FCC and ISED Test Report

Reelables, Inc.
Model: N-Label

In accordance with FCC 47 CFR Part 27, FCC CFR 47 Part 2 and ISED RSS-130 and ISED RSS-GEN

(LTE NB-IOT)

Prepared for: Reelables, Inc.
113 Cherry St. 76660,
Seattle,
Washington
United States 98104

FCC ID: 2A7TQRN0001 IC: 33042-RN0001

COMMERCIAL-IN-CONFIDENCE

Document 75961990-03 Issue 02

SIGNATURE			
S. MM			
NAME	**JOB TITLE**	**RESPONSIBLE FOR**	**ISSUE DATE**
Steve Marshall	Senior Engineer	Authorised Signatory	21 January 2025

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT

The measurements shown in this report were made in accordance with the procedures described on test pages. All reported testing was carried out on a sample equipment to demonstrate limited compliance with FCC 47 CFR Part 27, FCC CFR 47 Part 2 and ISED RSS-130 and ISED RSS-GEN. The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Thomas Biddlecombe	21 January 2025	
Testing	Phoebe Doyle	21 January 2025	P. Doyle

FCC Accreditation
492497/UK2010 Octagon House, Fareham Test Laboratory

ISED Accreditation
12669A/UK0003 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 27: 2023, FCC CFR 47 Part 2: 2023, ISED RSS-130: Issue 2 (02-2019) and ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021) for the tests detailed in section 1.3.

TÜV SÜD
is a trading name of TUV SUD Ltd
Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TUV SUD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuvsud.com/en

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom

Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	06 January 2025
2	Update to FCC ID, Antenna Gain, Device Category and Output Power	21 January 2025

Table 1

1.2 Introduction

Applicant	Reelables, Inc.
Manufacturer	Reelables Europe, Ltd.
Model Number(s)	N-Label
Serial Number(s)	RAD 1 CON 1
Hardware Version(s)	5.61
Software Version(s)	1.11
Number of Samples Tested	2
Test Specification/Issue/Date	FCC 47 CFR Part 27: 2023 FCC CFR 47 Part 2: 2023 ISED RSS-130: Issue 2 (02-2019) ISED RSS-GEN: Issue 5 (04-2018) + A2 (02-2021)
Order Number Date	15018 11-July-2024
Date of Receipt of EUT	10-September-2024
Start of Test	09-September-2024
Finish of Test	11-October-2024
Name of Engineer(s)	Thomas Biddlecombe Phoebe Doyle
Related Document(s)	ANSI C63.26 (2015) KDB 971168 D01 v03r01

1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 27, FCC CFR 47 Part 2 and ISED RSS-130 and ISED RSS-GEN is shown below.

Section	Specification Clause				Test Description	Result	Comments/Base Standard
	Part 27	Part 2	RSS-130	RSS-GEN			
Configuration and Mode: LTE FDD B12							
2.1	27.50	2.1046	4.6	6.12	Maximum Conducted Output Power	Pass	ANSI C63.26: 2015
2.2		2.1047(d)	4.2		Modulation Characteristics	Pass	
2.3		2.1049		6.7	Occupied Bandwidth	Pass	ANSI C63.26: 2015
2.4	27.53	2.1051	4.7		Spurious Emissions at Band Edge	Pass	ANSI C63.26: 2015
2.5	27.53	2.1053	4.7	6.13	Radiated Spurious Emissions	Pass	ANSI C63.26: 2015
2.6	27.54	2.1055	4.5	6.11	Frequency Stability	Pass	ANSI C63.26: 2015

Table 2

1.4 Application Form

Equipment Description

Technical Description: *(Please provide a brief description of the intended use of the equipment including the technologies the product supports)*	The N-Label from Reelables is an NB-IoT cellular device in the form factor of a thin 4x8" shipping label. It tracks the location of parcels and cargo using cell tower positioning and WiFi SSID scanning only. The intended use is a stickable label to corrugated paper cartons or other shippable containers. The N-Label comprises the following wireless technologies: NB-IoT, Bluetooth, WiFi (RX scan only) and NFC (passive).		
Manufacturer:	Reelables Europe, Ltd.		
Model:	N-Label		
Part Number:	N0001		
Hardware Version:	5.61		
Software Version:	1.11		
FCC ID of the product under test – see guidance here		FCC:2A7TQRN0001	
IC ID of the product under test – see guidance here		IC:33042-RN0001	
Device Category	Mobile ☐	Portable ☒	Fixed ☐
Equipment is fitted with an Audio Low Pass Filter		Yes ☐	No ☒

Table 3

Intentional Radiators

Technology	NB-IoT Band 13	NB-IoT Band 12	NB-IoT Band 5	Bluetooth Low Energy		
Frequency Range (MHz to MHz)	777MHz-787MHz	698MHz-716MHz	824MHz-849MHz	2400MHz-2483.5MHz		
Conducted Declared Output Power (dBm)	10dBm	20dBm	18dBm	2.5dBm		
Antenna Gain (dBi)	-0.4	-0.43	-2.07	2.14		
Supported Bandwidth(s) (MHz) (e.g. 1 MHz, 20 MHz, 40 MHz)	200KHz	200KHz	200KHz	1, 2		
Modulation Scheme(s) (e.g. GFSK, QPSK etc)	QPSK BPSK	QPSK BPSK	QPSK BPSK	GFSK		
ITU Emission Designator (see guidance here) (not mandatory for Part 15 devices)				1M00GXW, 2M00GXW		
Bottom Frequency (MHz)	777.0	701.5	826.5	2402		
Middle Frequency (MHz)	782.0	707.5	836.5	2440		
Top Frequency (MHz)	787.0	713.5	846.5	2480		

Table 4

Un-intentional Radiators

Highest frequency generated or used in the device or on which the device operates or tunes	2483.5MHz
Lowest frequency generated or used in the device or on which the device operates or tunes	699MHz
Class A Digital Device (Use in commercial, industrial or business environment) ☒ Class B Digital Device (Use in residential environment only) ☐	

Table 5

AC Power Source

AC supply frequency:	NA	Hz
Voltage	NA	V
Max current:	NA	A
Single Phase ☐ Three Phase ☐		

Table 6

DC Power Source

Nominal voltage:	NA	V
Extreme upper voltage:	NA	V
Extreme lower voltage:	NA	V
Max current:	NA	A

Table 7

Battery Power Source

Voltage:	4.5	V
End-point voltage:	2.2	V *(Point at which the battery will terminate)*
Alkaline ☐ Leclanche ☐ Lithium ☐ Nickel Cadmium ☐ Lead Acid* ☐ **(Vehicle regulated)*		
Other ☒ Zinc-carbon Please detail:	Zn-MnO2 coated battery	

Table 8

Charging

Can the EUT transmit whilst being charged	Yes ☐ No ☒

Table 9

Temperature

Minimum temperature:	-20	°C
Maximum temperature:	50	°C

Table 10

Cable Loss

Adapter Cable Loss (Conducted sample)	0.9	dB

Table 11

Antenna Characteristics

Antenna connector ☐			State impedance		Ohm
Temporary antenna connector ☐			State impedance		Ohm
Integral antenna ☒	Type:	PIFA	Gain	See above	dBi
External antenna ☐	Type:		Gain		dBi
For external antenna only: Standard Antenna Jack ☐ If yes, describe how user is prohibited from changing antenna (if not professional installed): Equipment is only ever professionally installed ☐ Non-standard Antenna Jack ☐ All part 15 applications will need to show how the antenna gain was derived either from a manufacturer data sheet or a measurement. Where the gain of the antenna is inherently accounted for as a result of the measurement, such as field strength measurements on a part 15.249 or 15.231 device, so the gain does not necessarily need to be verified. However, enough information regarding the construction of the antenna shall be provided. Such information maybe photographs, length of wire antenna etc.					

Table 12

Ancillaries (if applicable)

Manufacturer:		Part Number:	
Model:		Country of Origin:	

Table 13

I hereby declare that the information supplied is correct and complete.

Name: Brian Krejcarek
Position held: CEO
Date: January 16, 2025

1.5 Product Information

1.5.1 Technical Description

The N-Label from Reelables is an NB-IoT cellular device in the form factor of a thin 4x8" shipping label. It tracks the location of parcels and cargo using cell tower positioning and WiFi SSID scanning only. The intended use is a stickable label to corrugated paper cartons or other shippable containers. The N-Label comprises the following wireless technologies: NB-IoT, Bluetooth, WiFi (RX scan only) and NFC (passive).

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Model: , Serial Number:			
0	As supplied by the customer	Not Applicable	Not Applicable
Model: , Serial Number:			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 14

1.8 Test Location

TÜV SÜD conducted the following tests at our Octagon House Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: LTE FDD B12		
Maximum Conducted Output Power	Thomas Biddlecombe	UKAS
Occupied Bandwidth	Thomas Biddlecombe	UKAS
Spurious Emissions at Band Edge	Thomas Biddlecombe	UKAS
Radiated Spurious Emissions	Phoebe Doyle	UKAS
Modulation Characteristics	Thomas Biddlecombe	UKAS
Frequency Stability	Thomas Biddlecombe	UKAS

Table 15

Office Address:

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire
PO15 5RL
United Kingdom

2 Test Details

2.1 Maximum Conducted Output Power

2.1.1 Specification Reference

FCC 47 CFR Part 27.50
FCC 47 CFR Part 2.1046
ISED RSS-130 Clause 4.6
ISED RSS-GEN Clause 6.12

2.1.2 Equipment Under Test and Modification State

S/N: CON 1 - Modification State 0

2.1.3 Date of Test

10-September-2024

2.1.4 Test Method

The test was performed in accordance with KDB 971168 D01 v03r01, Clause 5.2.2.

The ERP was calculated using the following formula:
Average Power (conducted) + Antenna Gain (-0.43dBi) – 2.15dB (conversion from EIRP to ERP).

EUT was powered by 3x 1.5V battery cells.

2.1.5 Environmental Conditions

Ambient Temperature	21.4 °C
Relative Humidity	56.2 %

2.1.6 Test Results

LTE FDD B12

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	Average Power (dBm)	ERP (dBm)	PAPR (dB)
23035	701.5	π/2-BPSK	3.75	1	0	0	18.95	16.37	3.57
23035	701.5	π/2-BPSK	3.75	1	47	0	19.77	17.19	3.50
23035	701.5	π/2-BPSK	15	1	0	0	20.14	17.56	3.32
23035	701.5	π/2-BPSK	15	1	11	0	19.29	16.71	3.32
23035	701.5	π/4-QPSK	3.75	1	0	3	18.93	16.35	3.57
23035	701.5	π/4-QPSK	3.75	1	47	3	19.60	17.02	3.48
23035	701.5	π/4-QPSK	15	1	0	3	20.23	17.65	3.24
23035	701.5	π/4-QPSK	15	1	11	3	19.62	17.04	3.20
23035	701.5	QPSK	15	3	0	5	20.57	17.99	4.67
23035	701.5	QPSK	15	3	6	5	20.27	17.69	4.94
23035	701.5	QPSK	15	6	0	5	21.04	18.46	5.18
23035	701.5	QPSK	15	6	6	5	21.95	19.37	5.10
23035	701.5	QPSK	15	12	0	5	20.86	18.28	4.87

Table 16 - Maximum Conducted Output Power, Bottom Channel

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	Average Power (dBm)	ERP (dBm)	PAPR (dB)
23095	707.5	π/2-BPSK	3.75	1	0	0	18.97	16.39	3.85
23095	707.5	π/2-BPSK	3.75	1	47	0	19.64	17.06	3.72
23095	707.5	π/2-BPSK	15	1	0	0	20.28	17.70	3.34
23095	707.5	π/2-BPSK	15	1	11	0	19.20	16.62	3.35
23095	707.5	π/4-QPSK	3.75	1	0	3	18.94	16.36	3.58
23095	707.5	π/4-QPSK	3.75	1	47	3	19.64	17.06	3.46
23095	707.5	π/4-QPSK	15	1	0	3	20.21	17.63	3.26
23095	707.5	π/4-QPSK	15	1	11	3	19.38	16.80	3.25
23095	707.5	QPSK	15	3	0	5	20.52	17.94	4.61
23095	707.5	QPSK	15	3	6	5	20.25	17.67	4.76
23095	707.5	QPSK	15	6	0	5	21.06	18.48	5.35
23095	707.5	QPSK	15	6	6	5	21.78	19.20	5.25
23095	707.5	QPSK	15	12	0	5	21.07	18.49	5.07

Table 17 - Maximum Conducted Output Power, Middle Channel

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	Average Power (dBm)	ERP (dBm)	PAPR (dB)
23155	713.5	π/2-BPSK	3.75	1	0	0	18.78	16.20	3.82
23155	713.5	π/2-BPSK	3.75	1	47	0	19.51	16.93	3.80
23155	713.5	π/2-BPSK	15	1	0	0	20.11	17.53	3.35
23155	713.5	π/2-BPSK	15	1	11	0	19.16	16.58	3.36
23155	713.5	π/4-QPSK	3.75	1	0	3	18.85	16.27	3.62
23155	713.5	π/4-QPSK	3.75	1	47	3	19.61	17.03	3.52
23155	713.5	π/4-QPSK	15	1	0	3	20.17	17.59	3.28
23155	713.5	π/4-QPSK	15	1	11	3	19.40	16.82	3.23
23155	713.5	QPSK	15	3	0	5	19.50	16.92	4.35
23155	713.5	QPSK	15	3	6	5	20.49	17.91	4.46
23155	713.5	QPSK	15	6	0	5	20.02	17.44	5.46
23155	713.5	QPSK	15	6	6	5	21.03	18.45	5.35
23155	713.5	QPSK	15	12	0	5	21.79	19.21	5.26

Table 18 - Maximum Conducted Output Power, Top Channel

FCC 47 CFR Part 27, Limit Clause 50

Clause	Requirement
27.50(c)(9)(10)	Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.

Table 19 - FCC Part 27 Limit

The peak-to-average power ratio (PAPR) of the transmitter output power must not exceed 13 dB.

ISED RSS-130, Limit Clause 4.6

The transmitter output power shall be measured in terms of average power. In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time and shall use a signal corresponding to the highest PAPR during periods of continuous transmission.

Clause	Requirement
4.6.3	The e.r.p. shall not exceed 30 watts for mobile equipment and outdoor fixed subscriber equipment. The e.r.p. shall not exceed 3 watts for portable equipment and indoor fixed subscriber equipment.

Table 20 - RSS-130 Limit

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Directional Coupler	Krytar	1850	58	-	TU
Attenuator Switch Driver	Hewlett Packard	11713A	1083	-	TU
Attenuator (11dB, 1W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110dB, 1W)	Hewlett Packard	8496H	2786	6	O/P Mon
Hygrometer	Rotronic	I-1000	3220	12	28-Nov-2024
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	09-Mar-2025
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	18-Sep-2025
1m K-Type Cable	Junkosha	MWX221/B	5908	12	10-Jun-2025
2m Coaxial Cable Assy	Junkosha	MWX221-02000AMSAMS/A	6357	12	14-May-2025
Spectrum Analyser	Anritsu	MT8821C	6542	12	28-Jun-2025
Attenuator 5W 20dB DC-18GHz	Aaren	AT40A-4041-D18-20	6557	12	18-Jun-2025
Cable N to N 1m	Junkosha	MWX221-01000NMSN/B	6776	12	15-Apr-2025

Table 21

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.2 Modulation Characteristics

2.2.1 Specification Reference

FCC 47 CFR Part 2.1047 (d)
RSS-130 Clause 4.2

2.2.2 Equipment Under Test and Modification State

S/N: CON 1 - Modification State 0

2.2.3 Date of Test

11-September-2024

2.2.4 Test Method

The test was performed in accordance with KDB 971168 D01 v03r01, Clause 3.

EUT was powered by 3x 1.5V battery cells.

2.2.5 Environmental Conditions

Ambient Temperature	19.4 °C
Relative Humidity	45.8 %

2.2.6 Test Results

LTE FDD B12

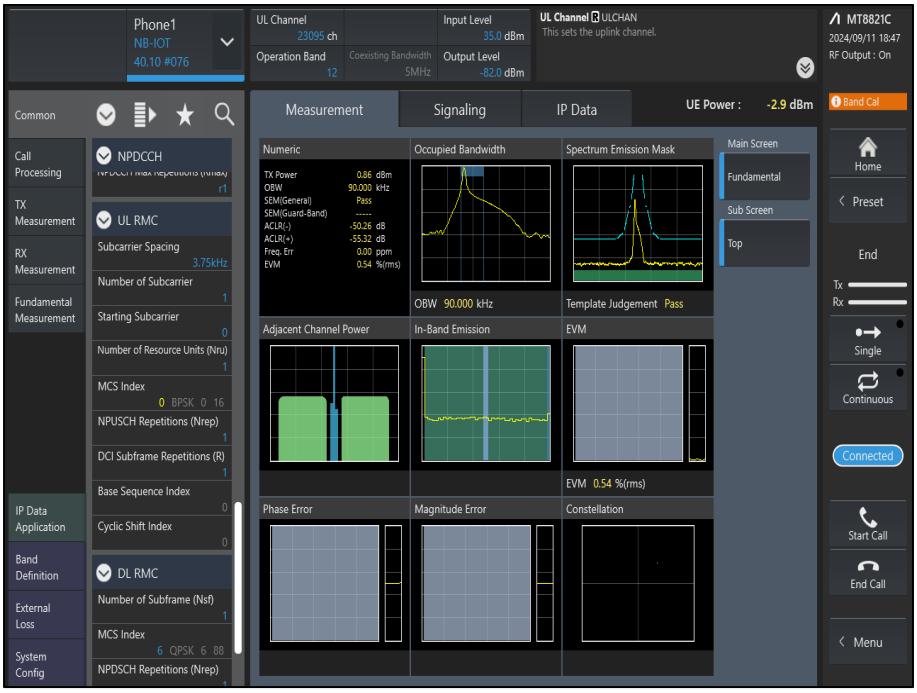

Figure 1 - π/2 BPSK MCS0

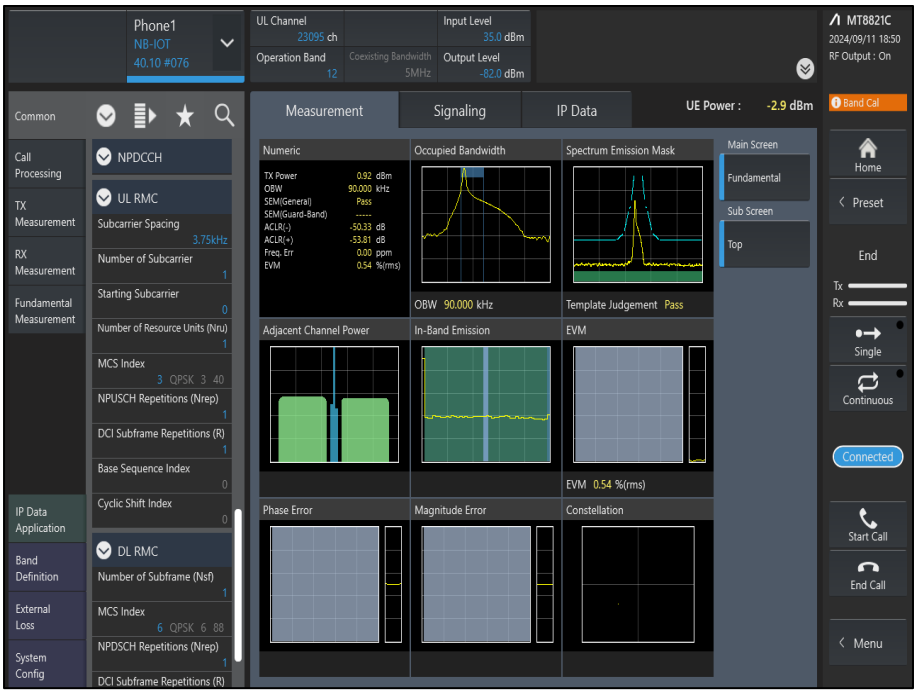

Figure 2 - π/4 QPSK MCS3

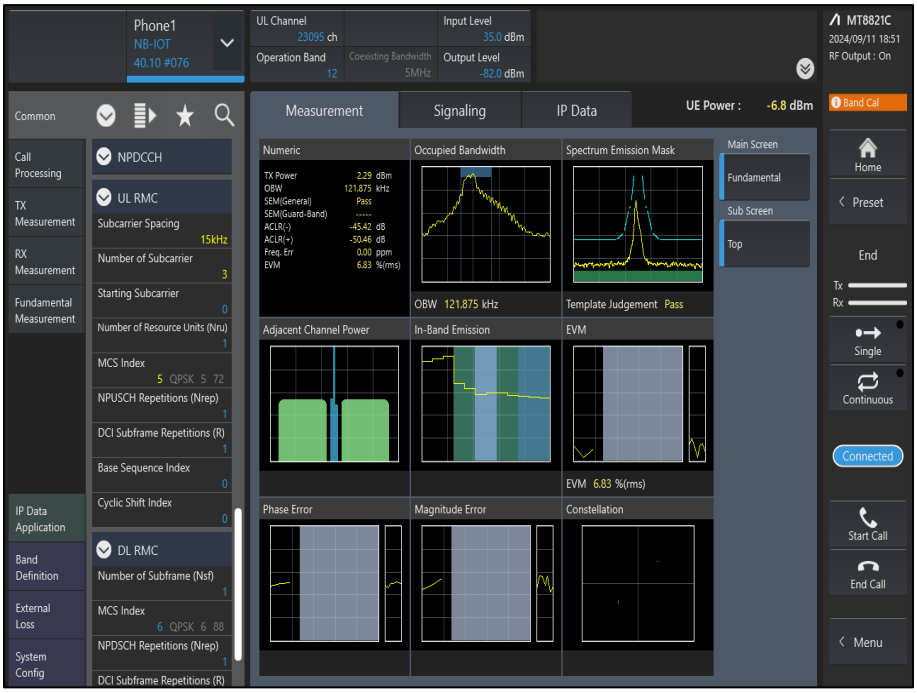

Figure 3 - QPSK MCS5

FCC 47 CFR Part 2, Limit Clause 2.1047 (d),

A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

RSS-130, Limit Clause 4.2

Equipment certified under this standard shall employ digital modulation.

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Directional Coupler	Krytar	1850	58	-	TU
Attenuator Switch Driver	Hewlett Packard	11713A	1083	-	TU
Attenuator (11dB, 1W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110dB, 1W)	Hewlett Packard	8496H	2786	6	O/P Mon
Thermocouple Thermometer	Fluke	51	3173	12	31-May-2025
Hygrometer	Rotronic	I-1000	3220	12	28-Nov-2024
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	09-Mar-2025
3 GHz High Pass Filter	RLC Electronics	F-100-3000-5-R	5228	12	18-Feb-2025
Climatic Chamber	Weiss Technik	TempEvent T/180/40/3	5894	12	15-Aug-2024
1m K-Type Cable	Junkosha	MWX221/B	5908	12	10-Jun-2025
2m Coaxial Cable Assy	Junkosha	MWX221-02000AMSAMS/A	6357	12	14-May-2025
Spectrum Analyser	Anritsu	MT8821C	6542	12	28-Jun-2025
Attenuator 5W 20dB DC-18GHz	Aaren	AT40A-4041-D18-20	6557	12	18-Jun-2025
Cable N to N 1m	Junkosha	MWX221-01000NMSN/B	6776	12	15-Apr-2025

Table 22

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.3 Occupied Bandwidth

2.3.1 Specification Reference

FCC 47 CFR Part 2.1049
ISED RSS-GEN 6.7

2.3.2 Equipment Under Test and Modification State

S/N: CON 1 - Modification State 0

2.3.3 Date of Test

10-September-2024

2.3.4 Test Method

The test was performed in accordance with ANSI C63.26 5.4.3 and 5.4.4

EUT was powered by 3x 1.5V battery cells.

2.3.5 Environmental Conditions

Ambient Temperature	21.4 °C
Relative Humidity	56.2 %

2.3.6 Test Results

LTE FDD B12

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	26 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
23035	701.5	π/2-BPSK	15	1	0	0	0.1749	0.15162
23035	701.5	π/4-QPSK	15	1	0	3	0.1600	0.13735
23035	701.5	QPSK	15	12	0	5	0.2164	0.18908

Table 23 - Emission Bandwidth, Bottom Channel

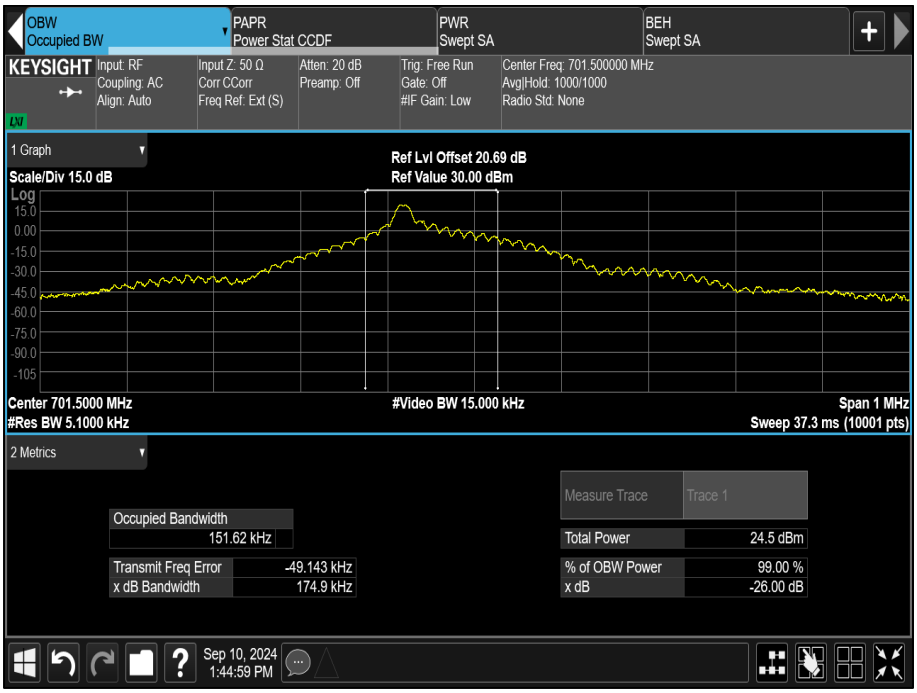

Figure 4 - Emission Bandwidth, 701.5 MHz, Modulation: π/2-BPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 0

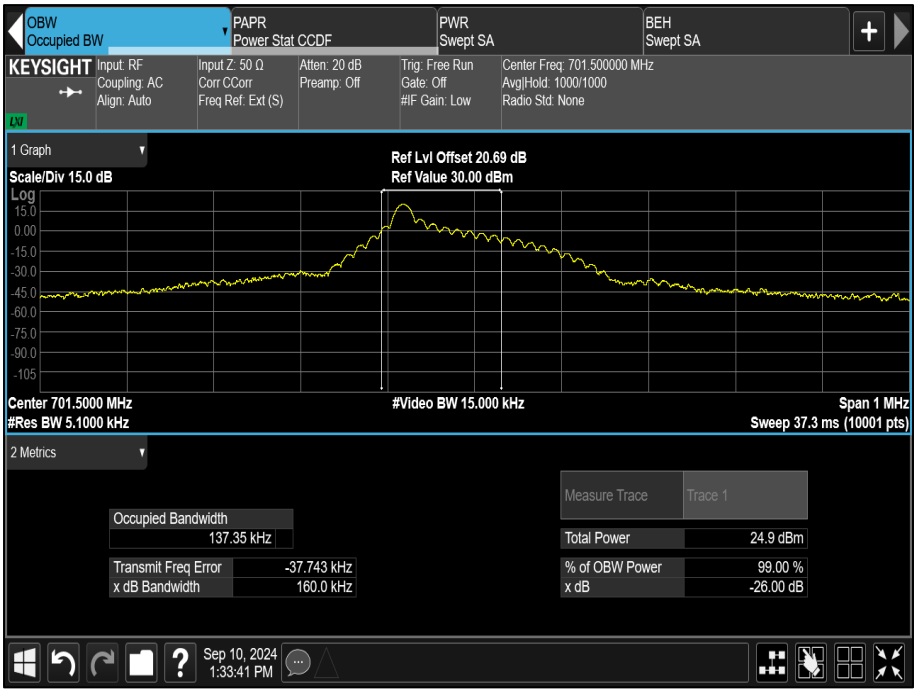

Figure 5 - Emission Bandwidth, 701.5 MHz, Modulation: π/4-QPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 0

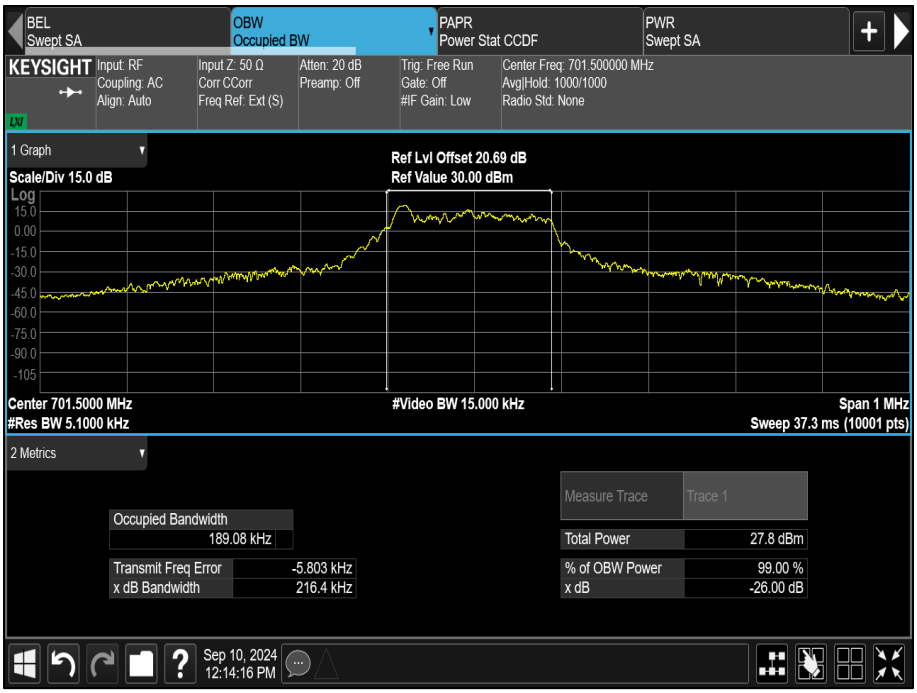

Figure 6 - Emission Bandwidth, 701.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 12, Start Sub-Carrier: 0

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	26 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
23095	707.5	π/2-BPSK	15	1	0	0	0.1757	0.15666
23095	707.5	π/4-QPSK	15	1	0	3	0.1605	0.13772
23095	707.5	QPSK	15	12	0	5	0.2153	0.19006

Table 24 - Emission Bandwidth, Middle Channel

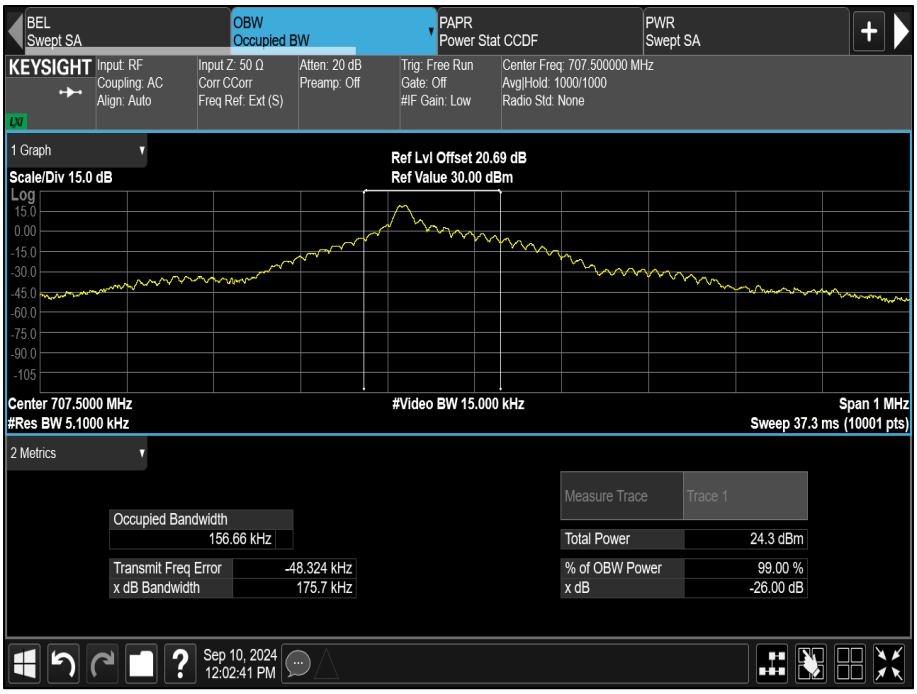

Figure 7 - Emission Bandwidth, 707.5 MHz, Modulation: π/2-BPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 0

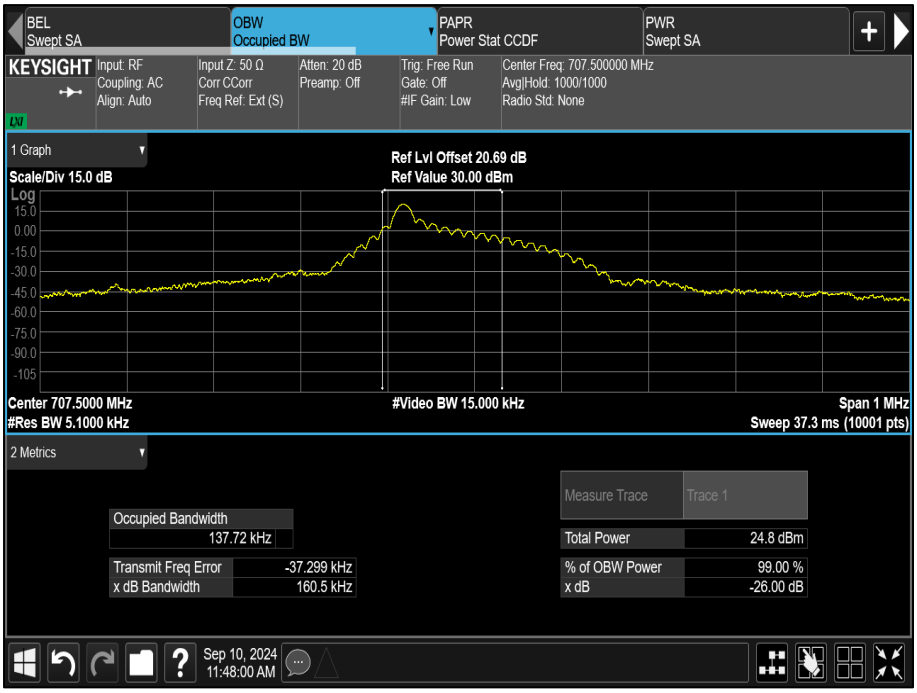

Figure 8 - Emission Bandwidth, 707.5 MHz, Modulation: π/4-QPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 0

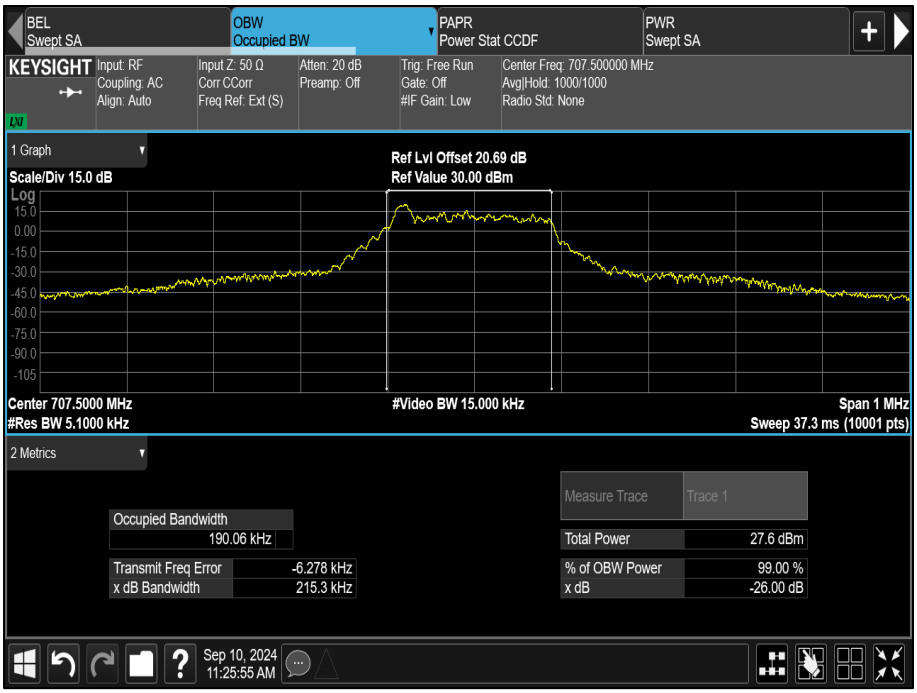

Figure 9 - Emission Bandwidth, 707.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 12, Start Sub-Carrier: 0

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	26 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
23155	713.5	π/2-BPSK	15	1	0	0	0.1761	0.15442
23155	713.5	π/4-QPSK	15	1	0	3	0.1601	0.13777
23155	713.5	QPSK	15	12	0	5	0.2158	0.18818

Table 25 - Emission Bandwidth, Top Channel

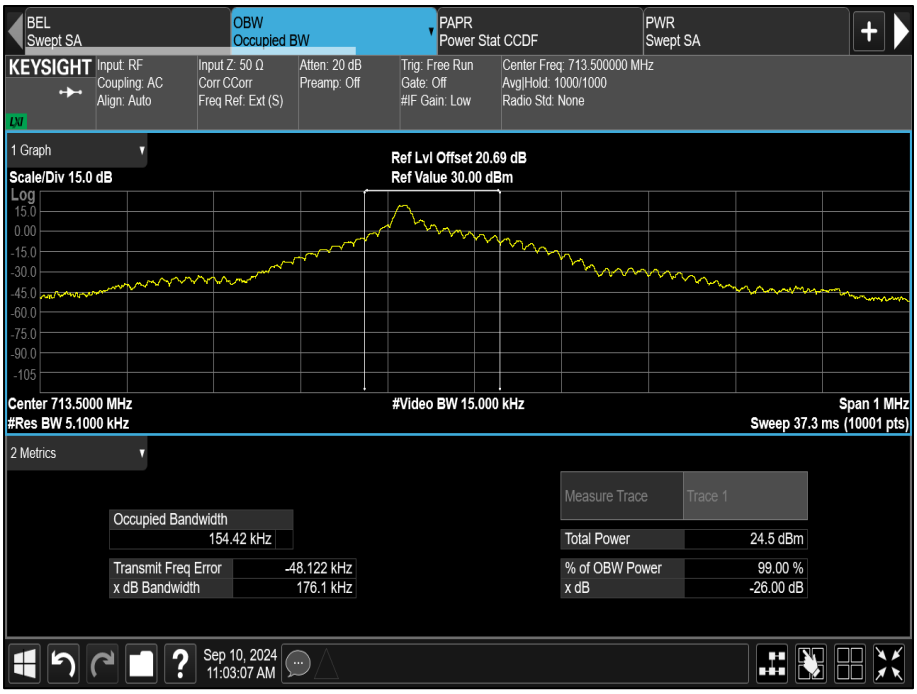

Figure 10 - Emission Bandwidth, 713.5 MHz, Modulation: π/2-BPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 0

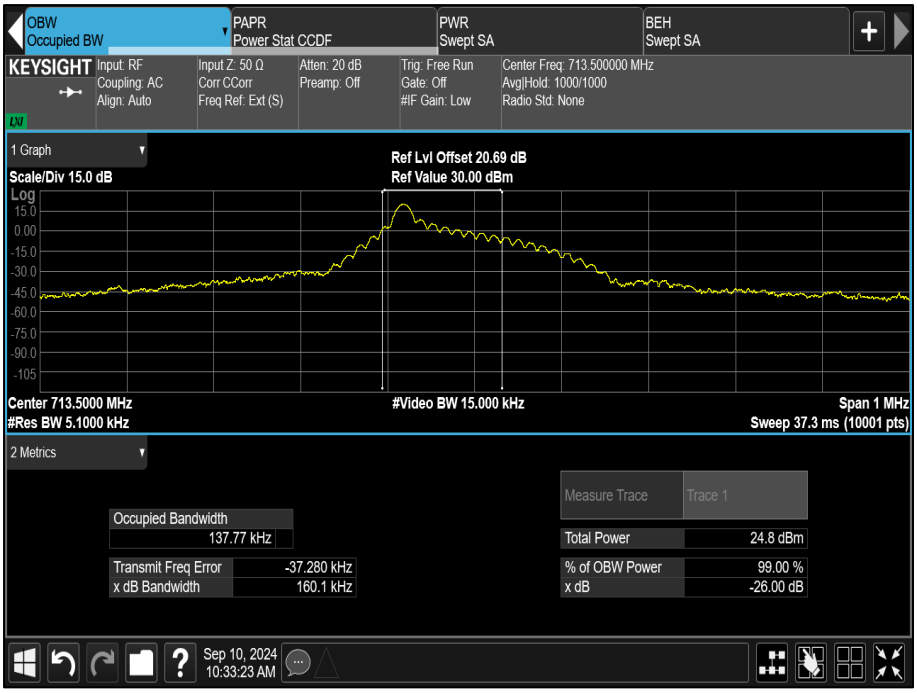

Figure 11 - Emission Bandwidth, 713.5 MHz, Modulation: π/4-QPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 0

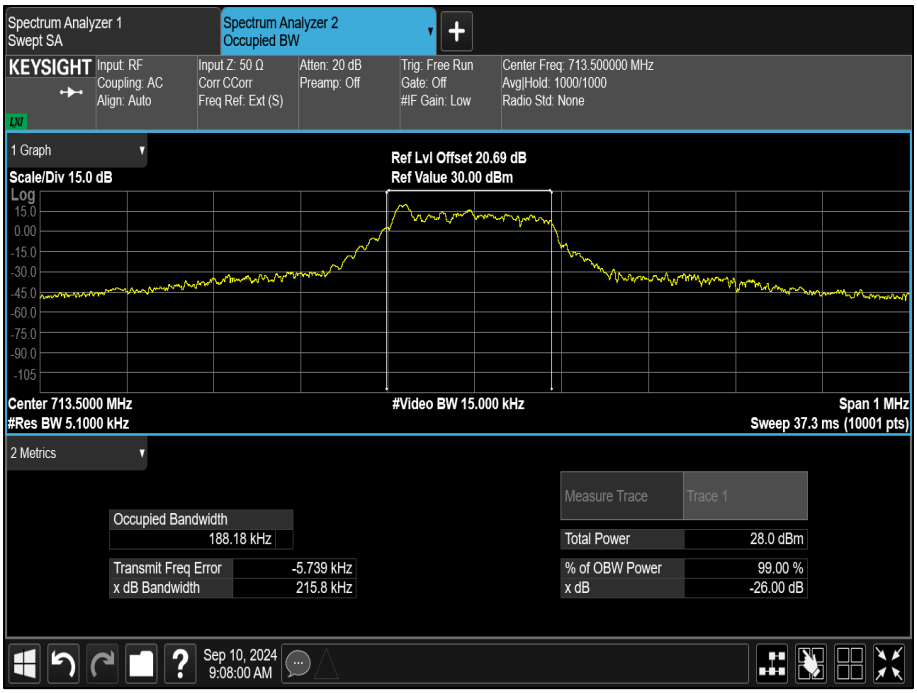

Figure 12 - Emission Bandwidth, 713.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 12, Start Sub-Carrier: 0

FCC 47 CFR Part 2.1049 and RSS-GEN

None specified.

2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Directional Coupler	Krytar	1850	58	-	TU
Attenuator Switch Driver	Hewlett Packard	11713A	1083	-	TU
Attenuator (11dB, 1W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110dB, 1W)	Hewlett Packard	8496H	2786	6	O/P Mon
Hygrometer	Rotronic	I-1000	3220	12	28-Nov-2024
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	09-Mar-2025
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	18-Sep-2025
1m K-Type Cable	Junkosha	MWX221/B	5908	12	10-Jun-2025
2m Coaxial Cable Assy	Junkosha	MWX221-02000AMSAMS/A	6357	12	14-May-2025
Spectrum Analyser	Anritsu	MT8821C	6542	12	28-Jun-2025
Attenuator 5W 20dB DC-18GHz	Aaren	AT40A-4041-D18-20	6557	12	18-Jun-2025
Cable N to N 1m	Junkosha	MWX221-01000NMSN/B	6776	12	15-Apr-2025

Table 26

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.4 Spurious Emissions at Band Edge

2.4.1 Specification Reference

FCC 47 CFR Part 27.53
FCC 47 CFR Part 2.1051
ISED RSS-130 Clause 4.7
ISED RSS-GEN Clause 6.13

2.4.2 Equipment Under Test and Modification State

S/N: CON 1 - Modification State 0

2.4.3 Date of Test

09-October-2024

2.4.4 Test Method

The test was performed in accordance with KDB 971168 D01 v03r01, Clause 6.

EUT was powered by 3x 1.5V battery cells.

2.4.5 Environmental Conditions

Ambient Temperature	22.8 °C
Relative Humidity	53.1 %

2.4.6 Test Results

LTE FDD B12

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	Level (dBm)
23035	701.5	π/2-BPSK	3.75	1	0	0	-24.38
23035	701.5	π/2-BPSK	15	1	0	0	-24.00
23035	701.5	QPSK	15	3	0	5	-18.28
23035	701.5	QPSK	15	12	0	5	-19.17

Table 27 - Lower Band Edge Results

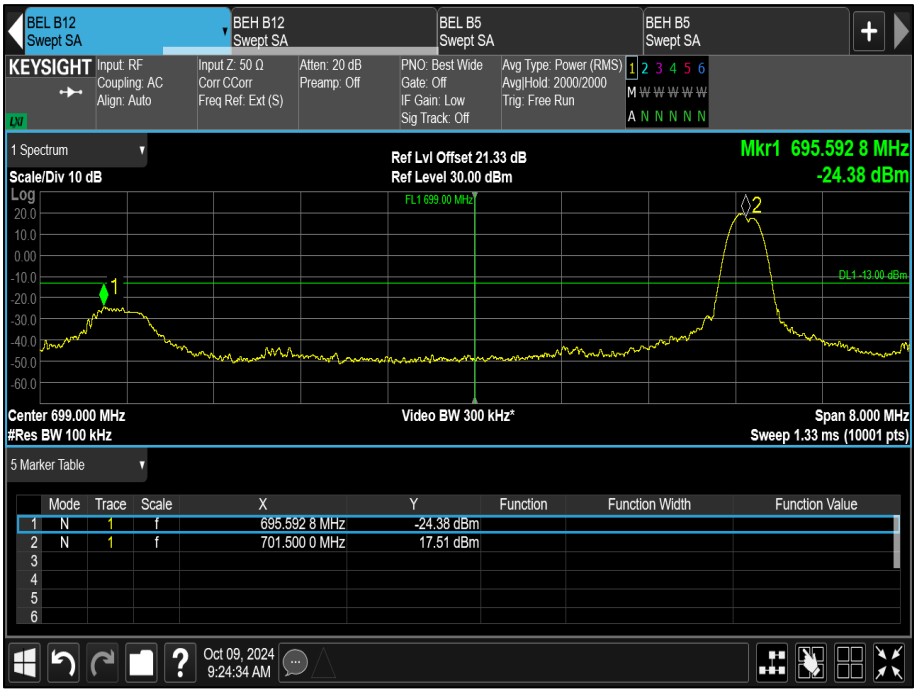

Figure 13 - Lower Band Edge, 701.5 MHz, Modulation: π/2-BPSK, SCS: 3.75 kHz, Tone Number: 1, Start Sub-Carrier: 0

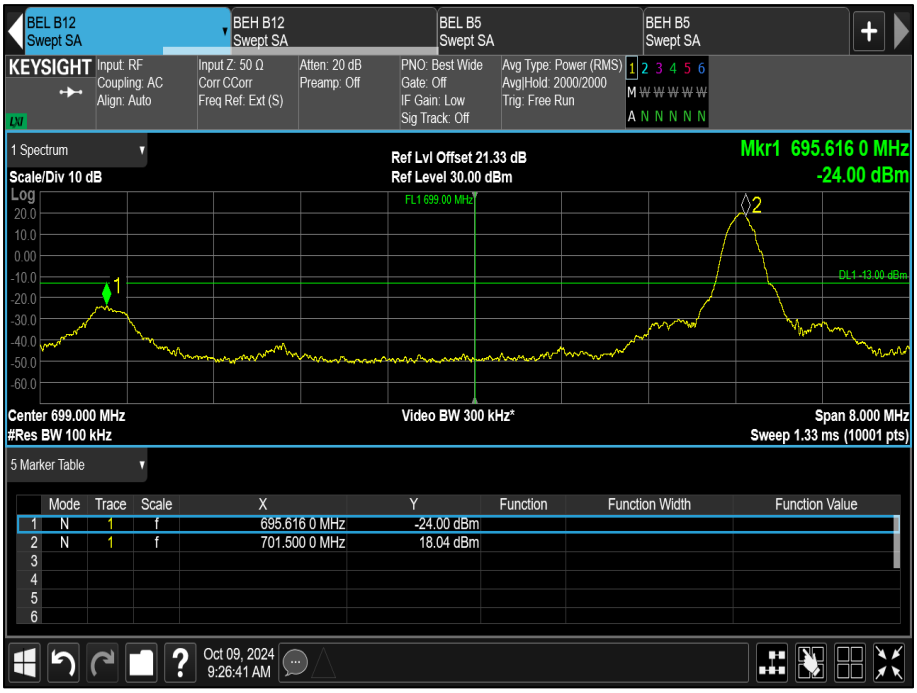

Figure 14 - Lower Band Edge, 701.5 MHz, Modulation: π/2-BPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 0

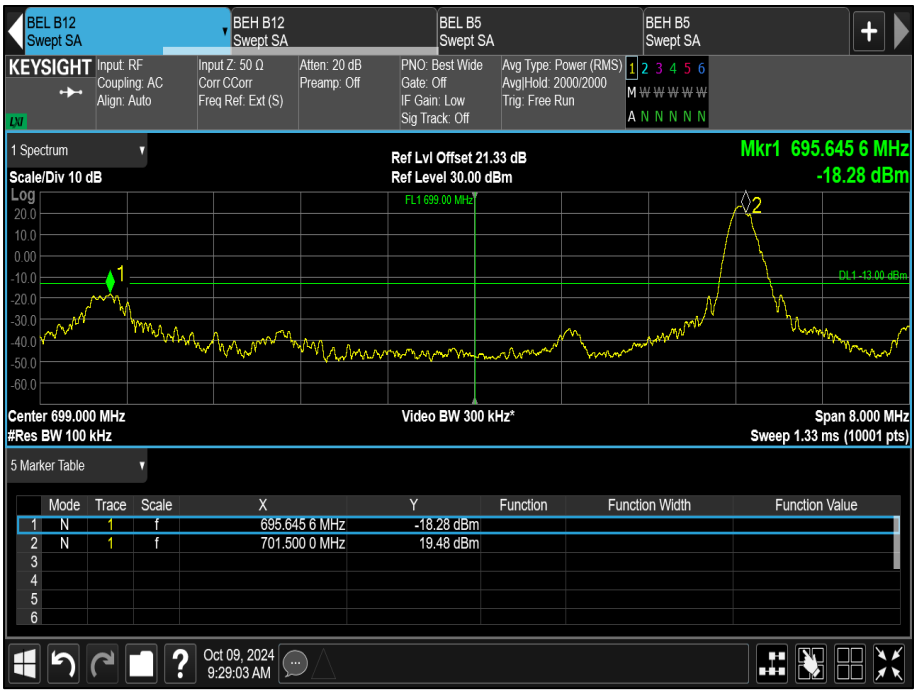

Figure 15 - Lower Band Edge, 701.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 3, Start Sub-Carrier: 0

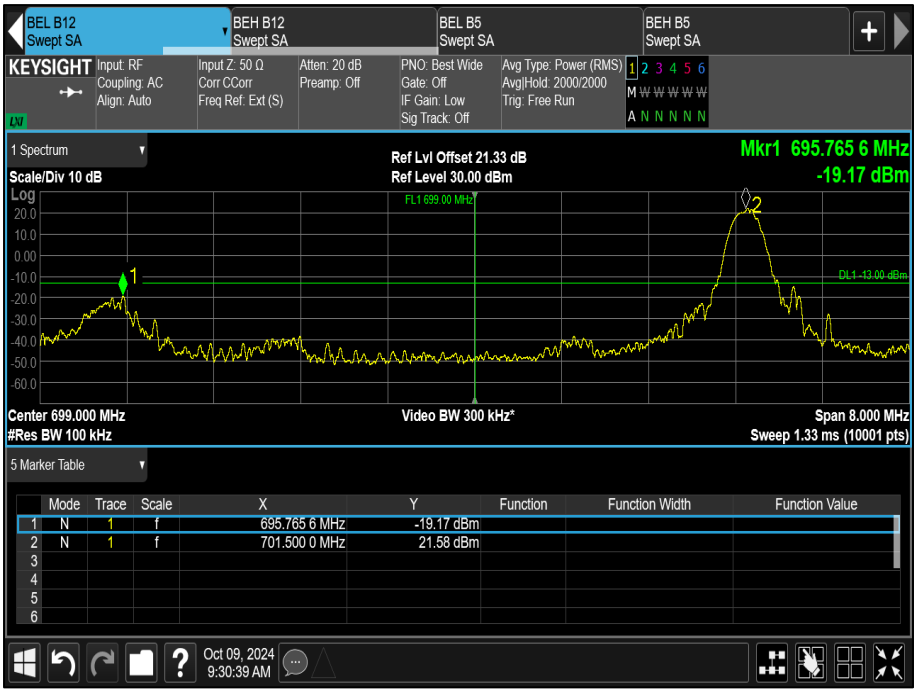

Figure 16 - Lower Band Edge, 701.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 12, Start Sub-Carrier: 0

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	Level (dBm)
23155	713.5	π/2-BPSK	3.75	1	47	0	-24.60
23155	713.5	π/2-BPSK	15	1	11	0	-23.96
23155	713.5	QPSK	15	3	6	5	-18.15
23155	713.5	QPSK	15	12	0	5	-22.43

Table 28 - Upper Band Edge Results

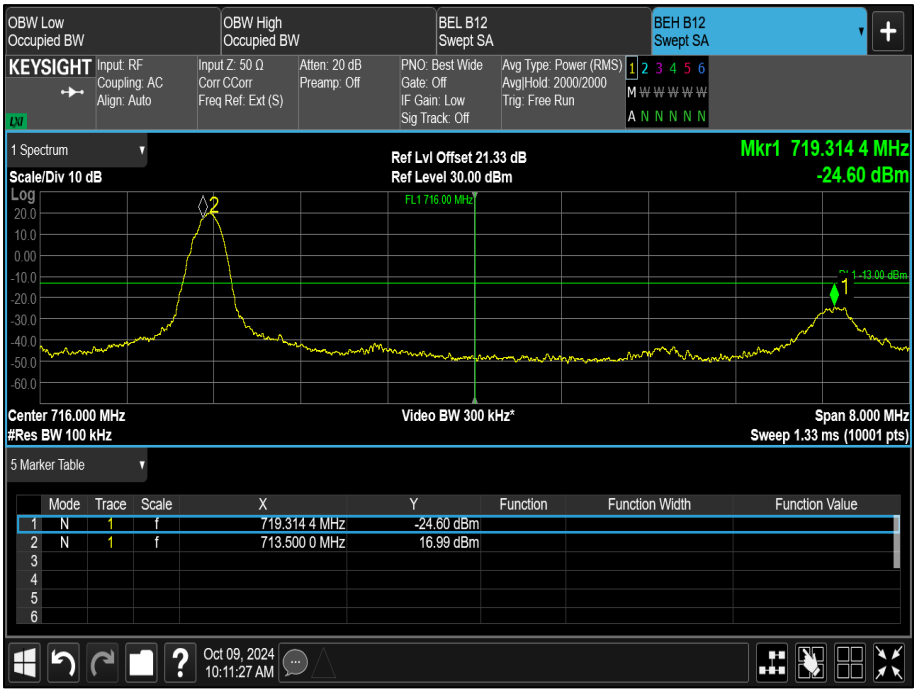

Figure 17 - Upper Band Edge, 713.5 MHz, Modulation: π/2-BPSK, SCS: 3.75 kHz, Tone Number: 1, Start Sub-Carrier: 47

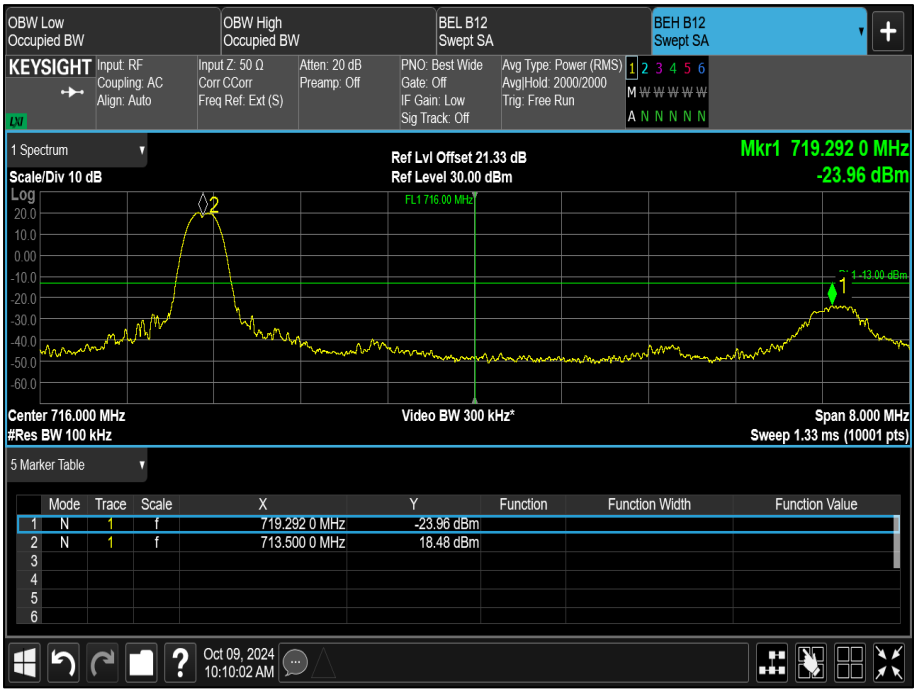

Figure 18 - Upper Band Edge, 713.5 MHz, Modulation: π/2-BPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 11

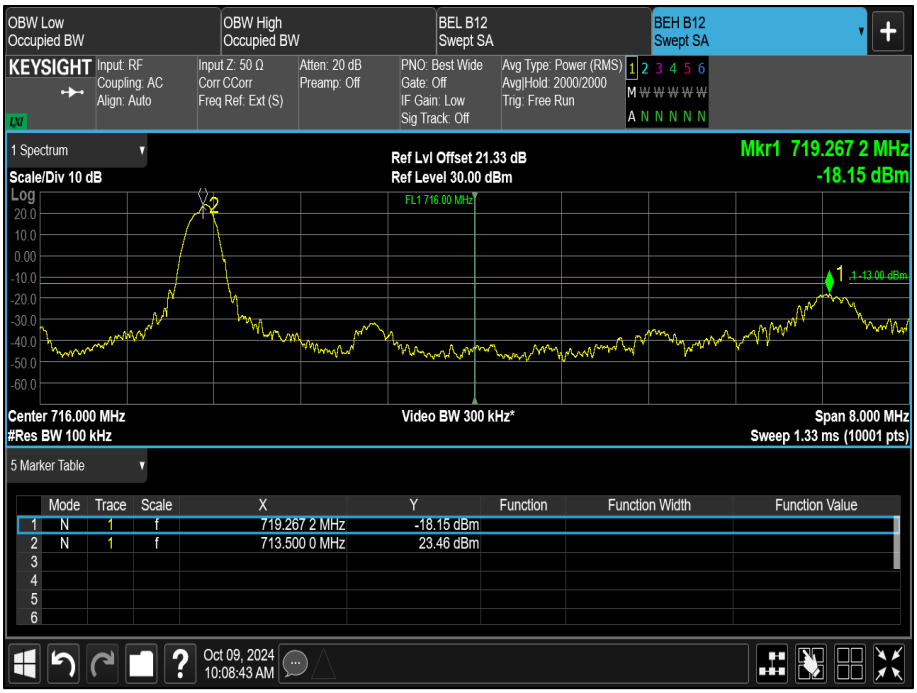

Figure 19 - Upper Band Edge, 713.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 3, Start Sub-Carrier: 6

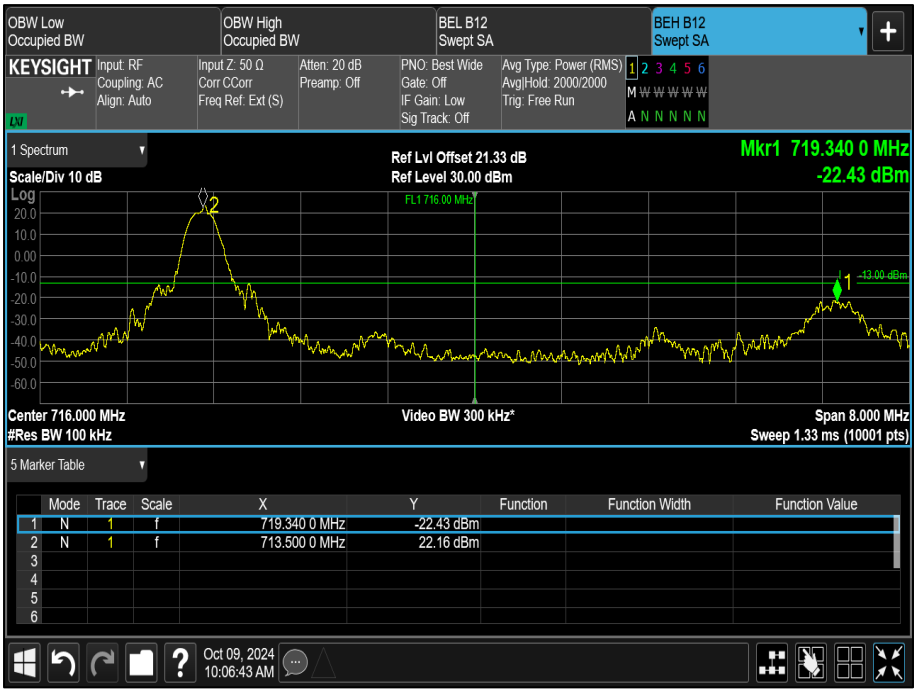

Figure 20 - Upper Band Edge, 713.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 12, Start Sub-Carrier: 0

FCC 47 CFR Part 27, Limit Clause 27.53

Clause	Requirement
27.53(g)	For operations in the 600 MHz band [663-698 MHz] and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB.

Table 29 - FCC Part 27 Limit

Clause	Requirement
4.7.1	The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Table 30 - ISED RSS-130 Limit

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Directional Coupler	Krytar	1850	58	-	TU
Attenuator Switch Driver	Hewlett Packard	11713A	1083	-	TU
Attenuator (11dB, 1W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110dB, 1W)	Hewlett Packard	8496H	2786	6	O/P Mon
Hygrometer	Rotronic	I-1000	3220	12	28-Nov-2024
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	09-Mar-2025
3.5 mm 1m Cable	Junkosha	MWX221-01000DMS	5419	12	02-Aug-2025
Attenuator 5W 10dB DC-18GHz	Aaren	AT40A-4041-D18-10	5493	12	09-May-2025
Attenuator 5W 10dB DC-18GHz	Aaren	AT40A-4041-D18-10	5495	12	07-Jan-2025
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	18-Sep-2025
1m K-Type Cable	Junkosha	MWX221/B	5908	12	10-Jun-2025
Cable (SMA to SMA 3m)	Junkosha	MWX221-03000AMSAMS/B	6023	12	06-Jun-2025
2m Coaxial Cable Assy	Junkosha	MWX221-02000AMSAMS/A	6357	12	14-May-2025
Radio Communications Analyser	Anritsu	MT8821C	6543	12	29-May-2025
Attenuator 5W 20dB DC-18GHz	Aaren	AT40A-4041-D18-20	6557	12	18-Jun-2025
Cable N to N 1m	Junkosha	MWX221-01000NMSN/B	6776	12	15-Apr-2025

Table 31

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

2.5 Radiated Spurious Emissions

2.5.1 Specification Reference

FCC 47 CFR Part 27.53
FCC 47 CFR Part 2.1053
ISED RSS-130 Clause 4.7
ISED RSS-GEN Clause 6.13

2.5.2 Equipment Under Test and Modification State

S/N: RAD 1 - Modification State 0

2.5.3 Date of Test

09-September-2024

2.5.4 Test Method

A preliminary profile of the Radiated Spurious Emissions was obtained up to the 10th harmonic by operating the EUT on a remotely controlled turntable within a semi-anechoic chamber. Measurements of emissions from the EUT were obtained with the Measurement Antenna in both Horizontal and Vertical Polarisations. The profiling produced a list of the worst-case emissions together with the EUT azimuth and antenna polarisation.

Testing was performed in accordance with ANSI C63.26, Clause 5.5.
Prescans and final measurements were performed using the direct field strength method.
Field strength measurements were performed and then converted to Equivalent Power Measurements in accordance with ANSI C63.26, Clause 5.2.7 equation c)

Example calculation:

E (dBuV/m) + 20log(d) - 104.8 = EIRP (dBm) where (d) is the measurement distance.
82.2 (dBuV/m) + 20log(3) – 104.8 = EIRP (dBm)
-13.0 = EIRP (dBm)

The EUT was powered by 3x AAA batteries for the duration of the test.

2.5.1 Example Test Setup Diagram

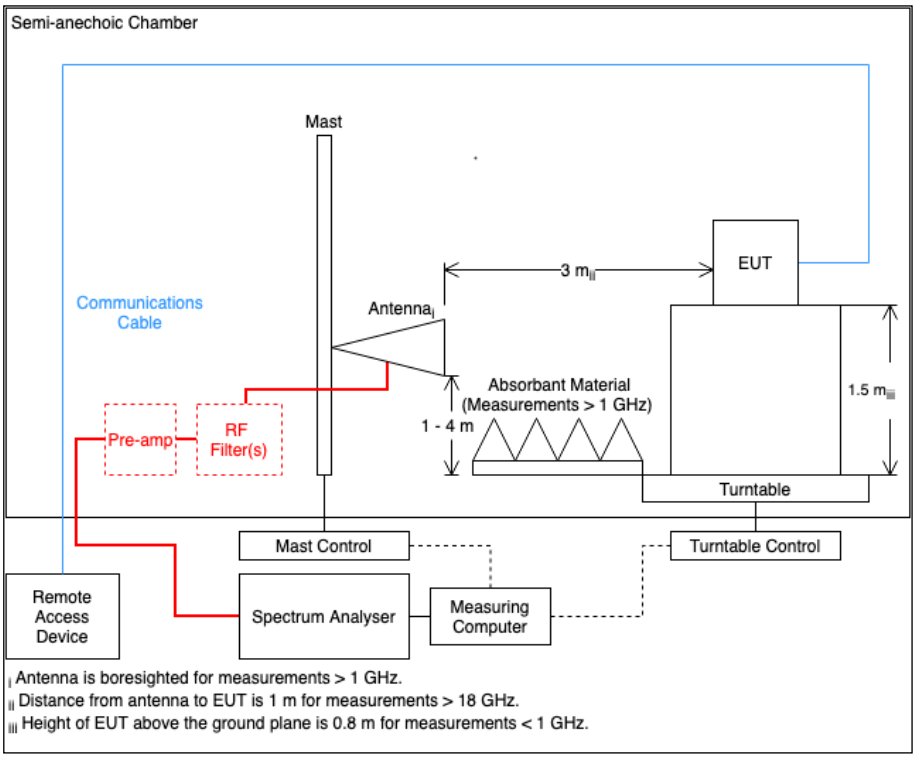

Figure 21

2.5.2 Environmental Conditions

Ambient Temperature	22.0 °C
Relative Humidity	63.3 %

2.5.3 Test Results

LTE FDD B12

Summary of Results

Frequency (MHz)	UARFCN	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS
701.5	23035	QPSK	15	6	0	5
707.5	23095	QPSK	15	6	6	5
713.5	231	QPSK	15	12	0	5

Table 32 – LTE NB IoT Carrier Configuration

LTE FDD B12

Frequency (MHz)	Level (dBm)	Angle	Height	Polarisation	Orientation
*					

Table 33 - 701.5 MHz

*No emissions were detected within 6 dB of the limit.

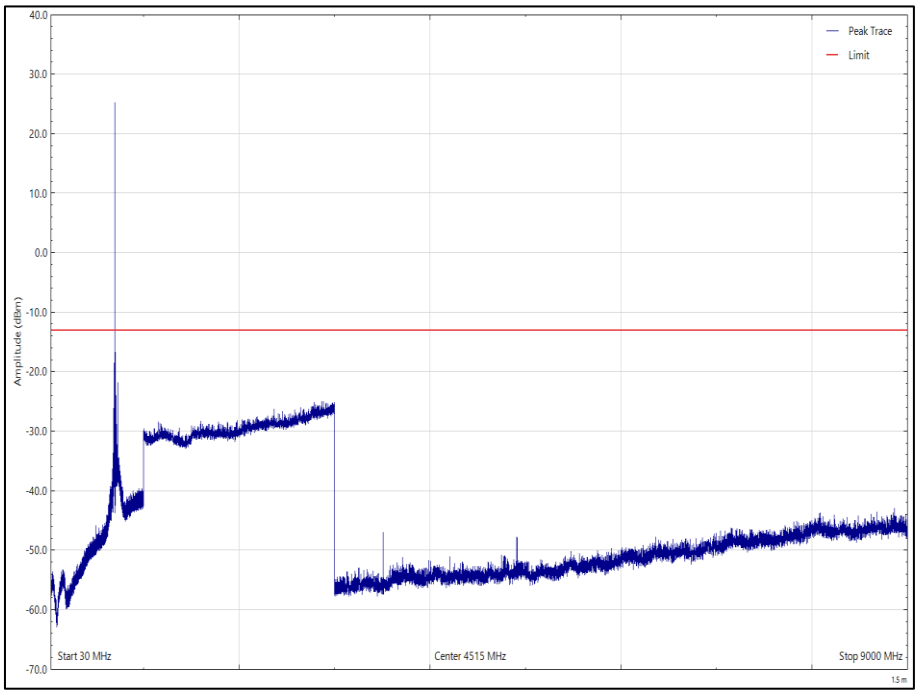

Figure 22 - 701.5 MHz - B12 Bot 30 MHz to 9 GHz, Horizontal, Orientation X

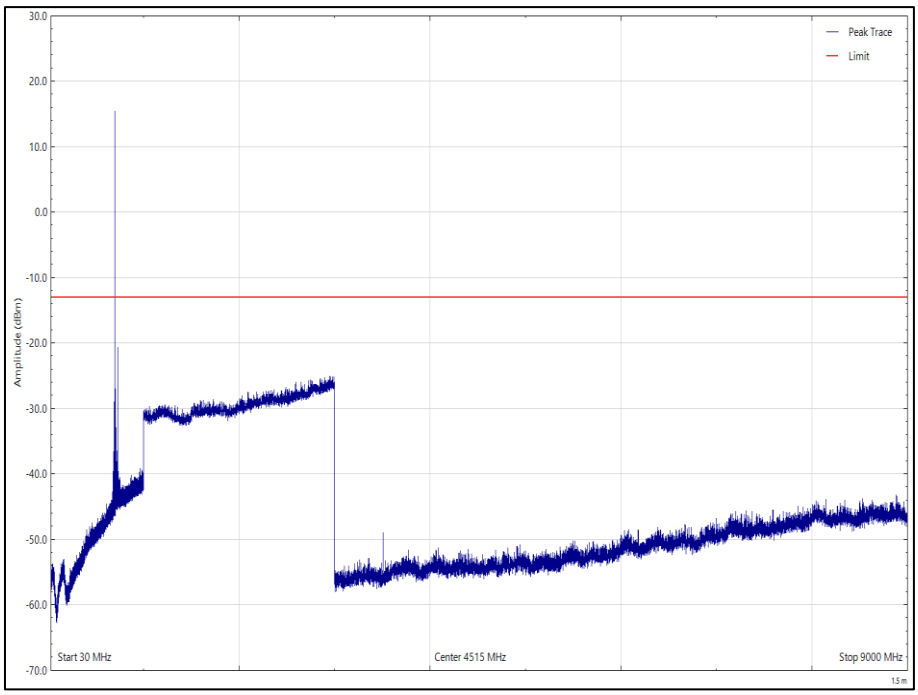

Figure 23 - 701.5 MHz - B12 Bot 30 MHz to 9 GHz, Vertical, Orientation X

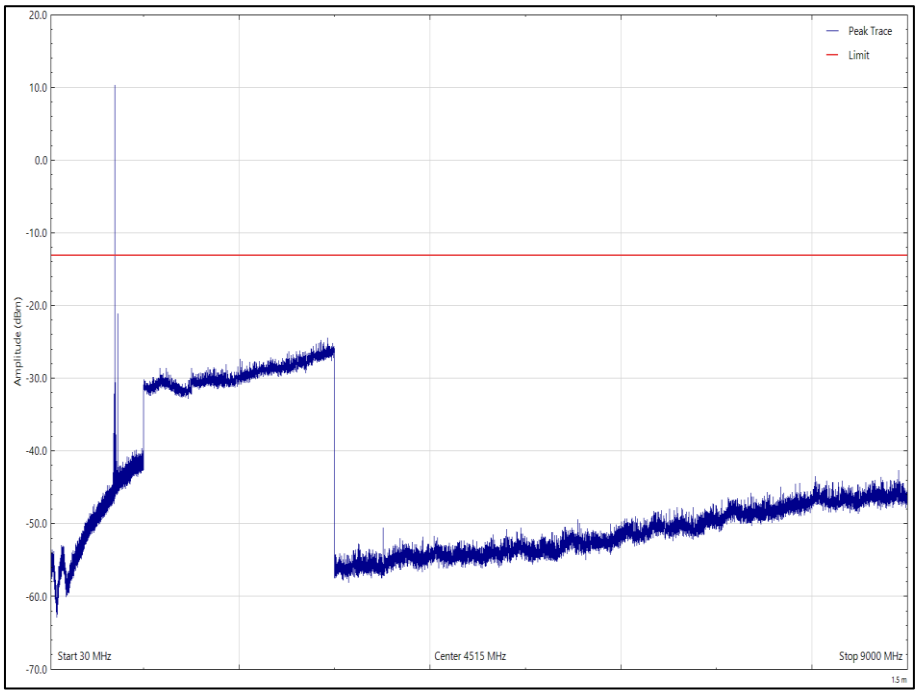

Figure 24 - 701.5 MHz - B12 Bot 30 MHz to 9 GHz, Horizontal, Orientation Y

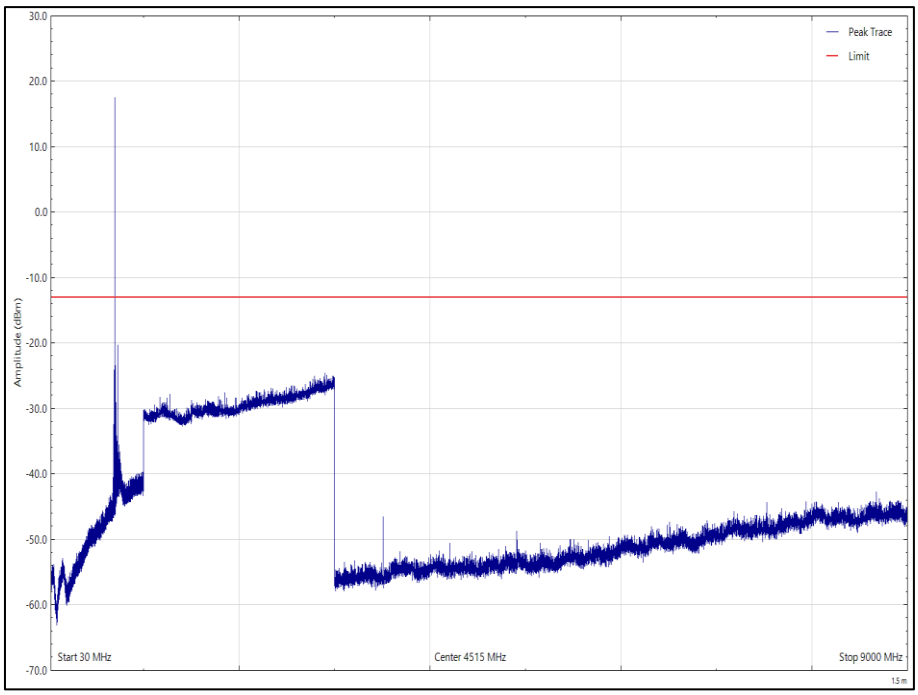

Figure 25 - 701.5 MHz - B12 Bot 30 MHz to 9 GHz, Vertical, Orientation Y

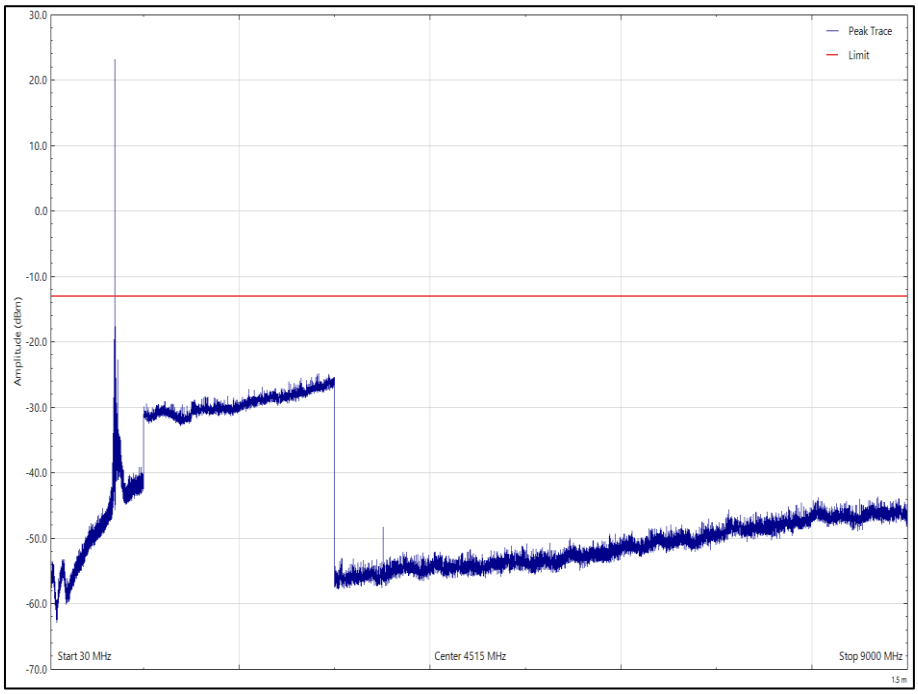

Figure 26 - 701.5 MHz - B12 Bot 30 MHz to 9 GHz, Horizontal, Orientation Z

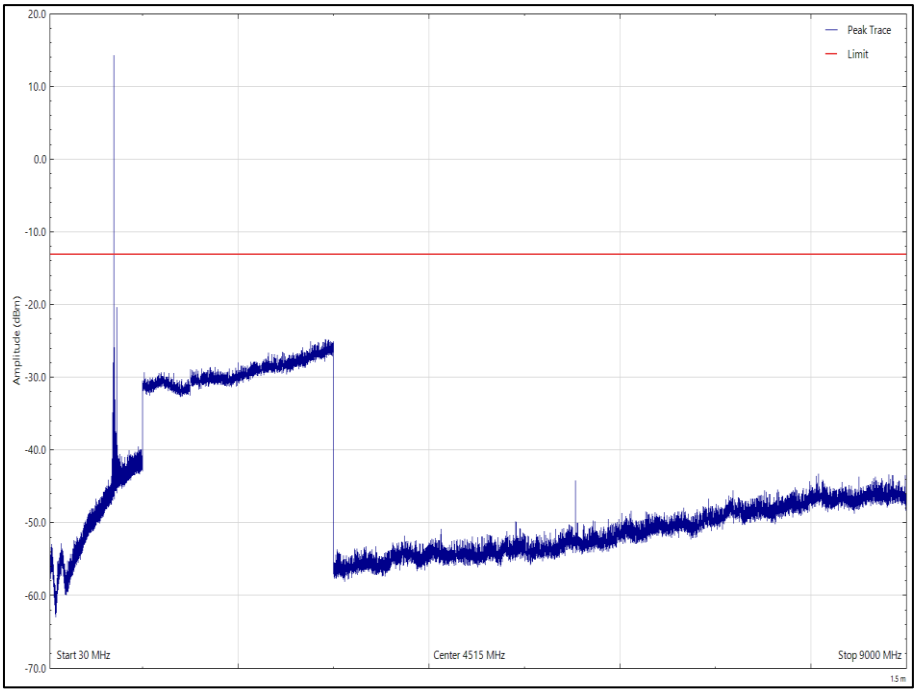

Figure 27 - 701.5 MHz - B12 Bot 30 MHz to 9 GHz, Vertical, Orientation Z

Frequency (MHz)	Level (dBm)	Angle	Height	Polarisation	Orientation
*					

Table 34 - 707.5 MHz

*No emissions were detected within 6 dB of the limit.

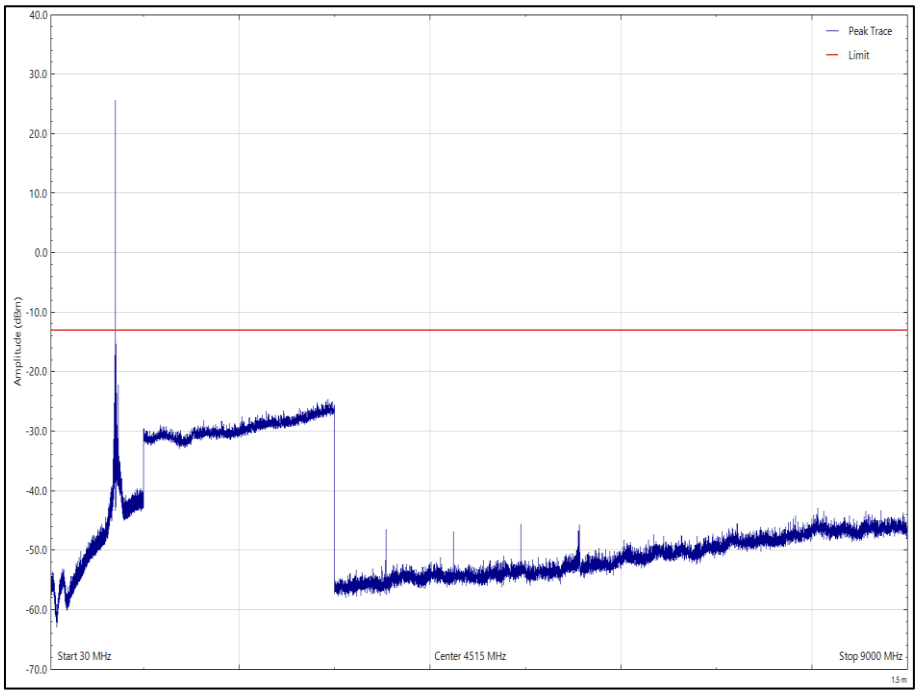

Figure 28 - 707.5 MHz - B12 Mid 30 MHz to 9 GHz, Horizontal, Orientation X

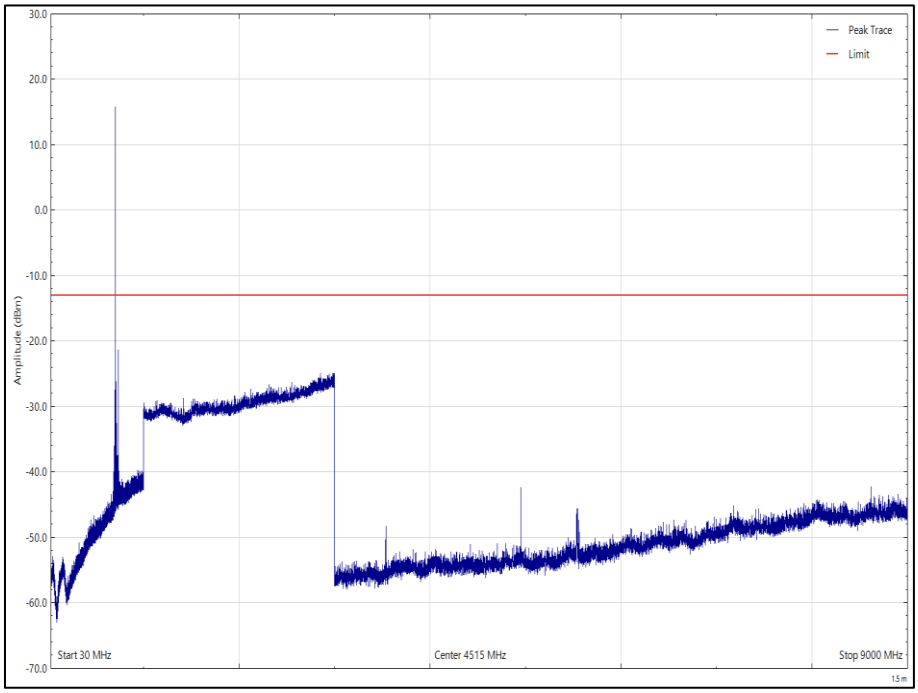

Figure 29 - 707.5 MHz - B12 Mid 30 MHz to 9 GHz, Vertical, Orientation X

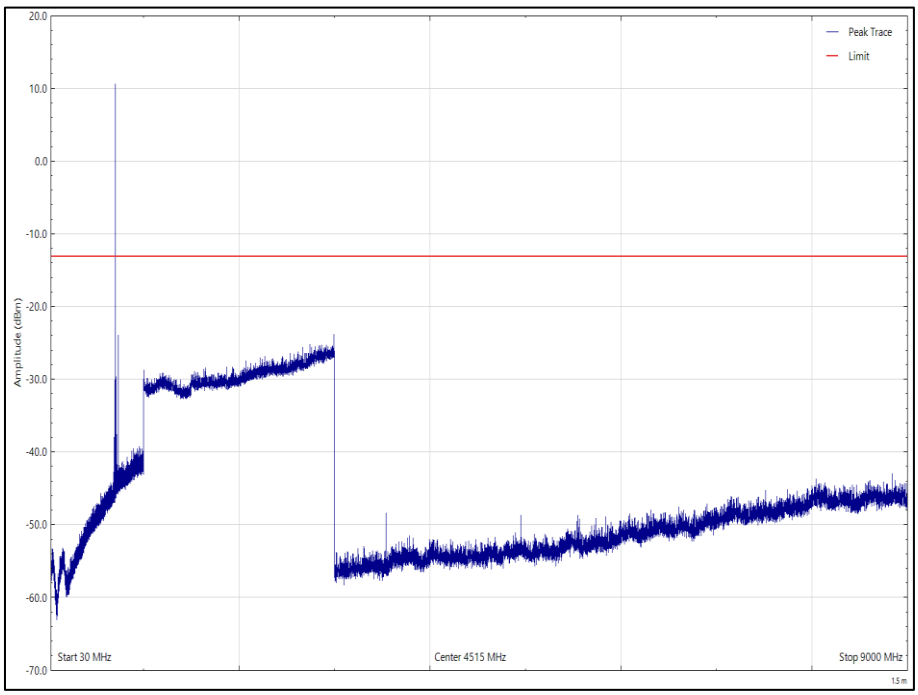

Figure 30 - 707.5 MHz - B12 Mid 30 MHz to 9 GHz, Horizontal, Orientation Y

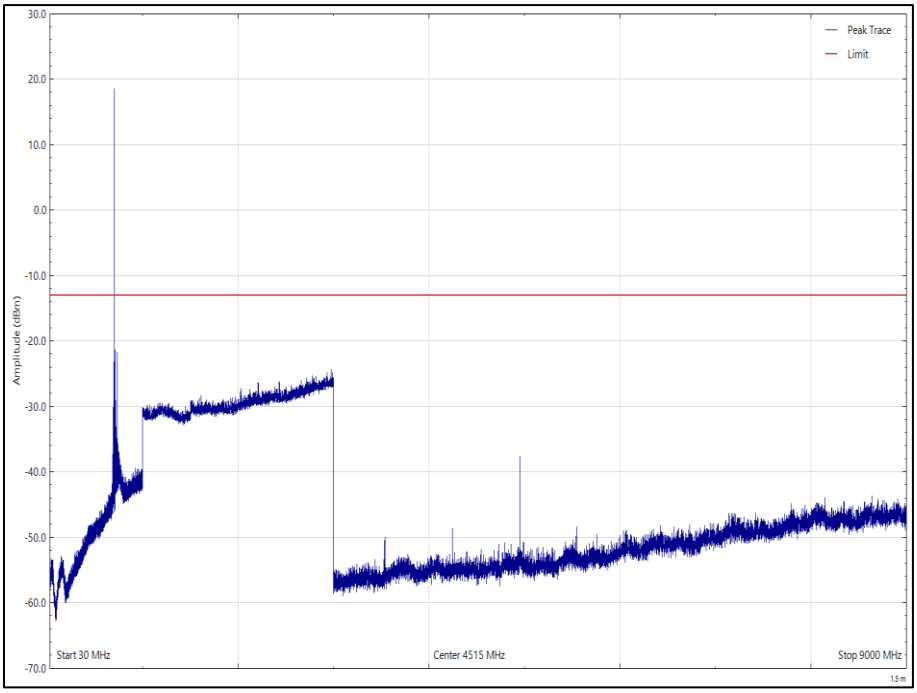

Figure 31 - 707.5 MHz - B12 Mid 30 MHz to 9 GHz, Vertical, Orientation Y

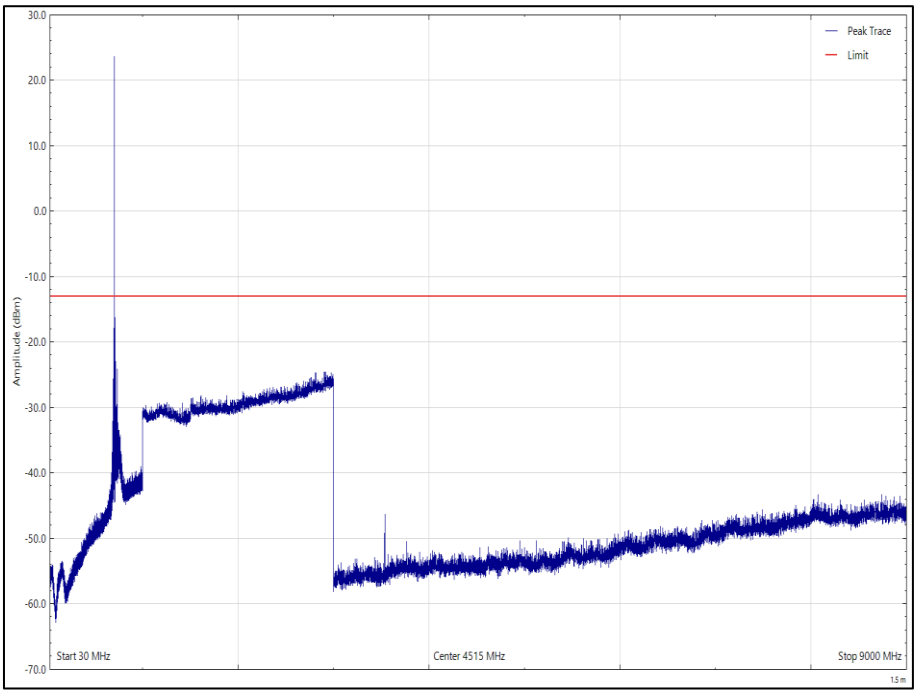

Figure 32 - 707.5 MHz - B12 Mid 30 MHz to 9 GHz, Horizontal, Orientation Z

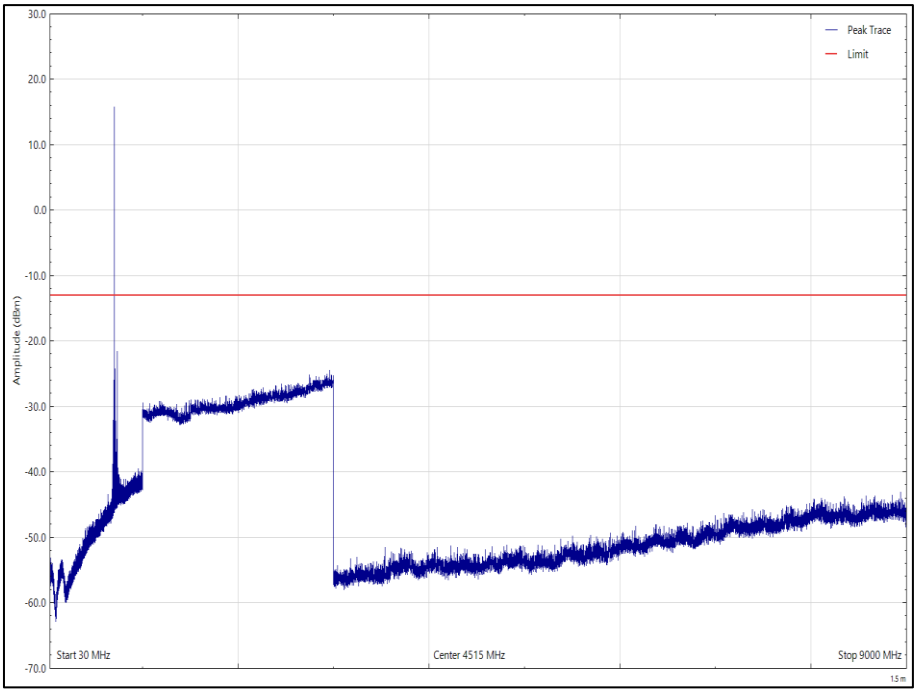

Figure 33 - 707.5 MHz - B12 Mid 30 MHz to 9 GHz, Vertical, Orientation Z

Frequency (MHz)	Level (dBm)	Angle	Height	Polarisation	Orientation
*					

Table 35 - 707.5 MHz

*No emissions were detected within 6 dB of the limit.

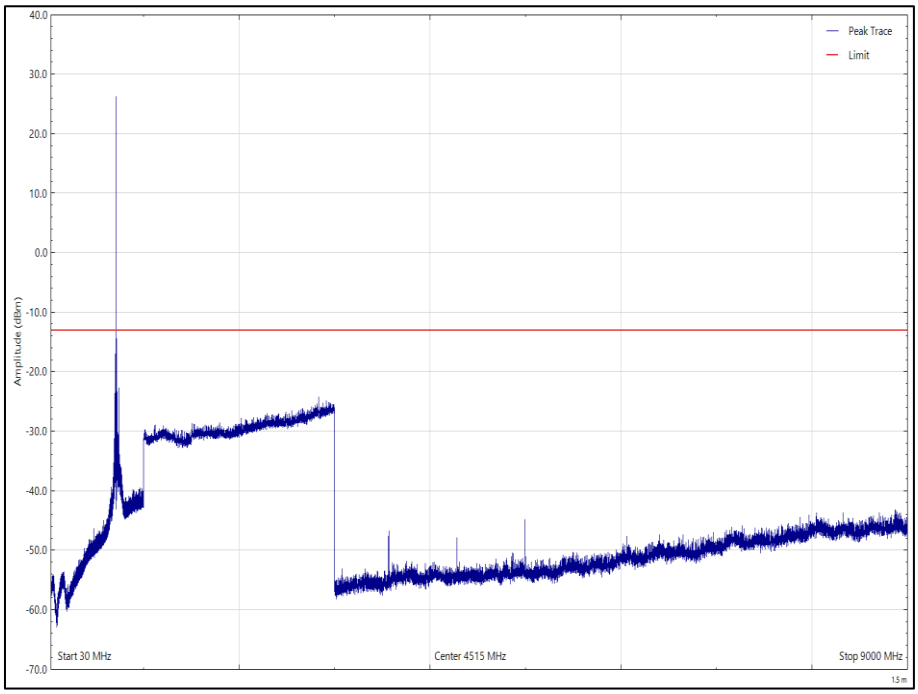

Figure 34 - 713.5 MHz - B12 Top 30 MHz to 9 GHz, Horizontal, Orientation X

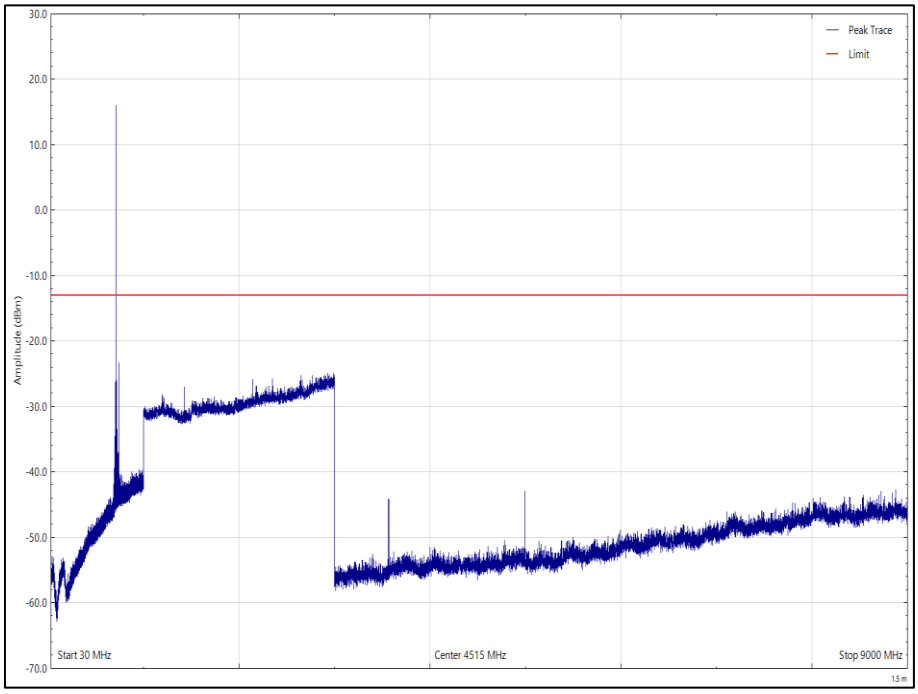

Figure 35 - 713.5 MHz - B12 Top 30 MHz to 9 GHz, Vertical, Orientation X

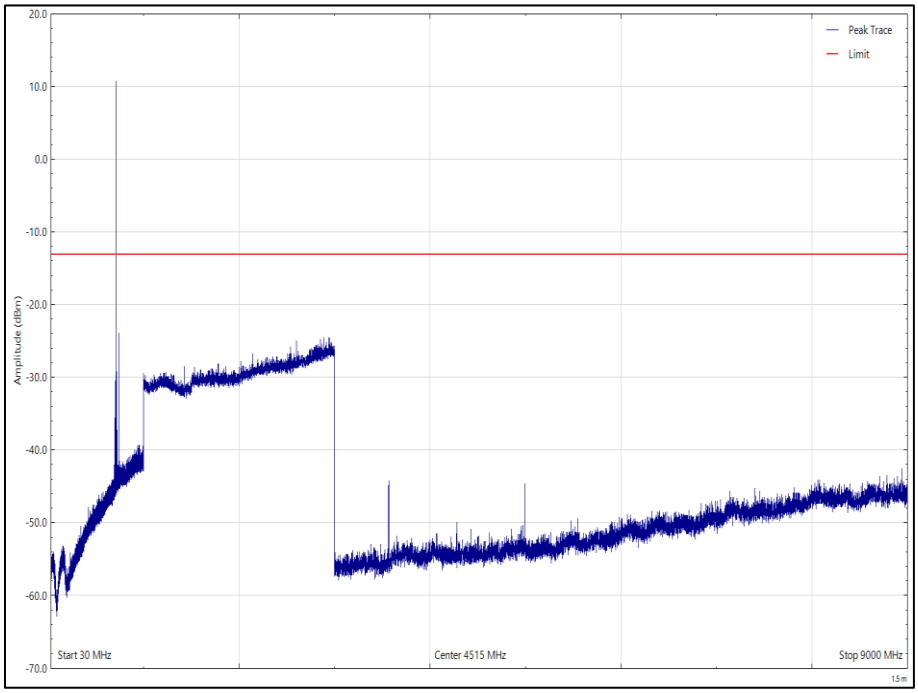

Figure 36 - 713.5 MHz - B12 Top 30 MHz to 9 GHz, Horizontal, Orientation Y

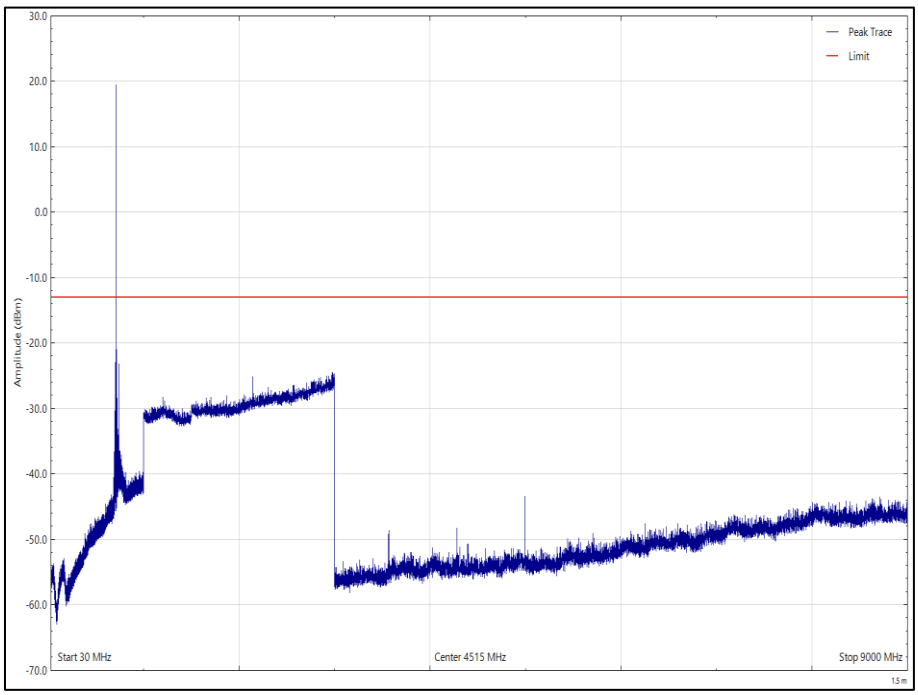

Figure 37 - 713.5 MHz - B12 Top 30 MHz to 9 GHz, Vertical, Orientation Y

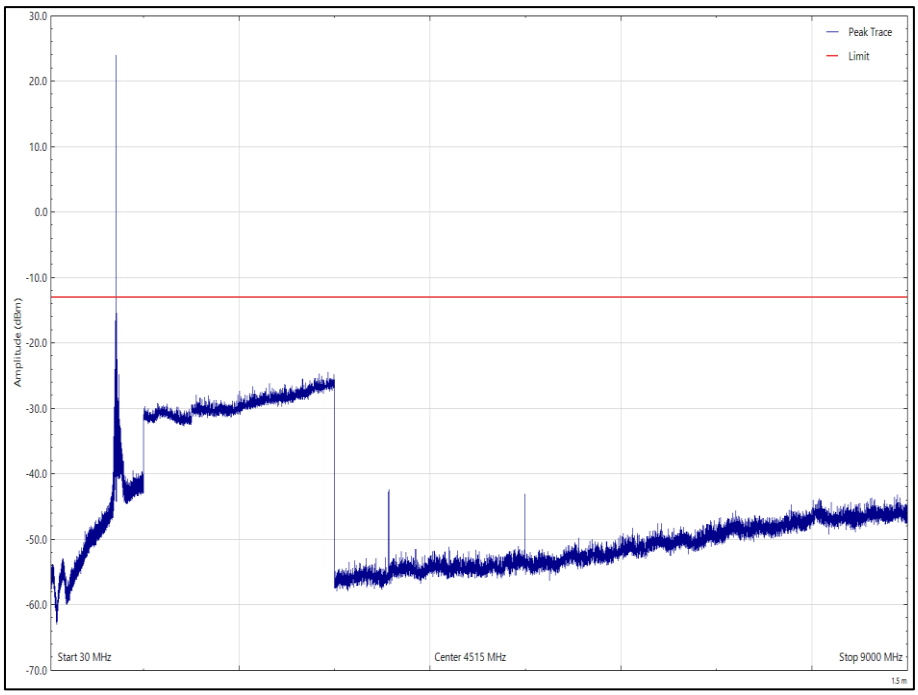

Figure 38 - 713.5 MHz - B12 Top 30 MHz to 9 GHz, Horizontal, Orientation Z

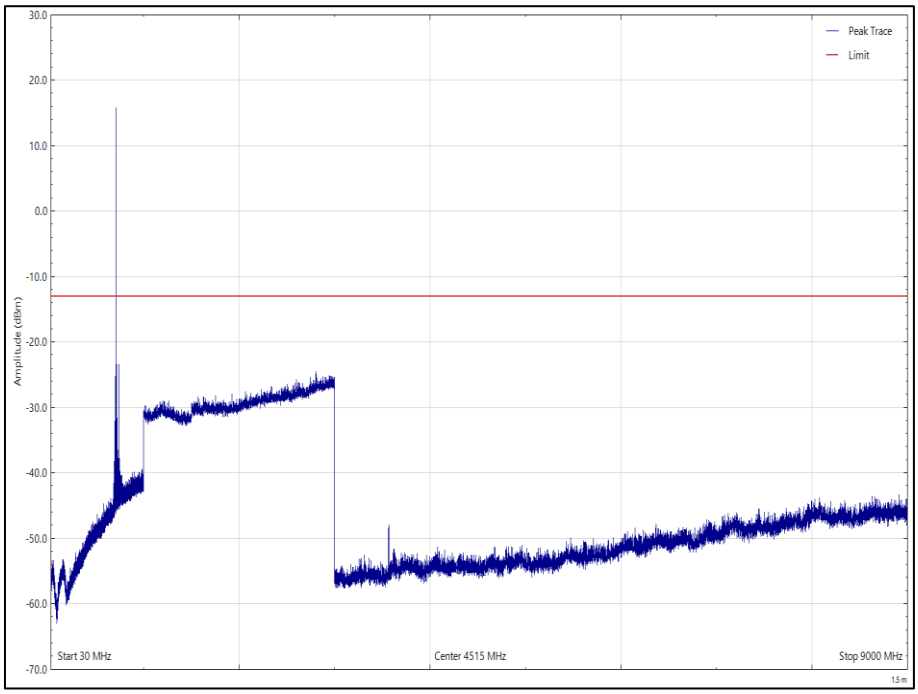

Figure 39 - 713.5 MHz - B12 Top 30 MHz to 9 GHz, Vertical, Orientation Z

FCC 47 CFR Part 27, Limit Clause 27.53

Clause	Requirement
27.53(g)	For operations in the 600 MHz band [663-698 MHz] and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least 43 + 10 log (P) dB.

Table 36 - FCC Part 27 Limit

Clause	Requirement
4.7.1	The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

Table 37 - ISED RSS-130 Limit

2.5.4 Test Location and Test Equipment Used

This test was carried out in EMC Chamber 5.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
3m Semi-Anechoic Chamber	Rainford	RF Chamber 5	1545	36	23-Apr-2027
Turntable Controller	Inn-Co GmbH	CO 1000	1606	-	TU
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	18-Apr-2025
Mast Controller	Maturo Gmbh	NCD	4810	-	TU
Tilt Antenna Mast	Maturo Gmbh	TAM 4.0-P	4811	-	TU
Antenna (DRG 1-10.5GHz)	Schwarzbeck	BBHA9120B	4848	12	14-Jul-2025
4dB Attenuator	Pasternack	PE7047-4	4935	12	31-Jul-2025
High Pass filter	Wainwright	WHKX12-1290-1500-18000-80SS	4962	12	14-Jun-2025
Emissions Software	TUV SUD	EmX V3.4.2	5125	-	Software
Pre-amplifier (30 dB, 1GHz to 18GHz)	Schwarzbeck	BBV 9718 C	5261	12	09-Apr-2025
Cable (SMA to SMA 1m)	Junkosha	MWX221-01000AMSAMS/A	5514	12	23-May-2025
Cable (SMA to SMA, 2 m)	Junkosha	MWX221-02000AMSAMS/A	5517	12	23-May-2025
3 GHz High pass Filter	Wainwright	WHKX12-2580-3000-18000-80SS	5548	12	15-Aug-2025
Humidity & Temperature meter	R.S Components	1364	6149	12	12-Aug-2025
Cable (N to N 8m)	Junkosha	MWX221-08000NMSNMS/B	6331	12	17-Feb-2025
Radio Communications Analyser	Anritsu	MT8821C	6543	12	29-May-2025
Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	6635	24	13-Jun-2025

Table 38

TU - Traceability Unscheduled

2.6 Frequency Stability

2.6.1 Specification Reference

FCC 47 CFR Part 27.54
FCC 47 CFR Part 2.1055
ISED RSS-130 Clause 4.5
ISED RSS-GEN Clause 6.11

2.6.2 Equipment Under Test and Modification State

S/N: CON 1 - Modification State 0

2.6.3 Date of Test

08-October-2024 to 11-October-2024

2.6.4 Test Method

This test was performed in accordance with ANSI C63.26, clause 5.6 and the provisions of RSS-GEN clause 6.11.

The measurement function of a spectrum analyser was used to measure the 99% occupied bandwidth as per ANSI C63.26 clause 5.4.4. The lower and upper boundaries were recorded to ensure the remained within the allocated frequency block.

EUT was powered by 3x 1.5V battery cells.

2.6.5 Environmental Conditions

Ambient Temperature	22.7 - 22.8 °C
Relative Humidity	33.2 - 55.5 %

2.6.6 Test Results

LTE FDD B12

Voltage	701.5 MHz		713.5 MHz	
	F_{LOWER} (MHz)	F_{UPPER} (MHz)	F_{LOWER} (MHz)	F_{UPPER} (MHz)
2.2	701.3981	7015853	713.3987	713.5864
4.5	701.3989	701.5880	713.3989	713.5876

Table 39 - Frequency Stability Under Voltage Variations

Temperature	701.5 MHz		713.5 MHz	
	F_{LOWER} (MHz)	F_{UPPER} (MHz)	F_{LOWER} (MHz)	F_{UPPER} (MHz)
50 °C	701.3987	701.5884	713.3986	713.5886
40 °C	701.3983	701.5878	713.3986	713.5882
30 °C	701.3987	701.5839	713.3994	713.5878
20 °C	701.3989	701.5880	713.3989	713.5876
10 °C	701.3987	701.5875	713.3986	713.5884
0 °C	701.3991	701.5887	713.3981	713.5877
-10 °C	701.3986	701.5872	713.3986	713.5873
-20 °C	701.3982	701.5873	713.3989	713.5866
-30 °C	Transmitter shut down			

Table 40 - Frequency Stability Under Temperature Variations

FCC 47 CFR Part 27, Limit Clause 27.54

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorised bands of operation.

ISED RSS-130, Limit Clause 4.5

For equipment that is capable of transmitting numerous channels simultaneously for different applications (e.g. LTE and narrowband – Internet of Things (IoT)), the occupied bandwidth shall be the bandwidth representing the sum of the occupied bandwidths of these channels.

The frequency stability shall be sufficient to ensure that the occupied bandwidth remains within each frequency block range when tested at the temperature and supply voltage variations specified in RSS-GEN.

2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Directional Coupler	Krytar	1850	58	-	TU
True RMS Multimeter	Fluke	79 Series III	411	12	12-Jan-2025
Attenuator Switch Driver	Hewlett Packard	11713A	1083	-	TU
Attenuator (11dB, 1W)	Hewlett Packard	8494H	2785	-	O/P Mon
Attenuator (110dB, 1W)	Hewlett Packard	8496H	2786	6	O/P Mon
Thermocouple Thermometer	Fluke	51	3173	12	31-May-2025
Hygrometer	Rotronic	I-1000	3220	12	28-Nov-2024
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	09-Mar-2025
3.5 mm 1m Cable	Junkosha	MWX221-01000DMS	5419	12	02-Aug-2025
Attenuator 5W 10dB DC-18GHz	Aaren	AT40A-4041-D18-10	5493	12	09-May-2025
Attenuator 5W 10dB DC-18GHz	Aaren	AT40A-4041-D18-10	5495	12	07-Jan-2025
MXA Signal Analyser	Keysight Technologies	N9020B	5528	24	18-Sep-2025
Modular Power System Mainframe	Keysight Technologies	N6701C	5835	-	TU
DC Power Module 60V 20A 300W	Keysight Technologies	N6754A	5836	-	O/P Mon
Climatic Chamber	Weiss Technik	TempEvent T/180/40/3	5894	12	O/P Mon
1m K-Type Cable	Junkosha	MWX221/B	5908	12	10-Jun-2025
Cable (SMA to SMA 3m)	Junkosha	MWX221-03000AMSAMS/B	6023	12	06-Jun-2025
Radio Communications Analyser	Anritsu	MT8821C	6543	12	29-May-2025
Attenuator 5W 20dB DC-18GHz	Aaren	AT40A-4041-D18-20	6557	12	18-Jun-2025
Programmable Power Supply 188 W	Rohde & Schwarz	HMP2020x0	6598	-	O/P Mon

Table 41

TU - Traceability Unscheduled
O/P Mon – Output Monitored using calibrated equipment

3 Photographs

3.1 Test Setup Photographs

Figure 40 - 30MHz-1GHz

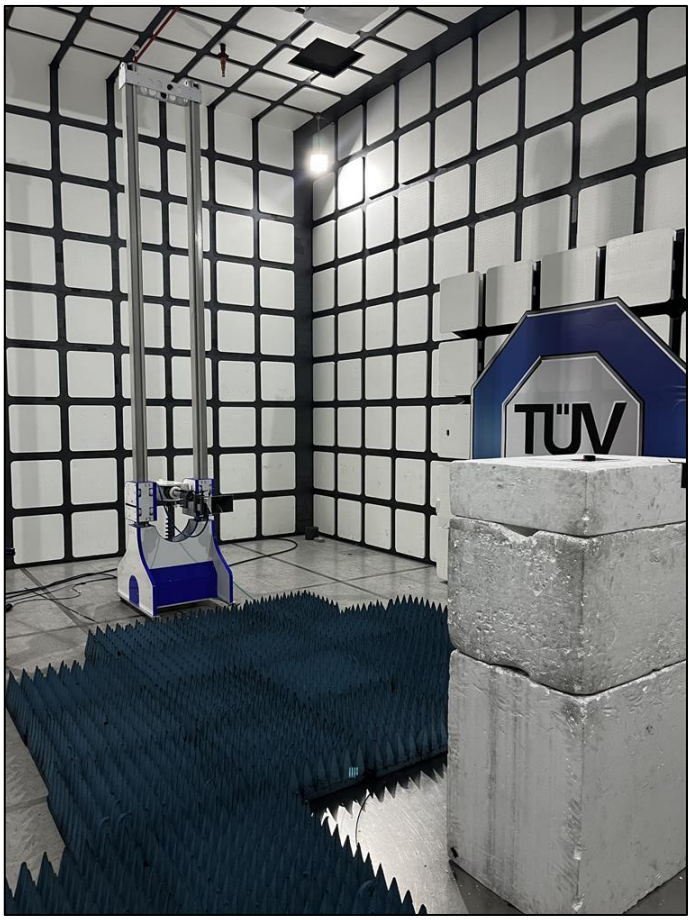

Figure 41 - 1GHz-9GHz

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Maximum Conducted Output Power	±3.2 dB
Occupied Bandwidth	± 4.505 kHz
Spurious Emissions at Band Edge	±3.454 dB
Radiated Spurious Emissions	30 MHz to 1 GHz: ±5.2 dB; 1 GHz to 40 GHz: ±6.3 dB
Modulation Characteristics	-
Frequency Stability	± 4.333 kHz

Table 42

Measurement Uncertainty Decision Rule – Accuracy Method

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115:2021, Clause 4.4.3 (Procedure 2). The measurement results are directly compared with the test limit to determine conformance with the requirements of the standard.

Risk: The uncertainty of measurement about the measured result is negligible with regard to the final pass/fail decision. The measurement result can be directly compared with the test limit to determine conformance with the requirement (compare IEC Guide 115). The level of risk to falsely accept and falsely reject items is further described in ILAC-G8.