FCC and ISED Test Report

Reelables, Inc.
Model: N-Label
In accordance with FCC 47 CFR Part 22, FCC 47 CFR Part 2 and ISED RSS-132 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 75961990-04 Issue 02

SIGNATURE			
			
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 22, FCC 47 CFR Part 2 and ISED RSS-132 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	

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 22: 2023, FCC 47 CFR Part 2: 2023, ISED RSS-132 Issue 4 (01-2023) and ISED RSS-GEN: Issue 5 (2018) + A2 (2021) for the tests detailed in section 1.3.

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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 22: 2023 FCC 47 CFR Part 2: 2023 ISED RSS-132: Issue 4 (2023) ISED RSS-GEN: Issue 5 (2018) + A2 (2021)
Order Number	15018
Date	11-July-2024
Date of Receipt of EUT	10-September-2024
Start of Test	11-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 22, FCC 47 CFR Part 2 and ISED RSS-132 and ISED RSS-GEN is shown below.

Section	Specification Clause				Test Description	Result	Comments/Base Standard
	Part 22	Part 2	RSS-132	RSS-GEN			
Configuration and Mode: LTE FDD B5							
2.1	22.913 (a)	2.1046	5.4	6.12	Maximum Conducted Output Power	Pass	ANSI C63.26: 2015
2.2		2.1047(d)	5.2		Modulation Characteristics	Pass	
2.3	22.917 (b)	2.1049 (h)	-	6.7	Emission Bandwidth	Pass	ANSI C63.26: 2015
2.4	22.917(a)(b)	2.1051	5.5	6.13	Spurious Emissions at Band Edge	Pass	ANSI C63.26: 2015
2.5	22.917	2.1053	5.5	6.13	Radiated Spurious Emissions	Pass	ANSI C63.26: 2015
2.6	22.355	2.1055	5.3	6.11	Frequency Tolerance	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 B5		
Maximum Conducted Output Power	Thomas Biddlecombe	UKAS
Emission Bandwidth	Thomas Biddlecombe	UKAS
Spurious Emissions at Band Edge	Thomas Biddlecombe	UKAS
Frequency Tolerance	Thomas Biddlecombe	UKAS
Radiated Spurious Emissions	Phoebe Doyle	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 22 Clause 22.913(a)
FCC 47 CFR Part 2 Clause 2.1046
ISED RSS-132 Clause 5.4
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

11-September-2024

2.1.4 Test Method

All measurements were made in accordance with ANSI C63.26 5.2.4.3.1 where a gated trigger was used on a signal analyser with the following settings:
Span - 5 MHz
RBW - 300 kHz
VBW - 910 kHz
Sweep Time - auto
Sweep Points - 10001
Detector - RMS
Average Hold, 150 sweeps

The ERP was calculated using the following formula:
Average Power (conducted) + Antenna Gain (-2.07dBi) – 2.15dB (conversion from EIRP to ERP).

Remarks:
* Maximum antenna system gain (including cable loss), GANT (dBi) 50 ohm, for the tested configurations, to comply with Maximum radiated output power in ISED SRSP-503.

EUT was powered by 3x 1.5V battery cells.

2.1.5 Environmental Conditions

Ambient Temperature	19.4 °C
Relative Humidity	45.8 %

2.1.6 Test Results

LTE FDD B5

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	Average Power (dBm)	ERP (dBm)	PAPR (dB)
20425	826.5	π/2-BPSK	3.75	1	0	0	16.788	12.568	4.01
20425	826.5	π/2-BPSK	3.75	1	47	0	17.315	13.095	3.96
20425	826.5	π/2-BPSK	15	1	0	0	18.018	13.798	3.58
20425	826.5	π/2-BPSK	15	1	11	0	18.064	13.844	3.60
20425	826.5	π/4-QPSK	3.75	1	0	3	17.107	12.887	3.76
20425	826.5	π/4-QPSK	3.75	1	47	3	17.376	13.156	3.72
20425	826.5	π/4-QPSK	15	1	0	3	17.490	13.270	3.50
20425	826.5	π/4-QPSK	15	1	11	3	17.123	12.903	3.49
20425	826.5	QPSK	15	3	0	5	18.177	13.957	5.61
20425	826.5	QPSK	15	3	6	5	17.998	13.778	5.87
20425	826.5	QPSK	15	6	0	5	21.052	16.832	6.45
20425	826.5	QPSK	15	6	6	5	20.816	16.596	6.30
20425	826.5	QPSK	15	12	0	5	19.169	14.949	5.83

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)
20525	836.5	π/2-BPSK	3.75	1	0	0	17.028	12.808	3.95
20525	836.5	π/2-BPSK	3.75	1	47	0	17.340	13.120	3.91
20525	836.5	π/2-BPSK	15	1	0	0	17.918	13.698	3.55
20525	836.5	π/2-BPSK	15	1	11	0	17.997	13.777	3.56
20525	836.5	π/4-QPSK	3.75	1	0	3	17.052	12.832	3.69
20525	836.5	π/4-QPSK	3.75	1	47	3	17.382	13.162	3.61
20525	836.5	π/4-QPSK	15	1	0	3	19.198	14.978	3.45
20525	836.5	π/4-QPSK	15	1	11	3	17.311	13.091	3.45
20525	836.5	QPSK	15	3	0	5	19.307	15.087	5.33
20525	836.5	QPSK	15	3	6	5	17.773	13.553	5.35
20525	836.5	QPSK	15	6	0	5	20.596	16.376	5.90
20525	836.5	QPSK	15	6	6	5	20.670	16.450	5.78
20525	836.5	QPSK	15	12	0	5	19.041	14.821	5.31

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)
20625	846.5	π/2-BPSK	3.75	1	0	0	16.904	12.684	4.03
20625	846.5	π/2-BPSK	3.75	1	47	0	16.847	12.627	3.98
20625	846.5	π/2-BPSK	15	1	0	0	17.443	13.223	3.59
20625	846.5	π/2-BPSK	15	1	11	0	17.496	13.276	3.60
20625	846.5	π/4-QPSK	3.75	1	0	3	16.962	12.742	3.74
20625	846.5	π/4-QPSK	3.75	1	47	3	16.724	12.504	3.74
20625	846.5	π/4-QPSK	15	1	0	3	17.312	13.092	3.50
20625	846.5	π/4-QPSK	15	1	11	3	16.492	12.272	3.48
20625	846.5	QPSK	15	3	0	5	18.286	14.066	5.78
20625	846.5	QPSK	15	3	6	5	17.524	13.304	6.25
20625	846.5	QPSK	15	6	0	5	20.779	16.559	6.86
20625	846.5	QPSK	15	6	6	5	20.974	16.754	6.73
20625	846.5	QPSK	15	12	0	5	18.429	14.209	6.27

Table 18 - Maximum Conducted Output Power, Top Channel

FCC 47 CFR Part 22, Limit Clause 22.913 (a)

Maximum ERP. The ERP of transmitters in the Cellular Radiotelephone Service must not exceed the limits in this section.

(5) The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 watts.

ISED RSS-132, Limit Clause 5.4

The transmitter output power shall be measured in terms of average power. The equivalent radiated power (e.r.p.) shall not exceed 7 watts for mobile equipment and 3 watts for portable equipment.

The effective isotropic radiated power (e.i.r.p.) shall not exceed the limits specified in SRSP-503 for base station equipment.

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 using a signal corresponding to the highest PAPR during periods of continuous transmission.

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 19

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, Clause 2.1047(d)
ISED RSS-132, Clause 5.2

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.

2.2.5 Environmental Conditions

Ambient Temperature	19.4 °C
Relative Humidity	45.8 %

2.2.6 Test Results

LTE FDD B5

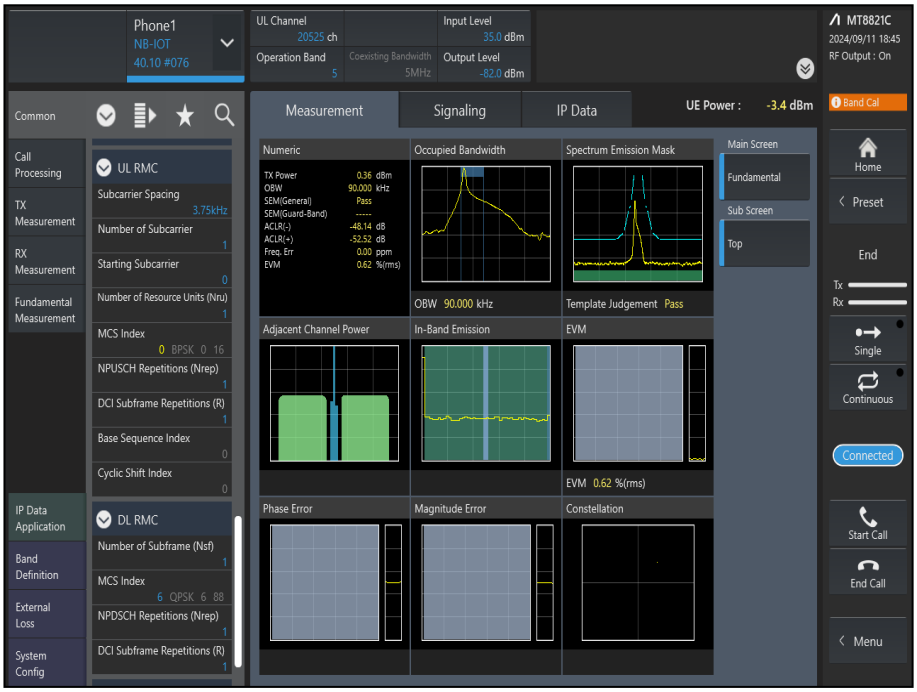

Figure 1 - π/2-BPSK MCS0

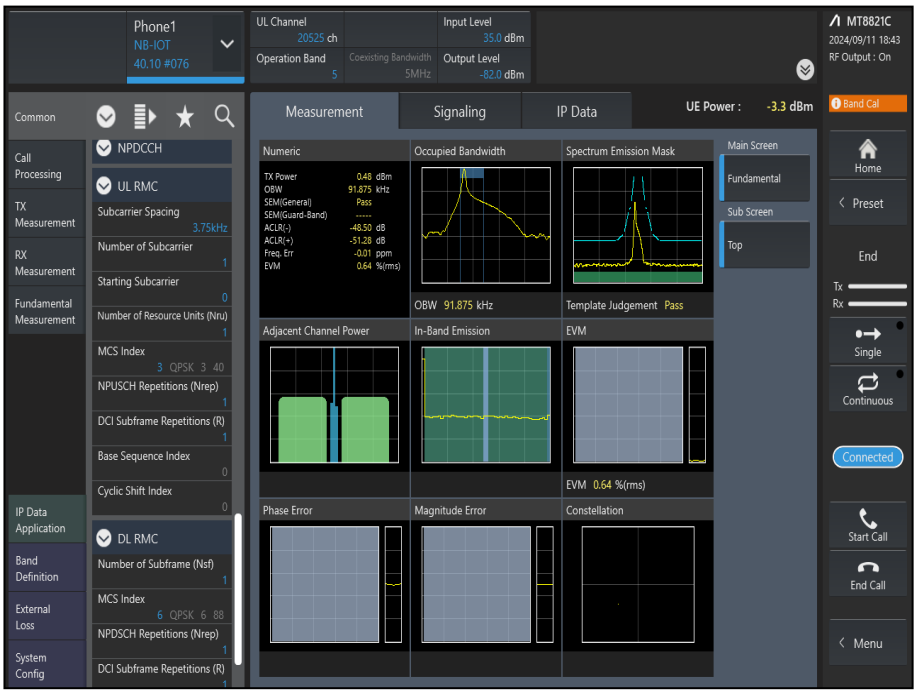

Figure 2 - π/4-QPSK MCS3

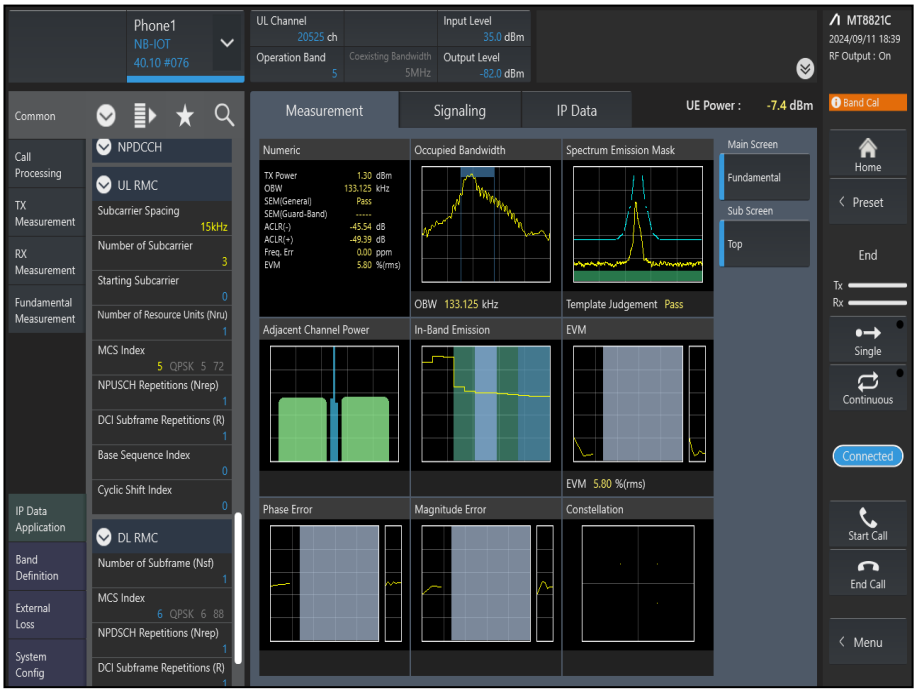

Figure 3 - QPSK MCS5

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.

ISED RSS-132, Limit Clause 5.2

Digital modulation shall be used.

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
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 20

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

2.3 Emission Bandwidth

2.3.1 Specification Reference

FCC 47 CFR Part 22 Clause 22.917 (b)
FCC 47 CFR Part 2 Clause 2.1049 (h)
ISED RSS-GEN Clause 6.7

2.3.2 Equipment Under Test and Modification State

S/N: CON 1 - Modification State 0

2.3.3 Date of Test

11-September-2024

2.3.4 Test Method

All measurements were made 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	19.4 °C
Relative Humidity	45.8 %

2.3.6 Test Results

LTE FDD B5

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	26 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
20425	826.5	π/2-BPSK	15	1	0	0	0.1764	0.15754
20425	826.5	π/4-QPSK	15	1	0	3	0.1598	0.13739
20425	826.5	QPSK	15	1	0	5	0.2222	0.18910

Table 21 - Emission Bandwidth Results, Bottom Channel

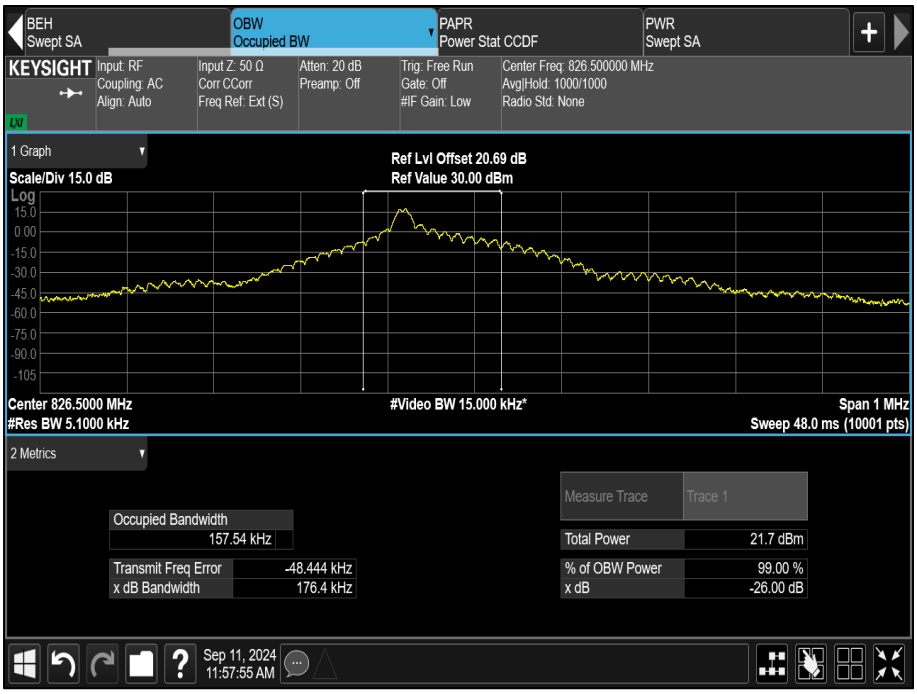

Figure 4 - Emission Bandwidth, 826.5 MHz, Modulation: π/2-BPSK, SCS: 15, Tone Number: 1, Start Sub-Carrier: 0

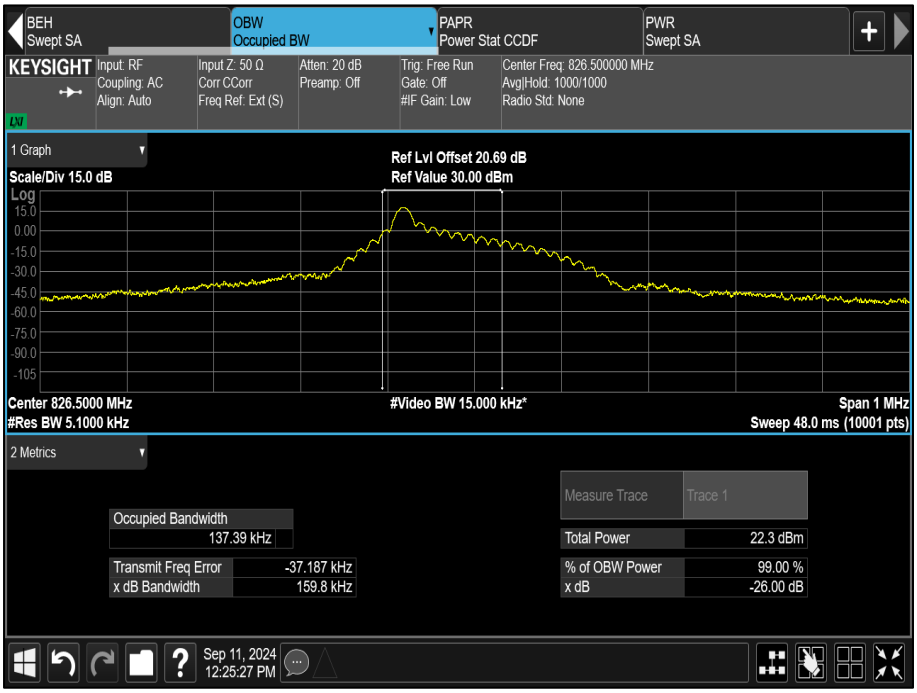

Figure 5 - Emission Bandwidth, 826.5 MHz, Modulation: π/4-QPSK, SCS: 15, Tone Number: 1, Start Sub-Carrier: 0

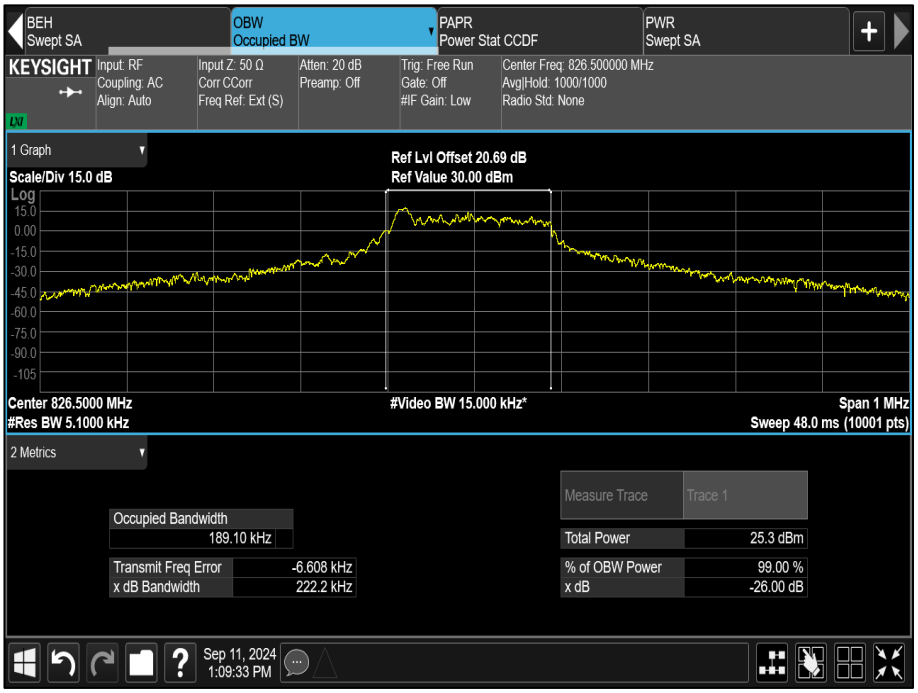

Figure 6 - Emission Bandwidth, 826.5 MHz, Modulation: QPSK, SCS: 15, Tone Number: 1, Start Sub-Carrier: 0

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	26 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
20525	836.5	π/2-BPSK	15	1	0	0	0.1740	0.15580
20525	836.5	π/4-QPSK	15	1	0	3	0.1599	0.13718
20525	836.5	QPSK	15	1	0	5	0.2230	0.18754

Table 22 - Emission Bandwidth Results, Middle Channel

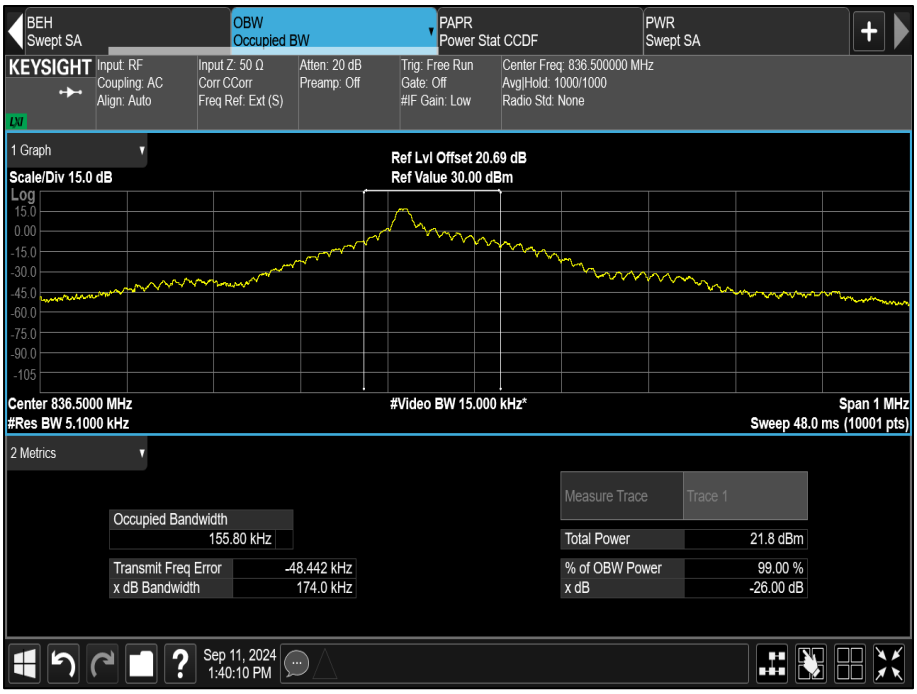

Figure 7 - Emission Bandwidth, 836.5 MHz, Modulation: π/2-BPSK, SCS: 15, Tone Number: 1, Start Sub-Carrier: 0

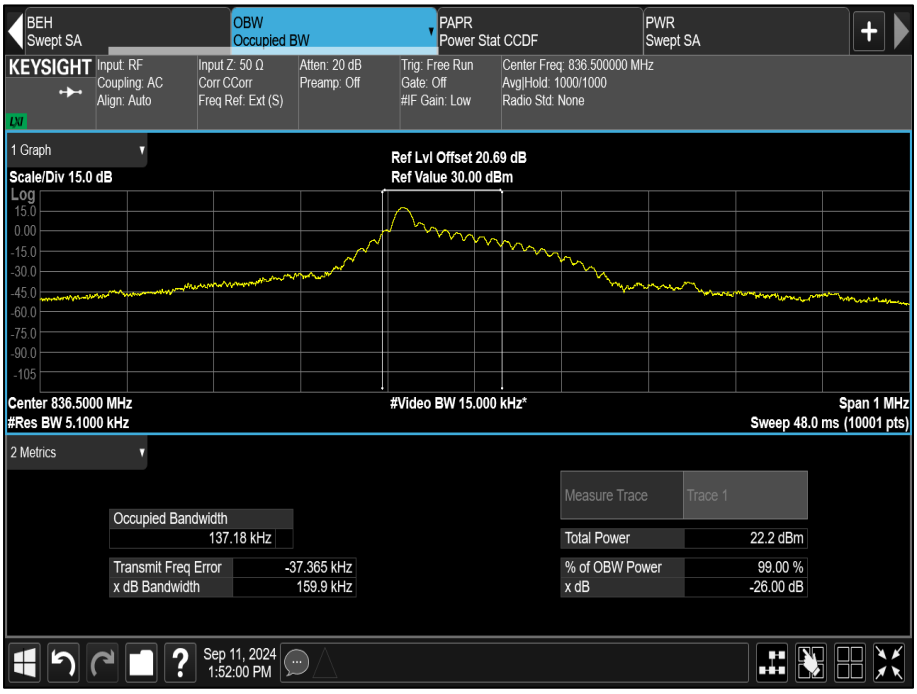

Figure 8 - Emission Bandwidth, 836.5 MHz, Modulation: π/4-QPSK, SCS: 15, Tone Number: 1, Start Sub-Carrier: 0

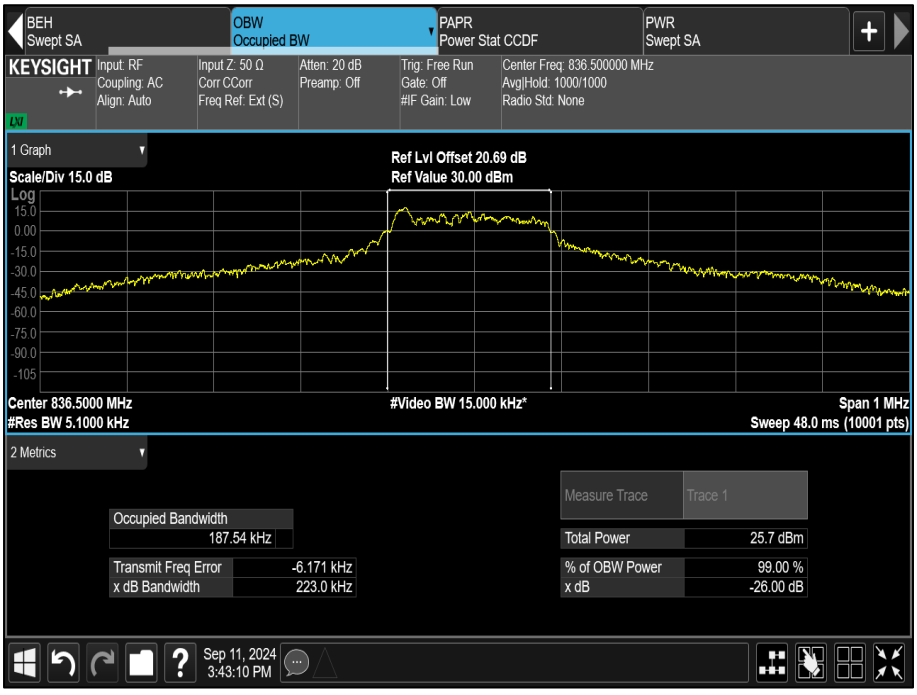

Figure 9 - Emission Bandwidth, 836.5 MHz, Modulation: QPSK, SCS: 15, Tone Number: 1, Start Sub-Carrier: 0

UARFCN	Frequency	Modulation	SCS	Tone	Start	MCS	26 dB	99%

	(MHz)		(kHz)	Number	Sub-Carrier		Bandwidth (MHz)	Occupied Bandwidth (MHz)
20625	846.5	π/2-BPSK	15	1	0	0	0.1753	0.15810
20625	846.5	π/4-QPSK	15	1	0	3	0.1594	0.13833
20625	846.5	QPSK	15	1	0	5	0.2234	0.18982

Table 23 - Emission Bandwidth Results, Top Channel

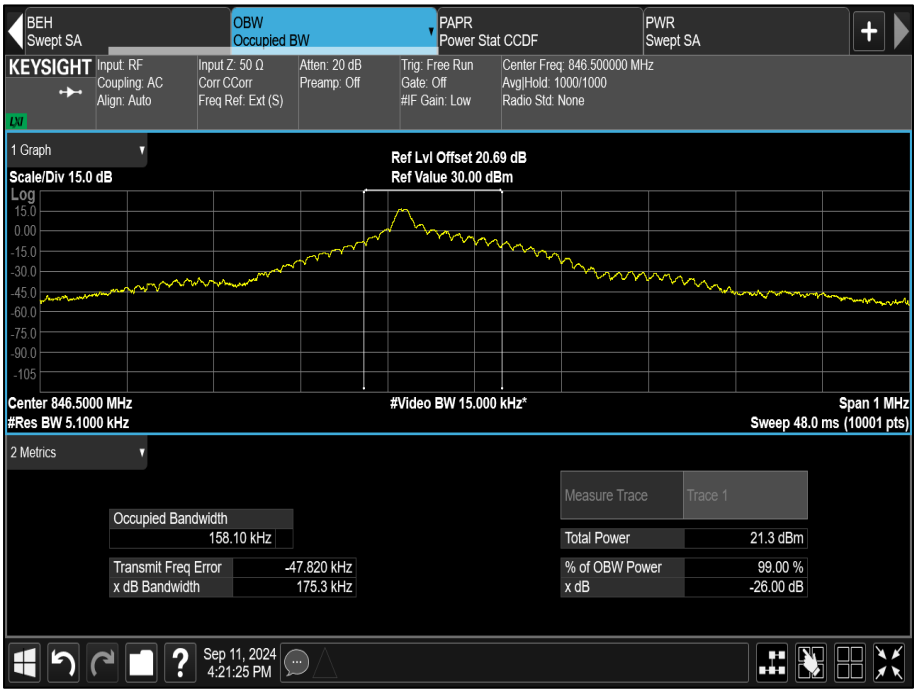

Figure 10 - Emission Bandwidth, 846.5 MHz, Modulation: π/2-BPSK, SCS: 15, Tone Number: 1, Start Sub-Carrier: 0

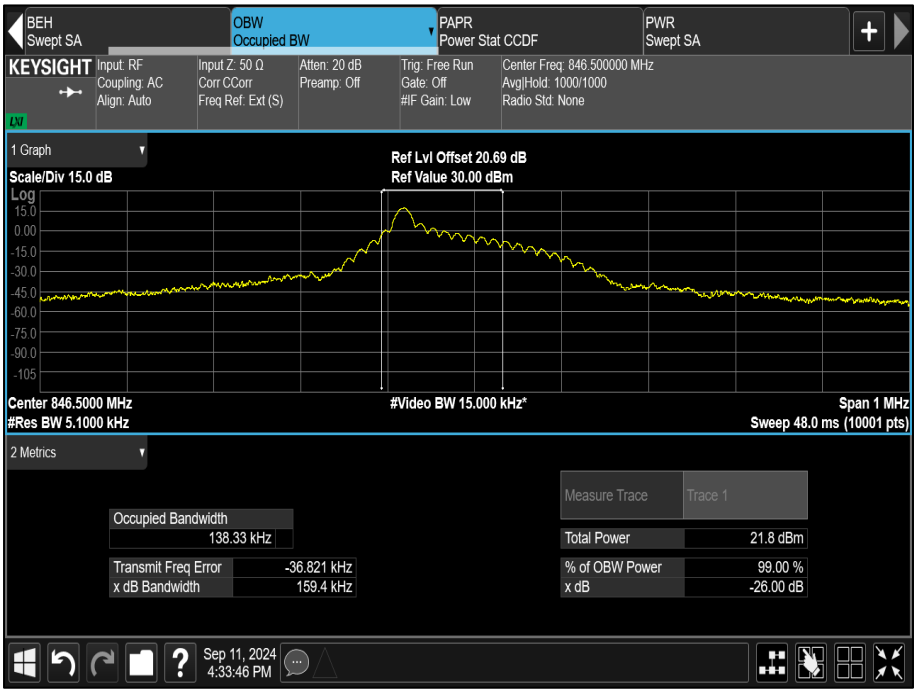

Figure 11 - Emission Bandwidth, 846.5 MHz, Modulation: π/4-QPSK, SCS: 15, Tone Number: 1, Start Sub-Carrier: 0

Figure 12 - Emission Bandwidth, 846.5 MHz, Modulation: QPSK, SCS: 15, Tone Number: 1, Start Sub-Carrier: 0

FCC 47 CFR Part 22, Limit Clause 22.917 (b)

None Specified

ISED RSS-GEN, Limit Clause 6.7

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 24

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 22 Clause 22.917(a)(b)
FCC 47 CFR Part 2 Clause 2.1051
ISED RSS-132 Clause 5.5
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 v03r0, 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 B5

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	Level (dBm)	Verdict
20425	826.5	π/2-BPSK	3.75	1	0	0	-25.42	Pass
20425	826.5	π/2-BPSK	15	1	0	0	-24.76	Pass
20425	826.5	QPSK	15	3	0	5	-22.35	Pass
20425	826.5	QPSK	15	12	0	5	-23.64	Pass

Table 25 - Lower Band Edge Results

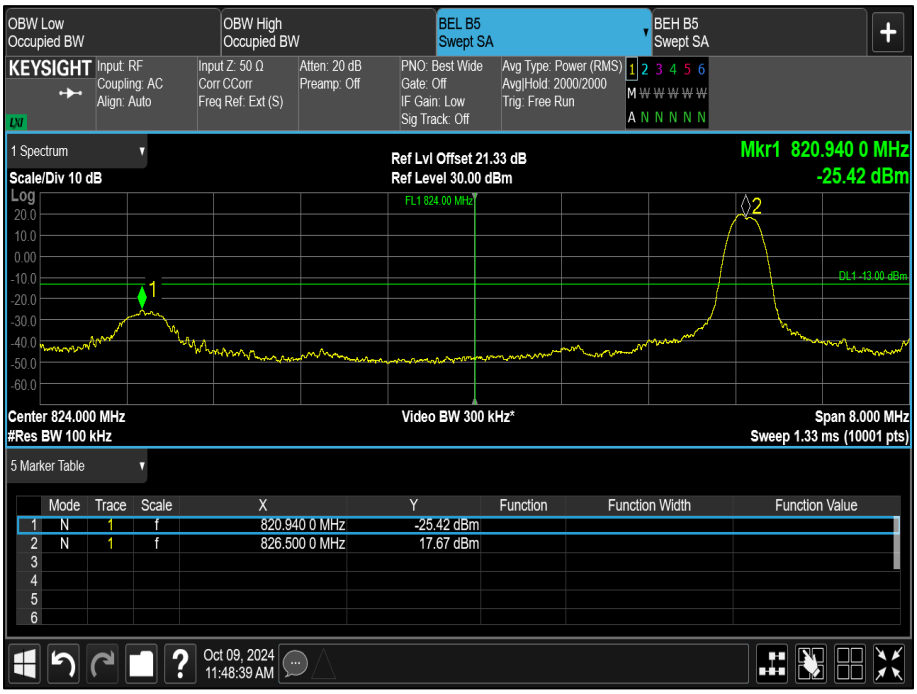

Figure 13 - Lower Band Edge, 826.5 MHz, Modulation: π/2-BPSK, SCS: 3.75 kHz, Tone Number: 1, Start Sub-Carrier: 0

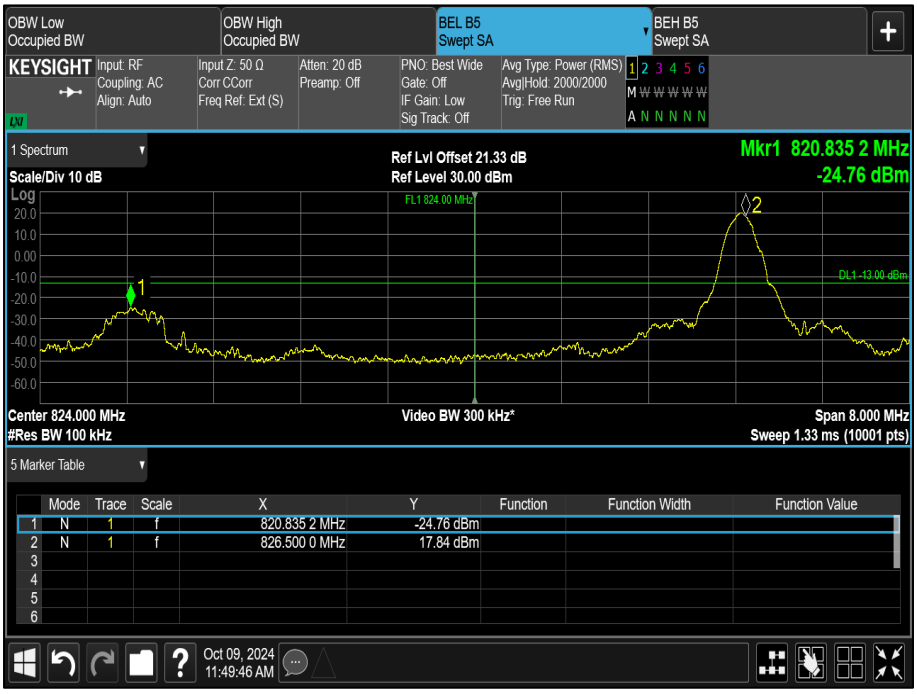

Figure 14 - Lower Band Edge, 826.5 MHz, Modulation: π/2-BPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 0

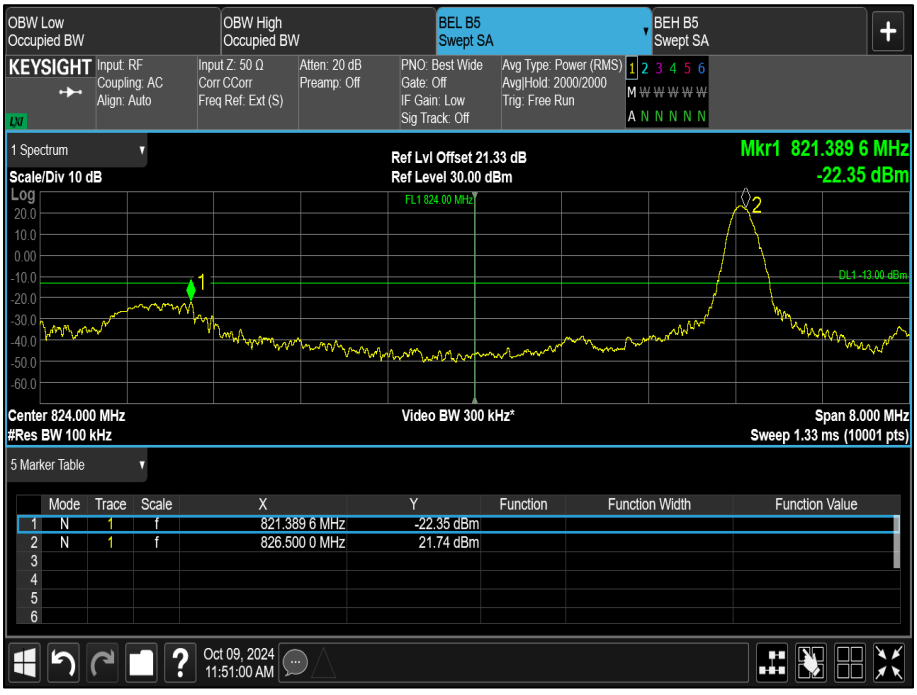

Figure 15 - Lower Band Edge, 826.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 3, Start Sub-Carrier: 0

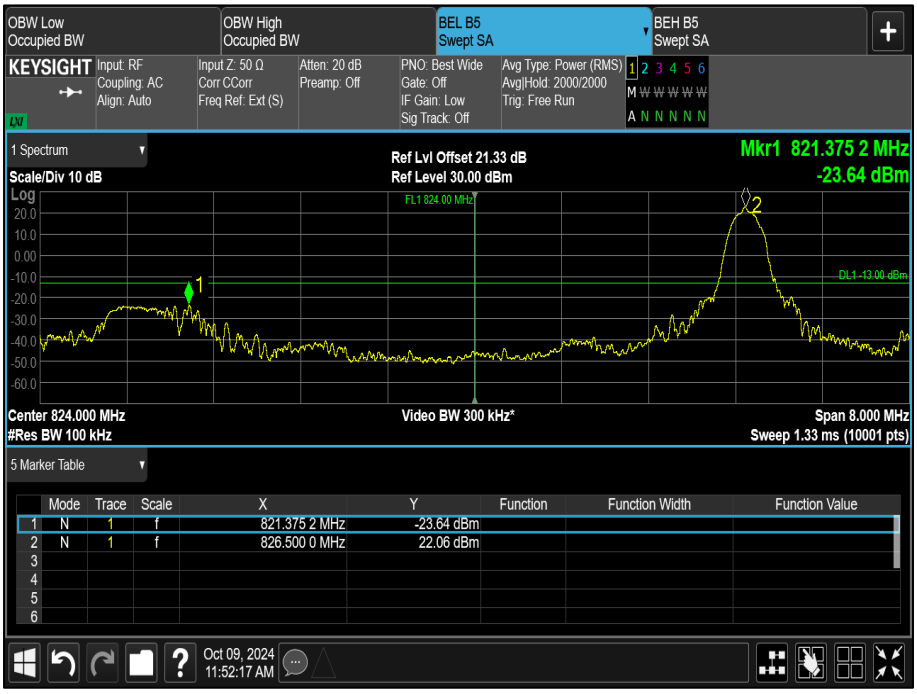

Figure 16 - Lower Band Edge, 826.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 12, Start Sub-Carrier: 0

UARFCN	Frequency (MHz)	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS	Level (dBm)	Verdict
20625	846.5	π/2-BPSK	3.75	1	47	0	-26.13	Pass
20625	846.5	π/2-BPSK	15	1	11	0	-25.74	Pass
20625	846.5	QPSK	15	3	6	5	-21.65	Pass
20625	846.5	QPSK	15	12	0	5	-24.11	Pass

Table 26 - Upper Band Edge Results

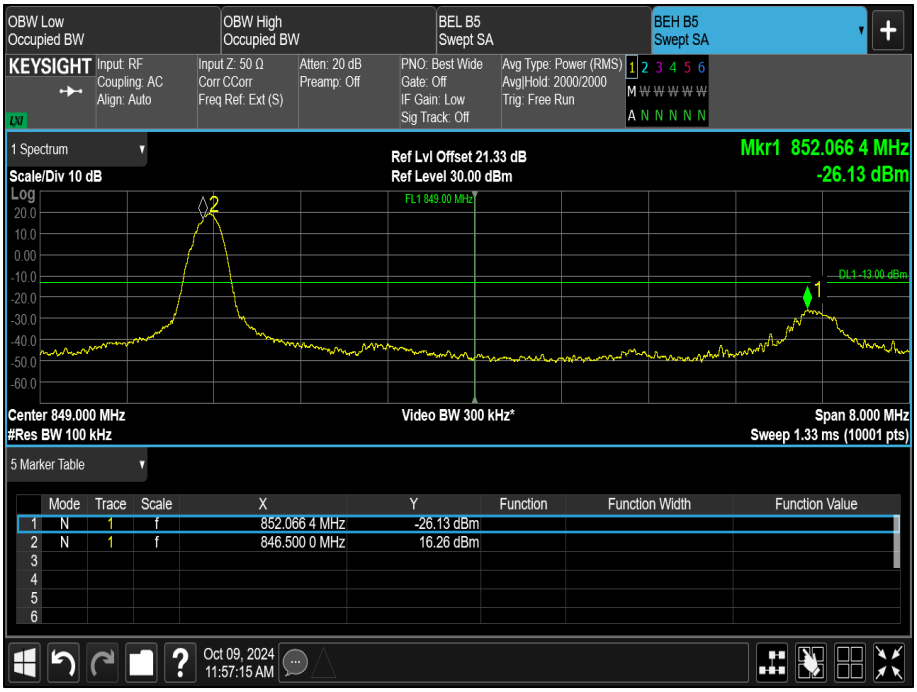

Figure 17 - Upper Band Edge, 846.5 MHz, Modulation: π/2-BPSK, SCS: 3.75 kHz, Tone Number: 1, Start Sub-Carrier: 47

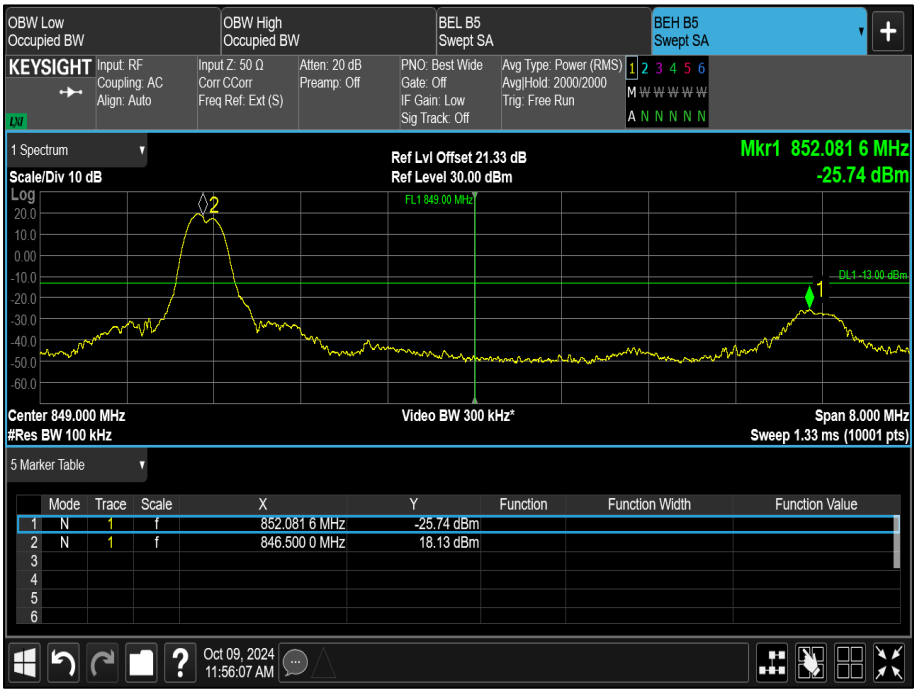

Figure 18 - Upper Band Edge, 846.5 MHz, Modulation: π/2-BPSK, SCS: 15 kHz, Tone Number: 1, Start Sub-Carrier: 11

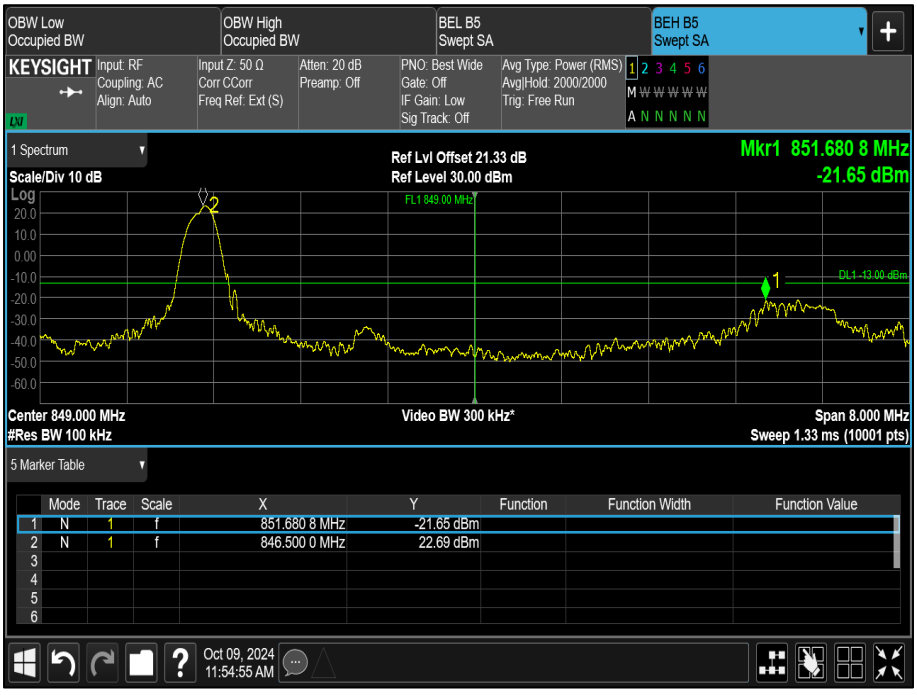

Figure 19 - Upper Band Edge, 846.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 3, Start Sub-Carrier: 6

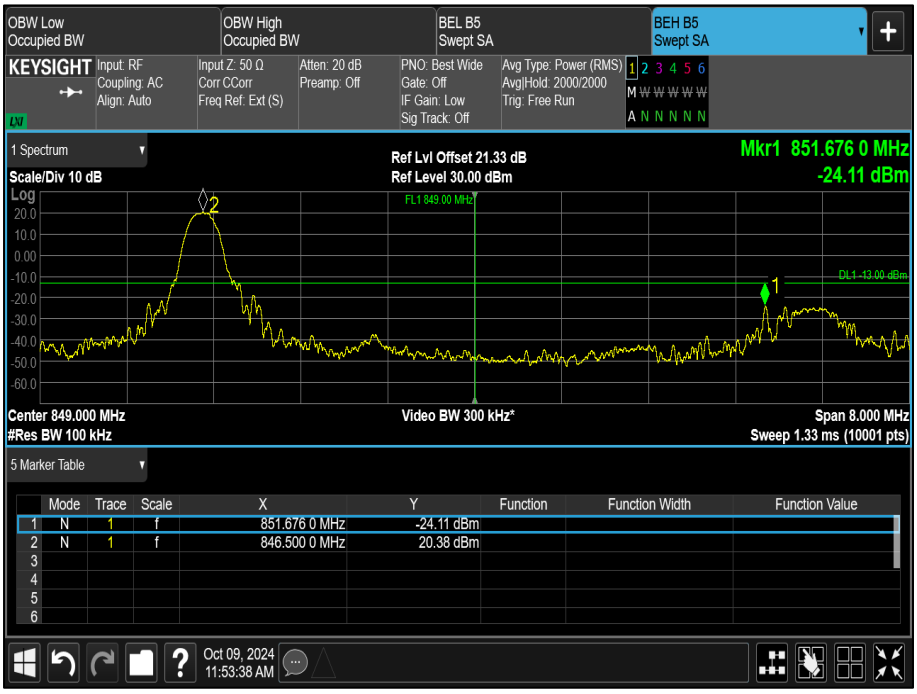

Figure 20 - Upper Band Edge, 846.5 MHz, Modulation: QPSK, SCS: 15 kHz, Tone Number: 12, Start Sub-Carrier: 0

FCC Part 22 Limit Clause 22.917(b)

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

In the 1 MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

ISED RSS-132, Limit Clause 5.5

In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated below the transmitter output power P (dBW) by at least 43 + 10 log(p) dB.

After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated below the transmitter output power P (dBW) by at least 43 + 10 log(p) dB. If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

p is the output power specified in watts.

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
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
Spectrum Analyser	Anritsu	MT8821C	6542	12	28-Jun-2025
Cable N to N 1m	Junkosha	MWX221-01000NMSN/B	6776	12	15-Apr-2025

Table 27

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 22 Clause 22.917
FCC 47 CFR Part 2 Clause 2.1053
ISED RSS-132 Clause 5.5
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

11-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 during the test.

2.5.1 Example Test Setup Diagram

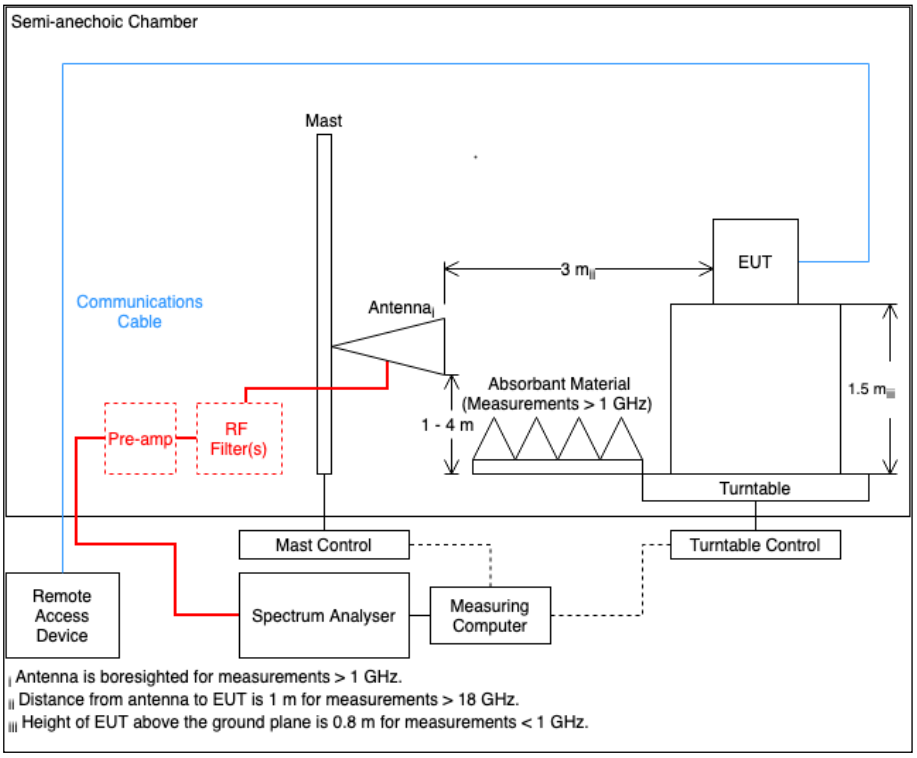

Figure 21

2.5.2 Environmental Conditions

Ambient Temperature	21.3 °C
Relative Humidity	53.4 %

2.5.3 Test Results

LTE FDD B5

Summary of Results

Frequency (MHz)	UARFCN	Modulation	SCS (kHz)	Tone Number	Start Sub-Carrier	MCS
826.5	20425	QPSK	15	6	0	5
836.5	20525	QPSK	15	6	6	5
846.5	20625	QPSK	15	6	6	5

Table 40 – LTE NB IoT Carrier Configuration

LTE FDD B5

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

Table 28 - 826.5 MHz

*No emissions were detected within 10 dB of the limit.

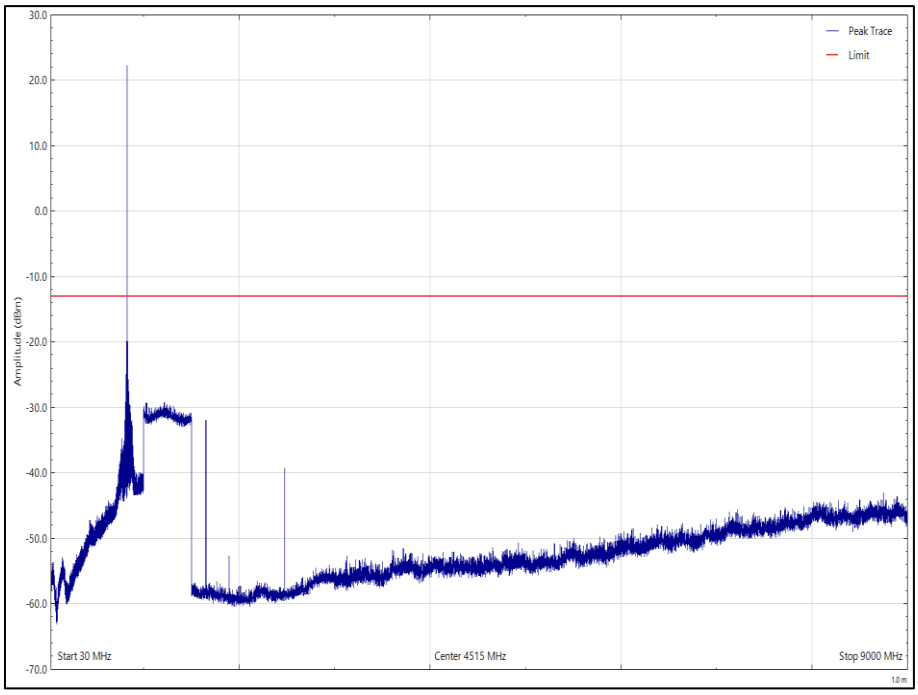

Figure 22 - 826.5 MHz - B5 Bot 30 MHz to 9 GHz, Horizontal, Orientation X

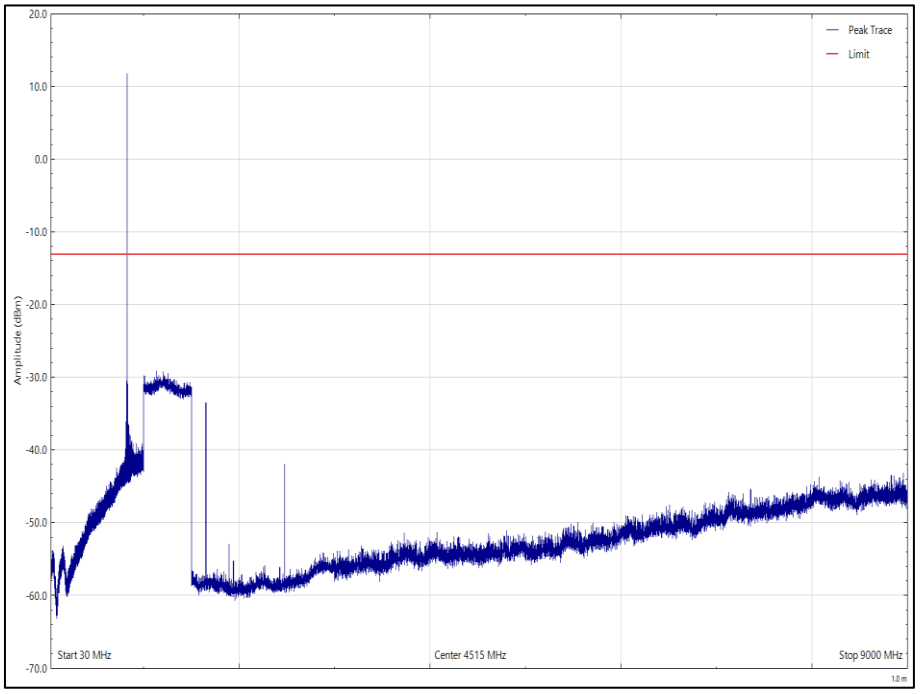

Figure 23 - 826.5 MHz - B5 Bot 30 MHz to 9 GHz, Vertical, Orientation X

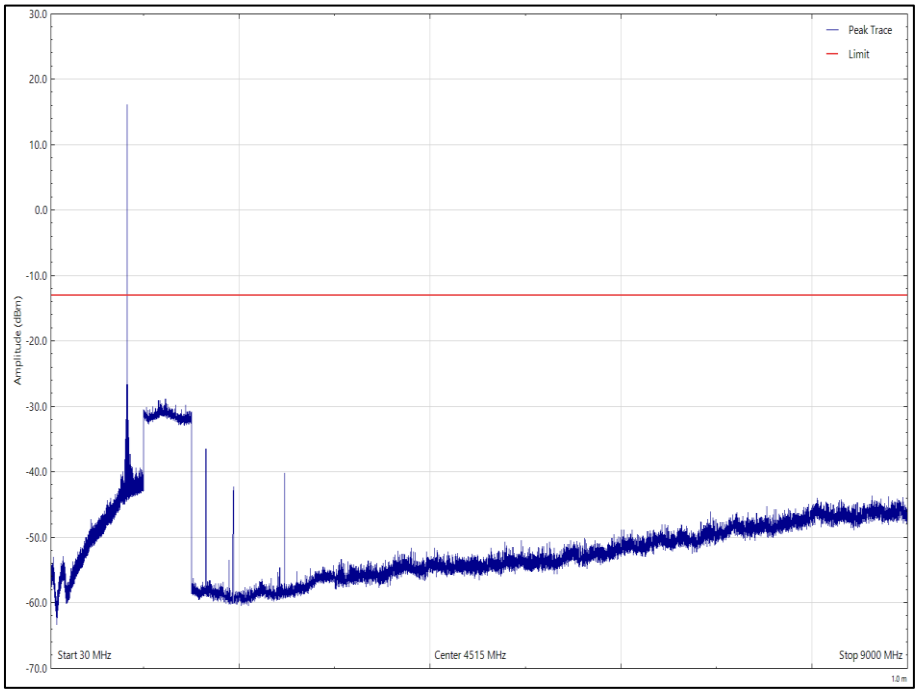

Figure 24 - 826.5 MHz - B5 Bot 30 MHz to 9 GHz, Horizontal, Orientation Y

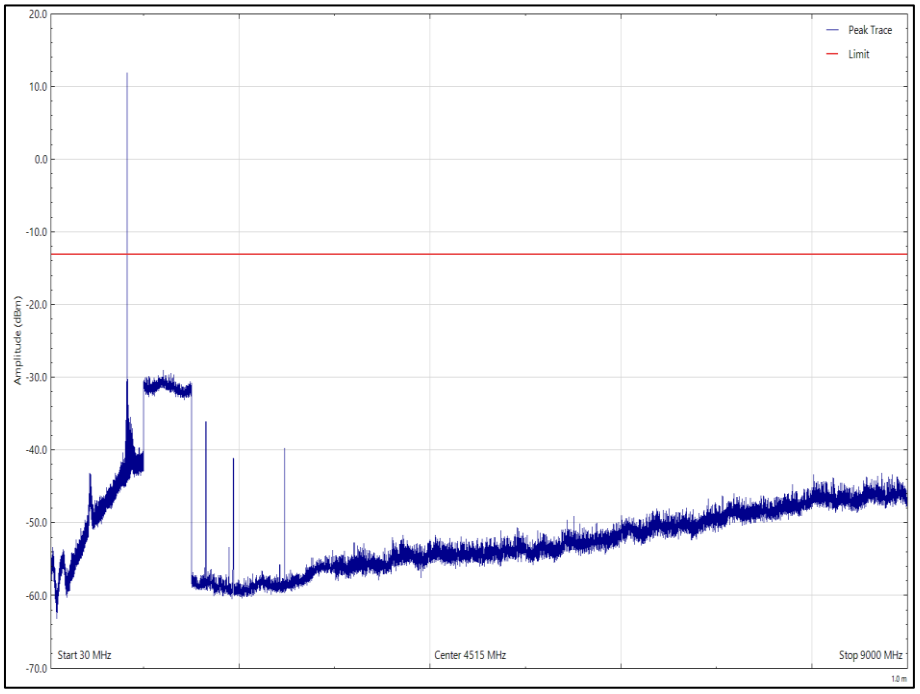

Figure 25 - 826.5 MHz - B5 Bot 30 MHz to 9 GHz, Vertical, Orientation Y

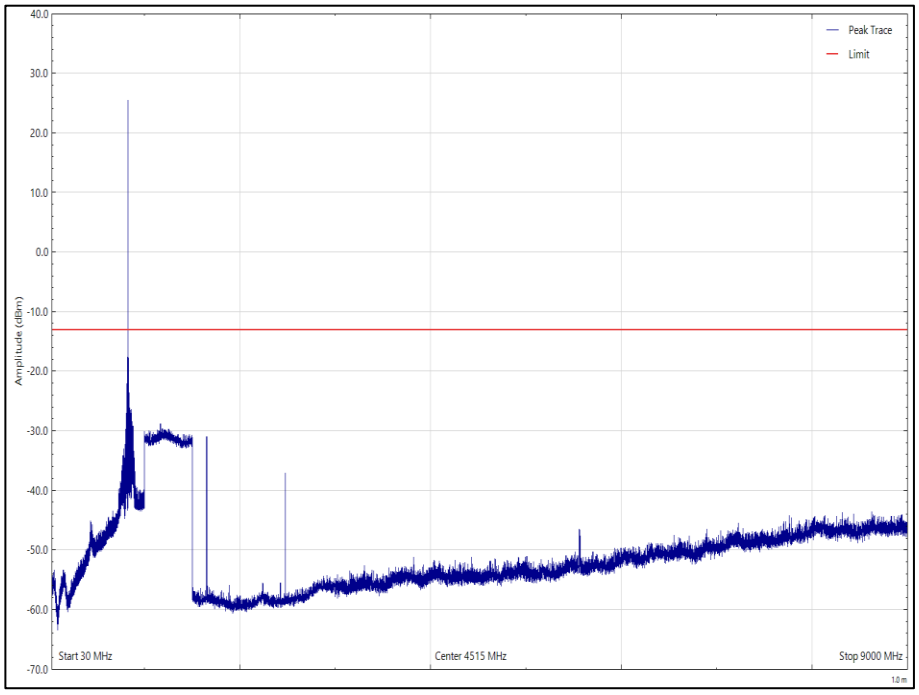

Figure 26 - 826.5 MHz - B5 Bot 30 MHz to 9 GHz, Horizontal, Orientation Z

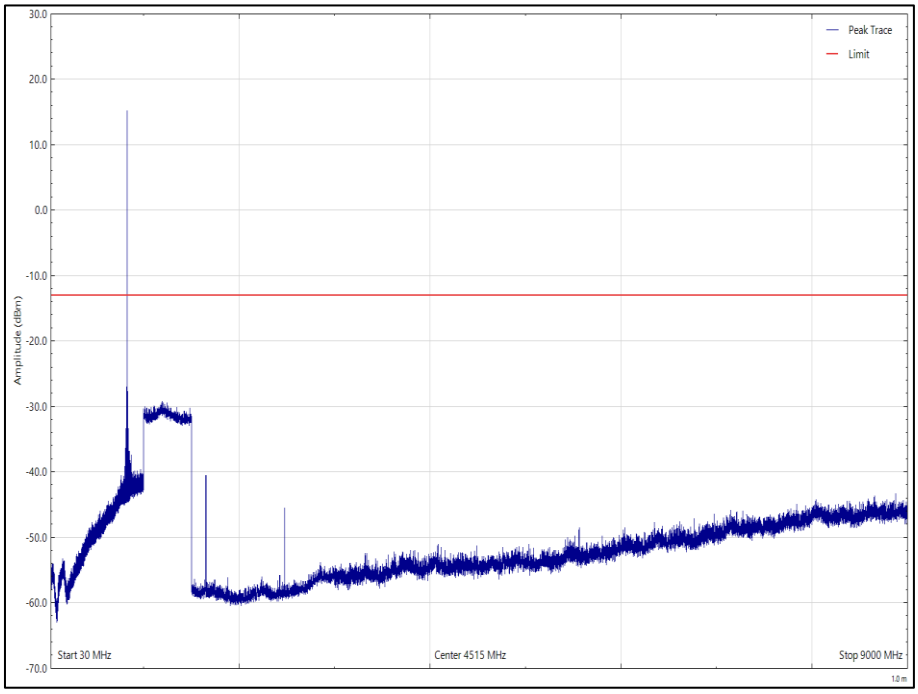

Figure 27 - 826.5 MHz - B5 Bot 30 MHz to 9 GHz, Vertical, Orientation Z

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

Table 29 - 836.5 MHz

*No emissions were detected within 10 dB of the limit.

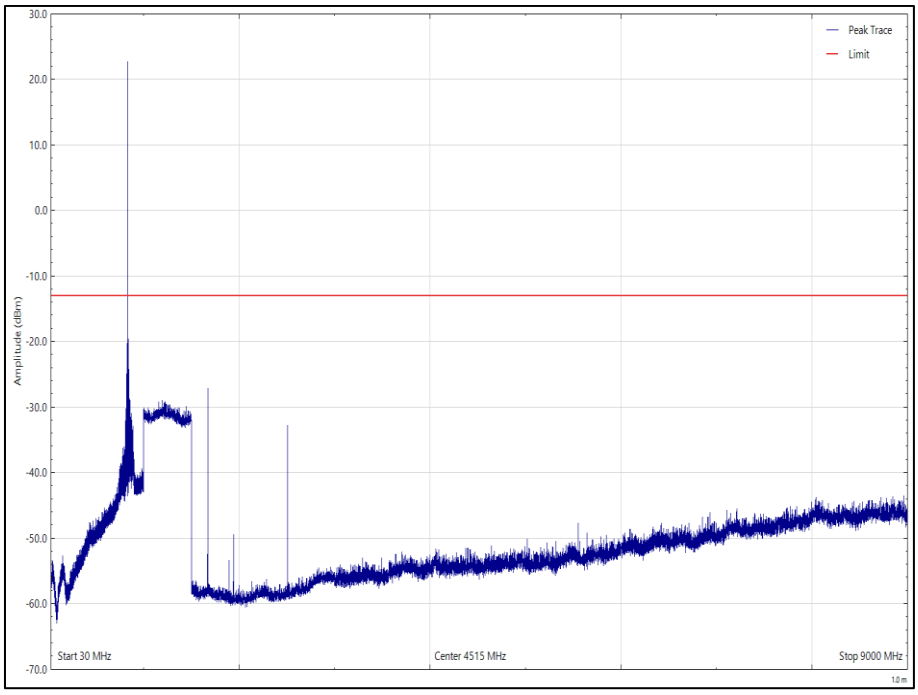

Figure 28 - 836.5 MHz - B5 Mid 30 MHz to 9 GHz, Horizontal, Orientation X

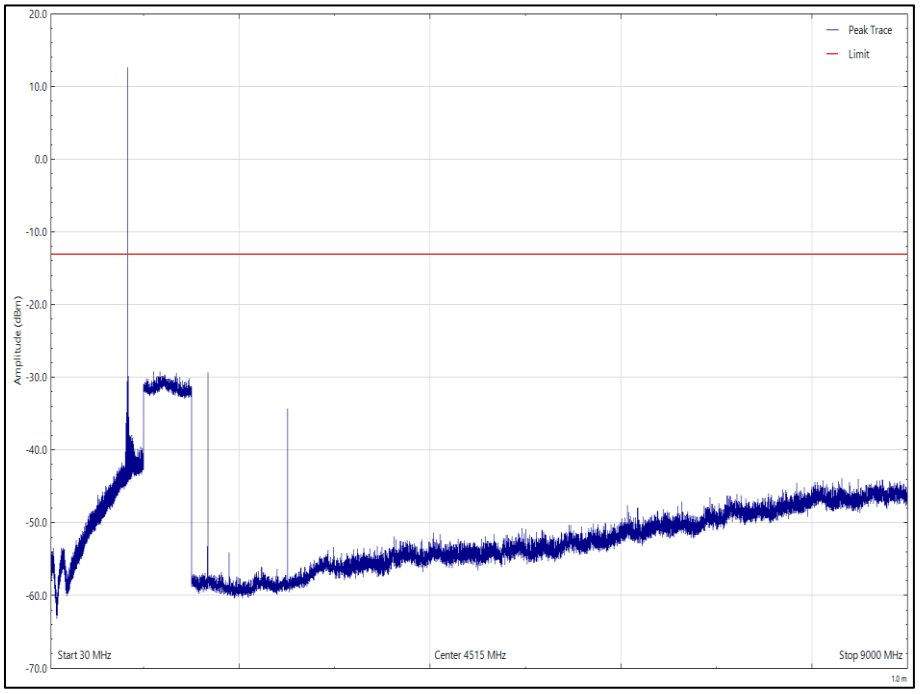

Figure 29 - 836.5 MHz - B5 Mid 30 MHz to 9 GHz, Vertical, Orientation X

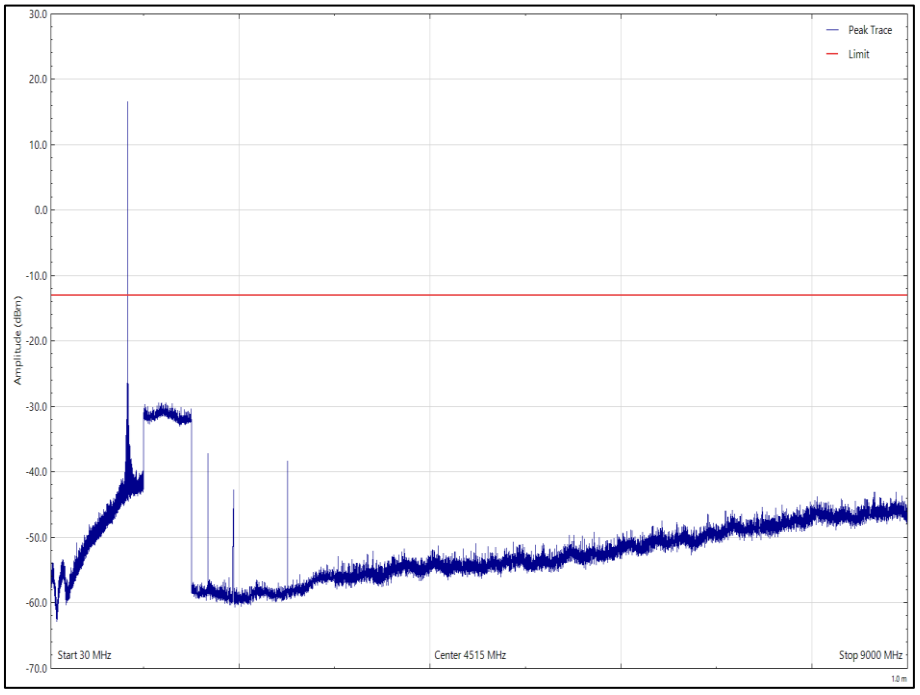

Figure 30 - 836.5 MHz - B5 Mid 30 MHz to 9 GHz, Horizontal, Orientation Y

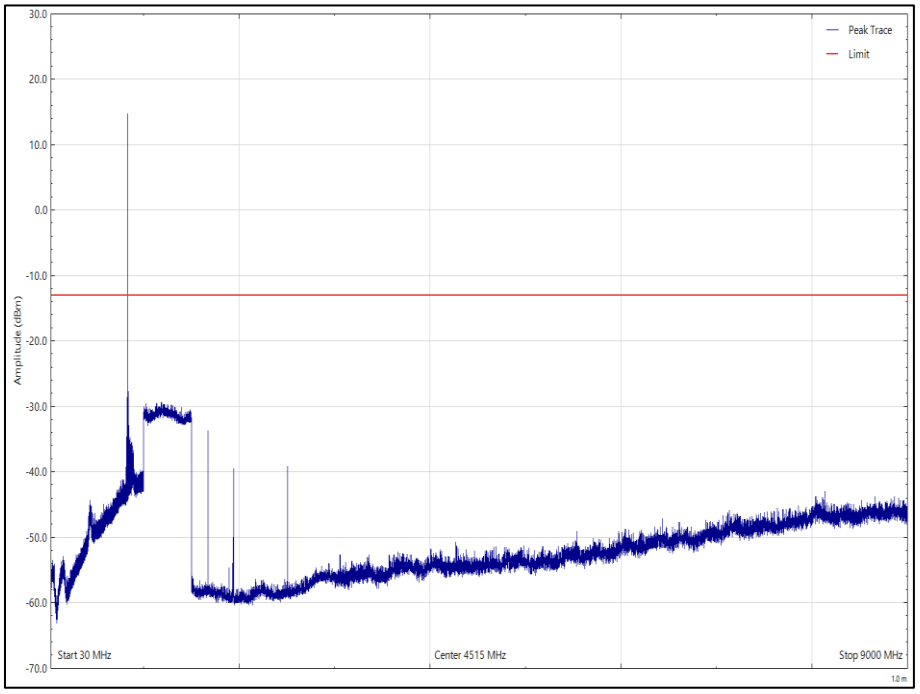

Figure 31 - 836.5 MHz - B5 Mid 30 MHz to 9 GHz, Vertical, Orientation Y

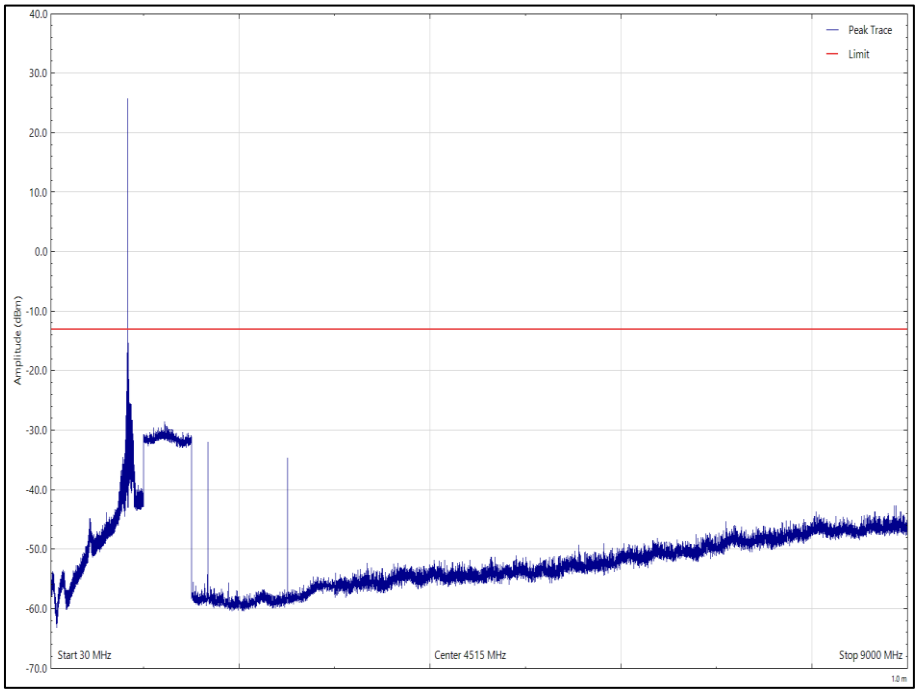

Figure 32 - 836.5 MHz - B5 Mid 30 MHz to 9 GHz, Horizontal, Orientation Z

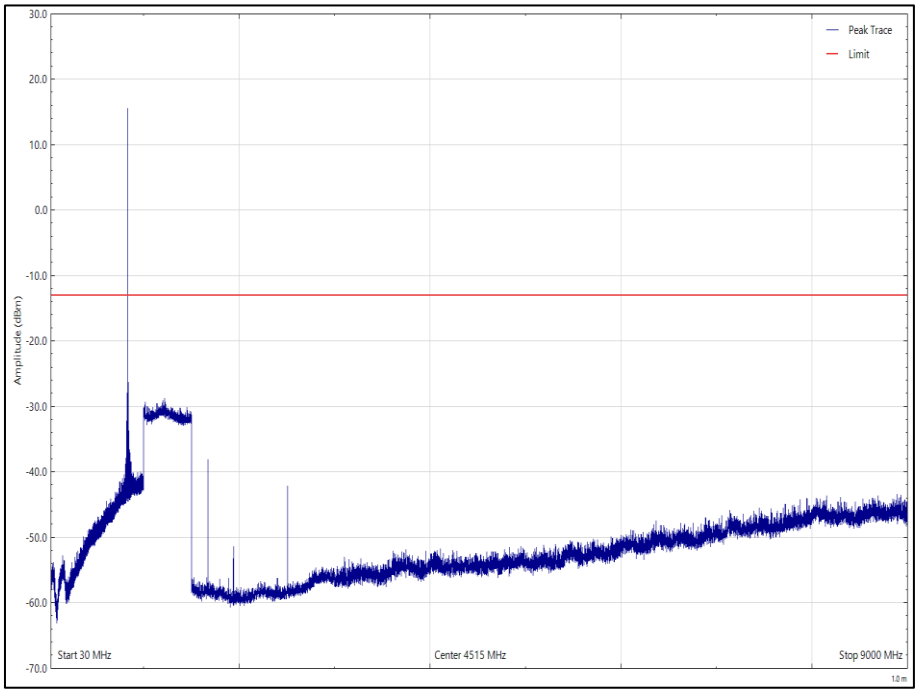

Figure 33 - 836.5 MHz - B5 Mid 30 MHz to 9 GHz, Vertical, Orientation Z

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

Table 30 - 846.5 MHz

*No emissions were detected within 10 dB of the limit.

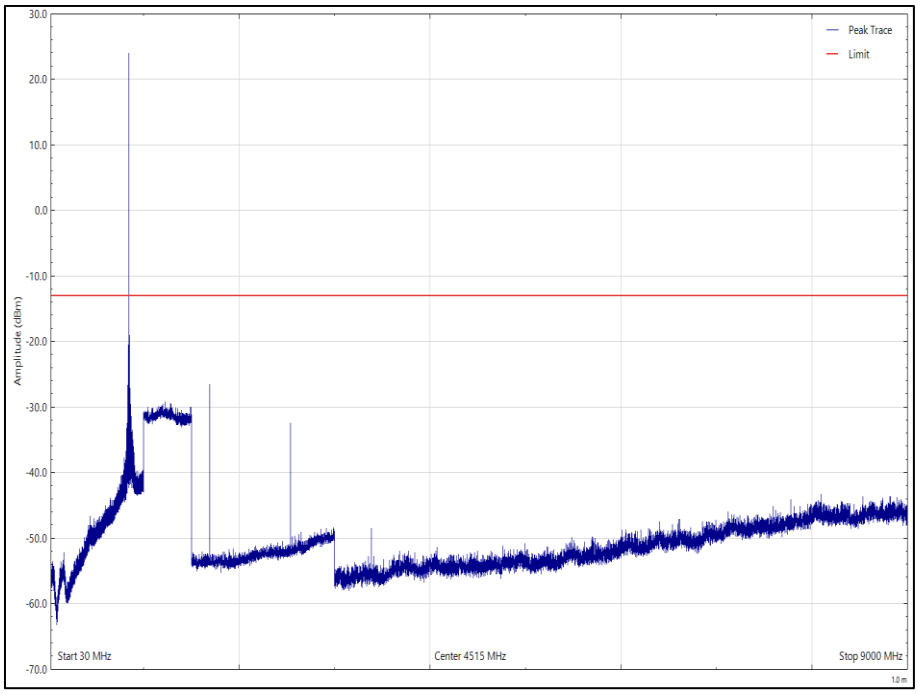

Figure 34 - 846.5 MHz - B5 Top 30 MHz to 9 GHz, Horizontal, Orientation X

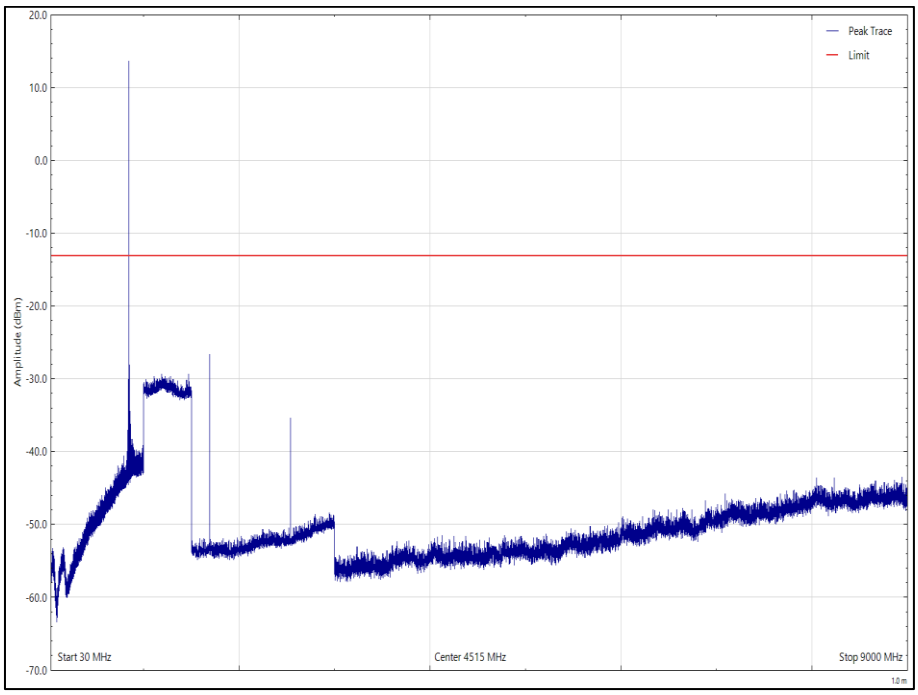

Figure 35 - 846.5 MHz - B5 Top 30 MHz to 9 GHz, Horizontal, Orientation X

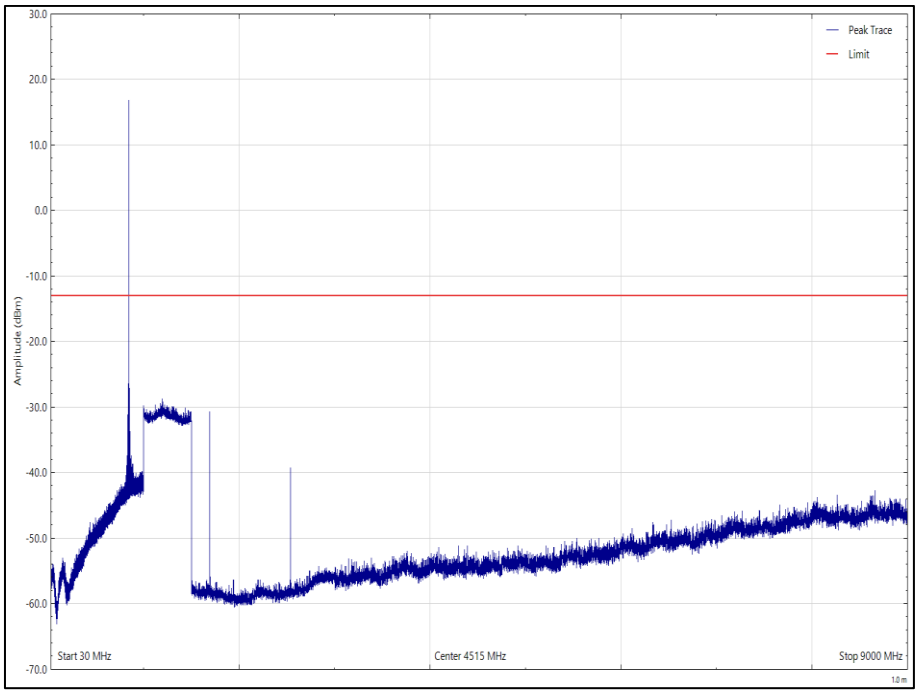

Figure 36 - 846.5 MHz - B5 Top 30 MHz to 9 GHz, Horizontal, Orientation Y

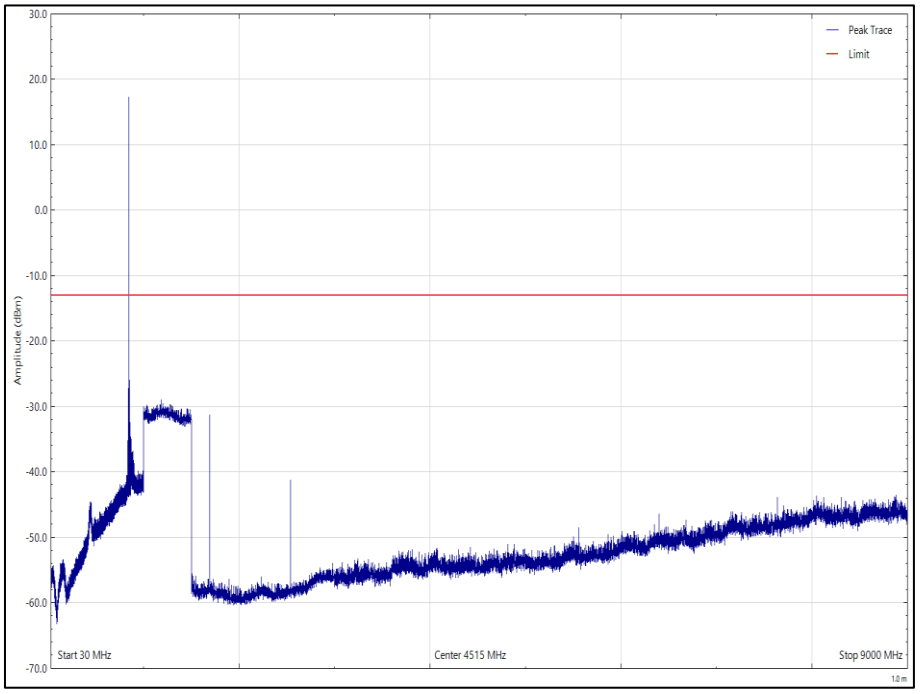

Figure 37 - 846.5 MHz - B5 Top 30 MHz to 9 GHz, Horizontal, Orientation Y

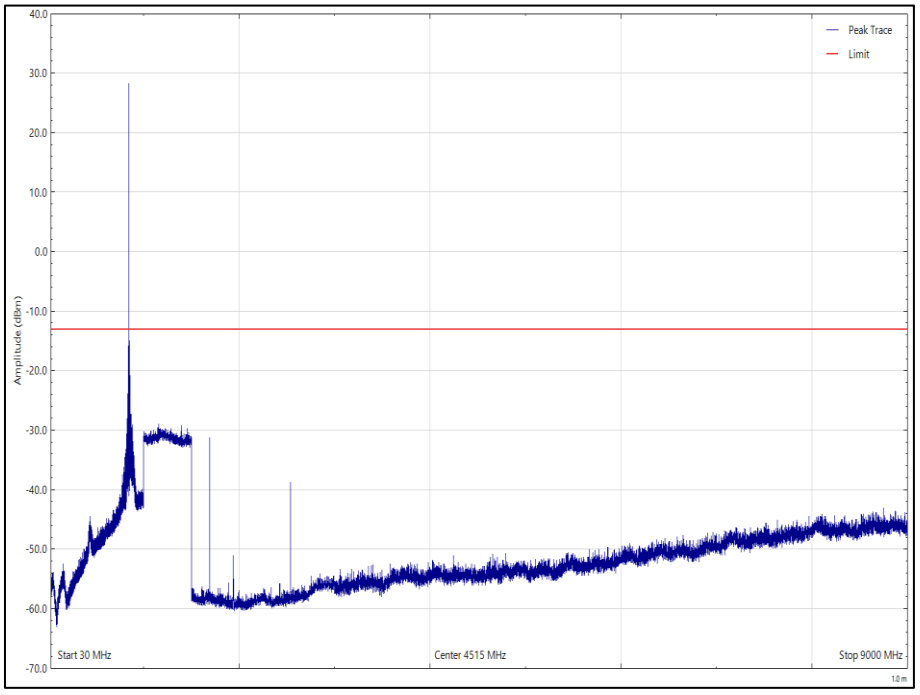

Figure 38 - 846.5 MHz - B5 Top 30 MHz to 9 GHz, Horizontal, Orientation Z

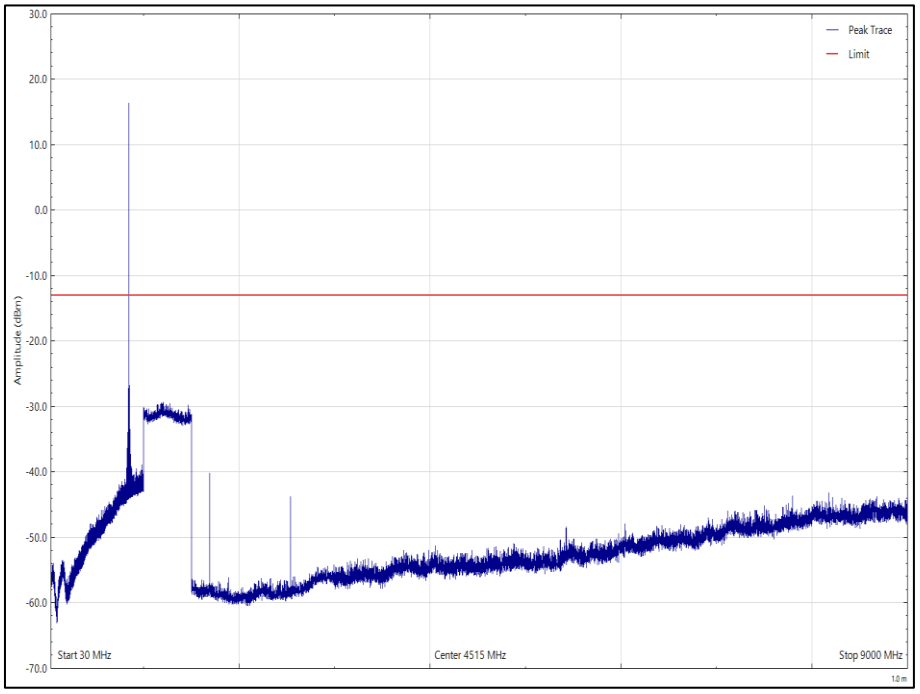

Figure 39 - 846.5 MHz - B5 Top 30 MHz to 9 GHz, Horizontal, Orientation Z

FCC 47 CFR Part 22, Limit Clause 22.917(a)

The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

ISED RSS-132, Limit Clause 5.5

In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated below the transmitter output power P (dBW) by at least 43 + 10 log(p) dB.

After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated below the transmitter output power P (dBW) by at least 43 + 10 log(p) dB. If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

p is the output power specified in watts.

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 31

TU - Traceability Unscheduled

2.6 Frequency Tolerance

2.6.1 Specification Reference

FCC 47 CFR Part 22 Clause 22.355
FCC 47 CFR Part 2 Clause 2.1055
ISED RSS-132 Clause 5.3
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

11-September-2024 to 11-October-2024

2.6.4 Test Method

All measurements were made in accordance with ANSI C63.26, Clause 5.6 and the provisions of RSS-GEN clause 6.11.

EUT was powered by 3x 1.5V battery cells.

2.6.5 Environmental Conditions

Ambient Temperature	19.4 - 22.7 °C
Relative Humidity	33.2 - 45.8 %

2.6.6 Test Results

LTE FDD B5

Voltage	Frequency Error (ppm)		
	826.5 MHz	836.5 MHz	846.5 MHz
2.2	0.00	0.00	0.01
4.5	0.02	0.02	0.01

Table 32 - Frequency Stability Under Voltage Variations

Temperature	Frequency Error (ppm)		
	826.5 MHz	836.5 MHz	846.5 MHz
+50.0 °C	0.02	0.02	0.01
+40.0 °C	0.01	0.01	0.01
+30.0 °C	0.02	0.01	0.02
+20.0 °C	0.02	0.02	0.01
+10.0 °C	0.02	0.01	0.02
0 °C	0.02	0.02	0.00
-10.0 °C	0.04	0.01	0.00
-20.0 °C	0.01	0.00	0.04
-30.0 °C	Transmitter shut down		

Table 33 - Frequency Tolerance Under Temperature Variations

FCC 47 CFR Part 22, Limit Clause 22.355

Frequency range (MHz)	Limit (ppm)
25 to 50	20.0
50 to 450	5.0
450 to 512	2.5
821 to 896	1.5
928 to 929	5.0
929 to 960	1.5
2110 to 2220	10.0

Table 34 - FCC Limit Table

ISED RSS-132, Limit Clause 5.3

The frequency stability shall be sufficient to ensure that the occupied bandwidth stays within each of the sub-bands 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 (10dB, 1W)	Sealectro	60-674-1010-89	1224	-	O/P Mon
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
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
Climatic Chamber	Weiss Technik	TempEvent T/180/40/3	5894	-	O/P Mon
Cable (SMA to SMA 3m)	Junkosha	MWX221-03000AMSAMS/B	6023	12	06-Jun-2025
Spectrum Analyser	Anritsu	MT8821C	6542	12	28-Jun-2025
Programmable Power Supply 188 W	Rohde & Schwarz	HMP2020x0	6598	-	O/P Mon
Cable N to N 1m	Junkosha	MWX221-01000NMSN/B	6776	12	15-Apr-2025

Table 35

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

3 Photographs

3.1 Test Setup Photographs

Figure 40 - 30MHz-1GHz

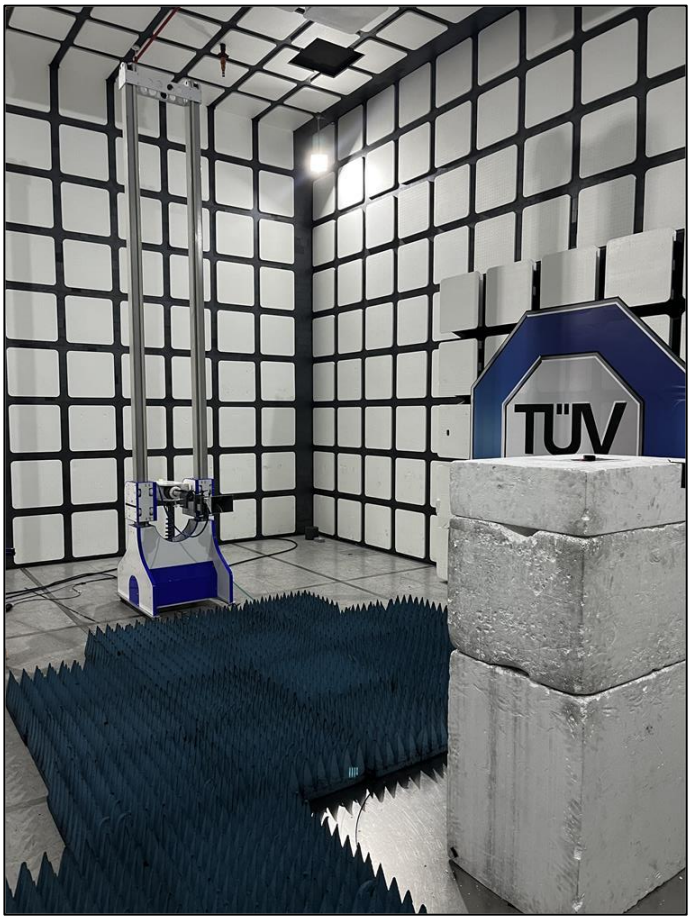

Figure 41 - 1GHz-9GHz

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
Emission Bandwidth	± 4.505 kHz
Spurious Emissions at Band Edge	±3.454 dB
Frequency Tolerance	± 4.333 kHz
Radiated Spurious Emissions	30 MHz to 1 GHz: ±5.2 dB; 1 GHz to 40 GHz: ±6.3 dB

Table 36

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.