.5	5.6	Vertical	0.00	49.9	74	24.1
8.141	40.7	37.3	37.5	6.8	Vertical	0.00	47.3	74	26.7
9.047	42.4	37.9	37.1	7.5	Vertical	0.00	50.7	74	23.4
2.713	55.6	28.7	38.4	3.8	Horizontal	0.00	49.7	74	24.3
3.618	48.5	31.3	37.6	4.6	Horizontal	0.00	46.8	74	27.2
4.523	49.4	32.4	37	5.0	Horizontal	0.00	49.8	74	24.2
5.428	37.7	33.5	37.5	5.6	Horizontal	0.00	39.3	74	34.7
8.141	45.9	37.3	37.5	6.8	Horizontal	0.00	52.5	74	21.5
9.047	40.1	37.9	37.1	7.5	Horizontal	0.00	48.4	74	25.6

### **Result: Pass**

### 5. Radiated Power at fundamental

For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

### Results

Frequency	Peak Level	Antenna Polarity	Antenna Factor	Cable loss	Final Field Strength Peak	Power	Power Limit	Margin
MHz	dBuV/m	V/H	dB	dB	dBuV/m	dBm	dBm	dB
902.147	94.49	Vertical	23.2	2.3	119.99	24.79	36.0	11.2
902.147	93.32	Horizontal	23.2	2.3	118.82	23.62	36.0	12.4
903.388	94.57	Vertical	23.2	2.3	120.07	24.87	36.0	11.1
903.388	93.23	Horizontal	23.2	2.3	118.73	23.53	36.0	12.5
904.663	94.63	Vertical	23.3	2.3	120.23	25.03	36.0	11.0
904.663	93.15	Horizontal	23.3	2.3	118.75	23.55	36.0	12.5

Hopset uses >50 channels =>EIRP power limit =36dBm

Note the Radiated field strength was measured at 3 metres and the conversion formula below was used to determine the EIRP in dBm EIRP (dBm) = E3m (dBuV/m) - 95.2

**Result: Pass** 

## 6 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-21	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	28-May-23	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
Antenna Horn	EMCO	3115	9905-5809	655	13-Dec-21	24

### 7 Measurement Uncertainties

Measurement	Uncertainty
Radio Frequency	+/- 5x10 <sup>-7</sup>
Maximum Frequency Deviation	+/- 1.7 %
Conducted Emissions	+/- 1 dB
Radiated Emission 30MHz-100MHz	+/- 5.3 dB
Radiated Emission 100MHz-300MHz	+/- 4.7 dB
Radiated Emission 300MHz-1GHz	+/- 3.9 dB
Radiated Emission 1GHz-40GHz	+/- 3.8 dB
Modulation bandwidth	+/- 5x10 <sup>-7</sup>
Duty Cycle	+/- 5 %
Power supply	±0.1 VDC
Temperature	±0.2 °C
Frequency	±0.01 ppm

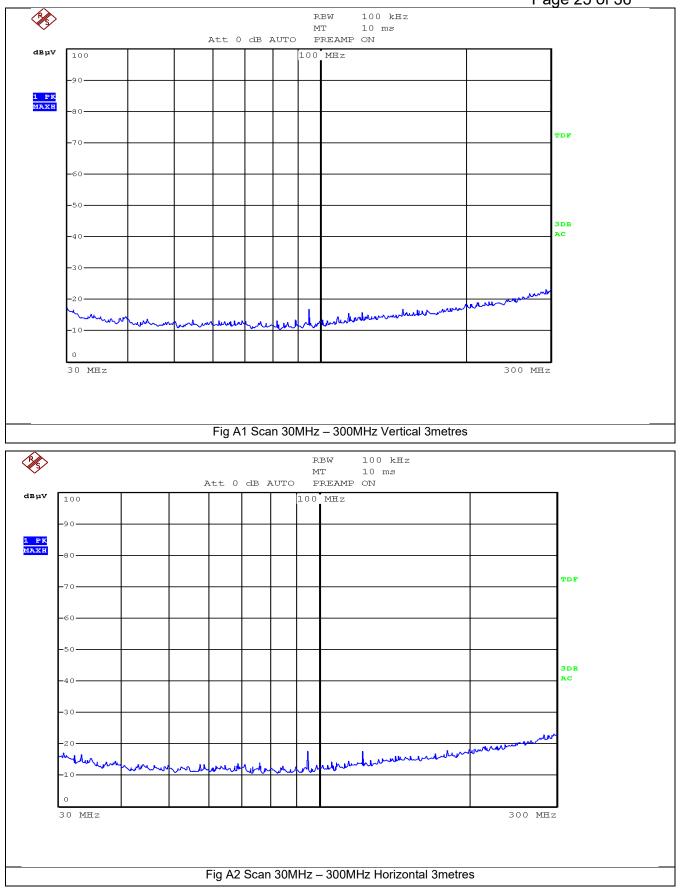
The measurement uncertainties stated were calculated with a k=2 for a confidence level of over 95% as per ETS TR100 028.

The test data can be compared directly to the specification limit to determine compliance, as the calculated measurement uncertainty meets the requirements of the applicable specification.

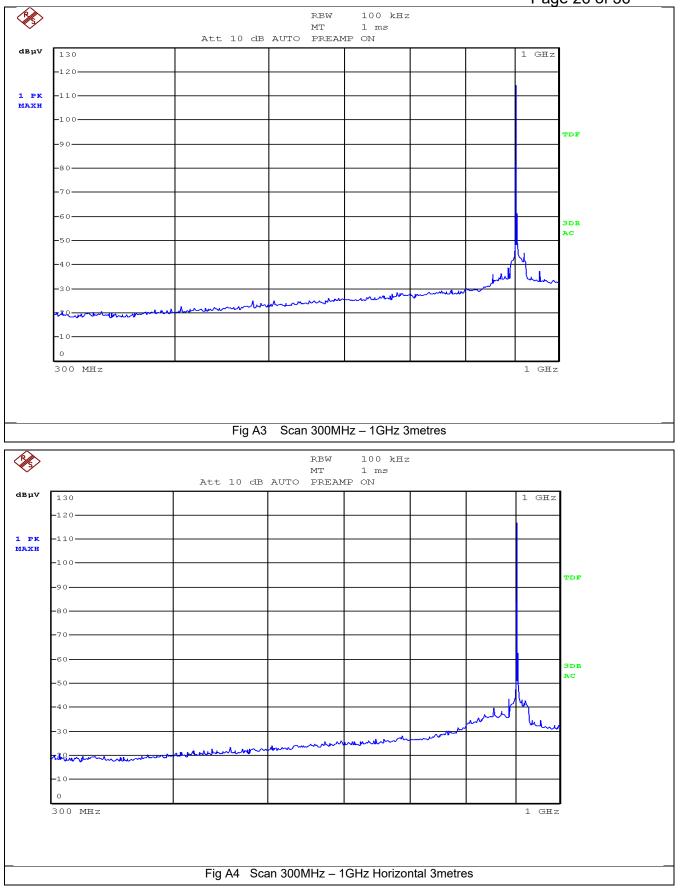
## Appendix A

Spurious Emissions Radiated

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TF

Stop 3.6 GHz

Spectrum Receiver 🗵	
RBW 1 MHz MT 100 ms	
Input 1 AC 🖷 Att 0 dB Preamp ON Step TD Scan	
Scan O1Pk MaxO2Av Max	
100 dBµV	
90 dBµV	
80 dBµV	
70 dBµV	
60 dBµV	
50 dBµV	and the another manufacture
50 dBμV	Man any war and a man and a second and as
30 dBµV	line
20 dBµV	
10 dBµV	
	ТБ
L Start 1.0 GHZ	Stop 3.6 GHZ
Fig A9 Scan 1GHz – 3.6G	
Spectrum Receiver 🗵	
RBW 1 MHz MT 100 ms	655Rx
Input 1 AC  Att 0 dB Preamp ON Step TD Scan Scan  Place Max Contemporation Scan	۱ ۱
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100 dBµV	
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90 dBµV	

Fig A10 Scan 1GHz – 3.6GHz Horizontal 3 metres

20 dBµV—

10 dBµV-

0 dBμV—

Start 1.0 GHz

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· ·	2					Det ResBW	M 1 MB	z		ıV
100	-					Det ResBW	M 1 MB	z	dB1	ıV
· ·	-					Det ResBW	M 1 MB	z	dB1	ıV
100	-					Det ResBW	M 1 MB	z	dB1	ıV
100 90						Det ResBW	M 1 MB	z	dB1	ıV
100						Det ResBW	M 1 MB	z	dB1	ıV
100 90						Det ResBW	M 1 MB	z	dB1	z
100 90						Det ResBW	M 1 MB	z	dB1	1WA
100 90 80						Det ResBW	M 1 MB	z	dB1	z
100 90 80						Det ResBW	M 1 MB	z	dB1	1WA
100 90 80						Det ResBW	M 1 MB	z	dB1	1WA
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## Appendix B

**Conducted Emissions** 

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50 dBm				-								1	1
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tart 30.0 MHz	b auto	Fig B	1 Scan	30MHz -	– 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	ĠHz
tart 30.0 MHz	b auto	Fig B	1 Scan	30MHz	– 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT	ĠHz
tart 30.0 MHz	b auto	Fig B	1 Scan	30MHz	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	ĠHz
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Att 0 dE Preamp I	b auto	Fig B	1 Scan	30MHz ·	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	ĠHz
Att 0 de Preamp I	b auto	Fig B	1 Scan	30MHz ·	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 de Preamp I	b auto	Fig B	1 Scan	30MHz	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -20 -30	b auto	Fig B	1 Scan	30MHz -	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I	b auto	Fig B	1 Scan	30MHz	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -10 -20 -30 -40	b auto	Fig B	1 Scan	30MHz	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -20 -30	b auto	Fig B	1 Scan	30MHz -	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -10 -20 -30 -40 -50 -60	b auto	Fig B	1 Scan	30MHz -	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -10 -20 -30 -40	b auto	Fig B	1 Scan	30MHz ·	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -10 -20 -30 -40 -50 -60 -70	b auto	Fig B	1 Scan	30MHz ·	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -10 -20 -30 -40 -50 -60	b auto	Fig B	1 Scan	30MHz -	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -10 -20 -30 -40 -50 -60 -70 -80	b auto	Fig B		30MHz ·	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -10 -20 -30 -40 -50 -60 -70	b auto	Fig B	1 Scan	30MHz -	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -10 -20 -30 -40 -50 -60 -70 -80 -90	b auto	Fig B	1 Scan	30MHz ·	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	ĠHz
Att 0 dE Preamp I -10 -20 -30 -40 -50 -60 -70 -80	b auto	Fig B		30MHz -	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHz
Att 0 dE Preamp I -10 -20 -30 -40 -50 -60 -70 -80 -90	b auto	Fig B	1 Scan	30MHz -	- 3.6GHz	Det Resi	BW	100	M ) kB	z	101	DB-ATT dBm	GHa

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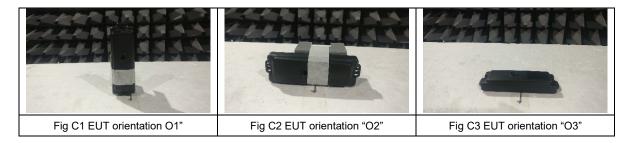
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				ower band edg	je conducte	a nobb	ing mode			
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-	30.00 dBm		(X)	<b>W</b> 100 kHz	Mode Aut			AC		
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Ref Level Att TDF 1AP Max	30.00 dBm	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT 1[1]		4C	904	(∆ 20.98 dBm .5920 MHz
Ref Level Att TDF 1AP Max 11 20 dBm	30.00 dBm	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT		AC	<b>904</b> -	(∆ 20.98 dBm
Ref Level Att TDF 1AP Max 1 20 dBm	30.00 dBm	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT 1[1]		AC	<b>904</b> -	20.98 dBm .5920 MHz 33.64 dBm
Ref Level Att TDF 1AP Max 11 20 dBm	30.00 dBm	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT 1[1]		4C	<b>904</b> -	20.98 dBm .5920 MHz 33.64 dBm
Ref Level Att TDF 1AP Max 1 20 dBm	30.00 dBm	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT 1[1]			<b>904</b> -	20.98 dBm .5920 MHz 33.64 dBm
Ref Level Att TDF 1AP Max 20 dBm	30.00 dBm	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT 1[1]		AC	<b>904</b> -	20.98 dBm .5920 MHz 33.64 dBm
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Ref Level Att TDF 1AP Max 20 dBm 10 dBm 0 dBm -10 dBm -20 dBm	30.00 dBm	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT 1[1]		4C	<b>904</b> -	20.98 dBm .5920 MHz 33.64 dBm .0000 MHz
Ref Level Att TDF 1AP Max 20 dBm 10 dBm 0 dBm -10 dBm -20 dBm -36 dBm	30.00 dBm	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT 1[1]		4C	<b>904</b> -	20.98 dBm .5920 MHz 33.64 dBm .0000 MHz
Ref Level Att TDF 1AP Max 20 dBm 10 dBm 0 dBm -10 dBm -20 dBm -38 dBm -40 dBm	30.00 dBm	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT 1[1]			<b>904</b> -	20.98 dBm .5920 MHz 33.64 dBm .0000 MHz
Ref Level           Att           TDF           1AP Max           1           20 dBm           10 dBm           0 dBm           -10 dBm           -20 dBm           -30 dBm           -30 dBm           -30 dBm           -30 dBm           -60 dBm	30.00 dBm 50 dB	ectrum 4	(X)	W 100 kHz W 300 kHz	Mode Aut	o FFT 1[1]		AC	904 - 928	20.98 dBm .5920 MHz 33.64 dBm .0000 MHz
Ref Level Att TDF ● 1AP Max 1 20 dBm 10 dBm -10 dBm -20 dBm -36 dBm -40 dBm -50 dBm	30.00 dBm 50 dB	ectrum 4	(X)	<b>W</b> 100 kHz	Mode Aut	o FFT 1[1]			904 - 928	20.98 dBm .5920 MHz 33.64 dBm .0000 MHz
Ref Level           Att           TDF           • 1AP Max           1           20 dBm           10 dBm           • 0 dBm           • 10 dBm           • 10 dBm           • 20 dBm           • 20 dBm           • -20 dBm           • -38, dBm           • -30, dBm           • -30, dBm           · 50 dBm           · 60 dBm           · 60 dBm           · 700 dBm           · 700 dBm	30.00 dBm 50 dB	ectrum 4 SWT 37.9	× P μs VB	W 100 kHz W 300 kHz	Mode Aut M M	o FFT 1[1] 2[1]			904 - 928	20.98 dBm .5920 MHz 33.64 dBm .0000 MHz
Ref Level           Att           TDF           1AP Max           1           20 dBm           10 dBm           0 dBm           -10 dBm           -20 dBm           -20 dBm           -30,dBm           -40 dBm           -50 dBm           -60 dBm           Marker           Type           M1	30.00 dBm 50 dB	ectrum 4 SWT 37.9	корона (С. 1975) конструкций (С. 1975) конструки (С. 1975) конструки (С. 1975) констру	W 100 kHz W 300 kHz	Mode Aut M M M	o FFT 1[1] 2[1]			904 - 928 	20.98 dBm .5920 MHz 33.64 dBm .0000 MHz
Ref Level           Att           TDF           • 1AP Max           1           20 dBm           10 dBm           • 0 dBm           • 10 dBm           • 10 dBm           • 20 dBm           • 20 dBm           • -20 dBm           • -38, dBm           • -30, dBm           • -30, dBm           · 50 dBm           · 60 dBm           · 60 dBm           · 700 dBm           · 700 dBm	30.00 dBm 50 dB	ectrum 4 SWT 37.9	× P μs VB	W 100 kHz W 300 kHz	Mode Aut M M M	o FFT 1[1] 2[1]			904 - 928 	20.98 dBm .5920 MHz 33.64 dBm .0000 MHz

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Spectrum	R	eceiver 🗴				
Ref Level 3	0.00 dBm		<b>RBW</b> 100 kHz			
Att	50 dB	5 <b>SWT</b> 18.8 μs 👄 '	<b>VBW</b> 300 kHz	Mode Auto FFT	Input 1 AC	
PS TDF		•			-	
⊖1AP Max						
				M1[1]		21.25 dBm
00 40						902.1400000 MH
20 dBm				M2[1]		-6.04 dBm
10 dBm						902.000000 MHz
0 dBm						
U UBIII						MZ
-10 dBm						
-10 000						
-20 dBm——						
-20 ubm						
-30 dBm		M3				
-So abiii		Y North Contraction				
-40 dBm						
10 dbiir						
-50 dBm						
oo abiii						
-60 dBm						
00 0011						
Start 901.0	MHz		32000	pts		Stop 902.14 MHz
Marker						
Type Ref		X-value	Y-value	Function	Fun	ction Result
M1	1	902.14 MHz	21.25 dBn			
M2	1	902.0 MHz	-6.04 dBn			
МЗ	1	901.407459 MHz	-33.75 dBn			]
		Fig B6 Scan I	ower band edge	conducted non Ho	pping Mode	

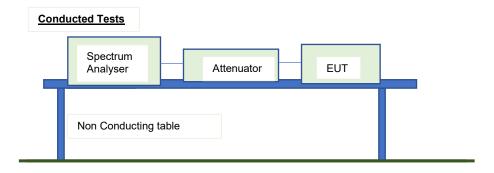
Spectrum	Re	ceiver 🙁						
Ref Level 3			RBW 100 kHz					
Att	50 dB	<b>SWT</b> 37.9 µs 👄	<b>VBW</b> 300 kHz	Mode Aut	oFFT In	put 1 AC		
PS TDF								
		1		5.4	1511			21.25 dBm
11				I¥I	1[1]			71730 MHz
20 dBm——				M	2[1]			39.25 dBm
					~[*]			00000 MHz
10 dBm——								
0 dBm								
ų asm								
-10 dBm								
10 dbm								
-20 dBm								
5								
-30 dBm ——								
malan	100 0	mannon		A			4 000 0	M2 M
-40 dBm	ALL THE MONTH	all we are a second as a second as	1 mar - and	and the second	and a start with the start of t	Alex frances of and the	and the address	Mr. Way Marine
-50 dBm								
co do-s								
-60 dBm								
Start 904.5	MHz		3200	) pts			Stop 9	930.0 MHz
Marker								
	Trc	X-value	Y-value	Func	tion	Fund	ction Result	
M1	1	904.67173 MHz	21.25 dB	er son en				
M2	1	928.0 MHz	-39.25 dB					
МЗ	1	930.0 MHz	-38.39 dB					
		Fig B7 Scan l	Jpper band edge	conducted	non Hoppii	ng mode		

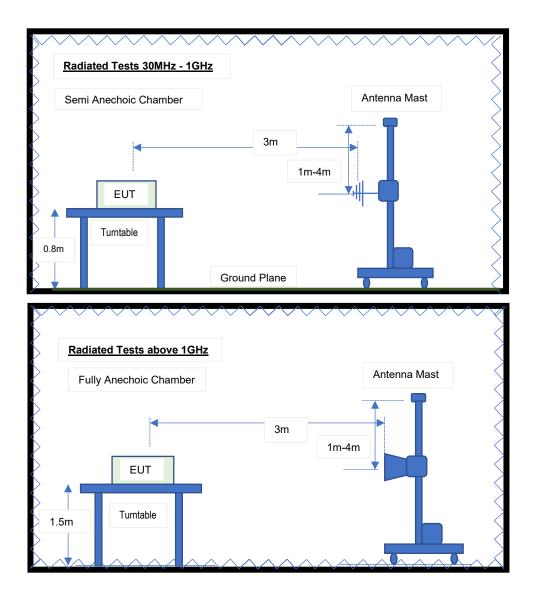
## Appendix C



**Orientations for Radiated Emissions** 

### Appendix D Block Diagrams of test set up





## Appendix E

### Summary of Antennas and EUT samples

The EUT contained transmitters using Sigfox and BLE technology. All antennas were internal.

The Sigfox antenna was a folded metal antenna and the BLE antenna was a printed antenna..

All conducted tests were performed on EUT sample labelled "Sample Y" All radiated tests were performed on EUT sample labelled "Sample Z"

### 1 Antenna 902-904MHz (Sigfox)

1.1 Antenna Details Pcb antenna Gain 3.86 dBi Impedance 50Ω

1.2 All Radiated tests on Sigfox were performed with the antenna above (unit labelled "Sample Y")

1.3 All Conducted tests on Sigfox were performed with the antenna above replaced by cable and SMA connector (unit labelled "Sample Z")

### 2 Antenna 2.4GHz (BLE antenna on main pcb)

2.1 Antenna Details

Pcb antenna Gain 0.9dBi Impedance 50Ω

2.2 All Radiated tests on BLE pcb antenna were performed with the antenna above (unit labelled "Sample Y")

2.3 All Conducted tests on BLE were performed with the antenna above replaced by cable and SMA connector (unit labelled "Sample Z")

### **End of Report**