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Test Report Num	24E10894-1a Part 1 of 2
Quotation	Q24-2009-1
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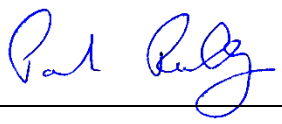
Test Report By	Michael Kirby
FCC Test Firm Registration	IE0002
ISED CAB identifier:	IE0001
Date	15th Oct 2024
EUT Description	Asset Tracker
FCC ID	2AT4V-HATI
IC ID	26629-HATI
Authorised by	**Paul Reilly**
Authorised Signature:	

TEST SUMMARY

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

FCC 15.247 Section	RSS-247 Section	TEST PARAMETERS	Test Result
15.247 (a)2	RSS-247 5.2a	6dB bandwidth	Pass
15.247 (e)	RSS-247 5.2b	Power Spectral Density	Pass
15.247 (b)3	RSS-247 5.4d	Output power Conducted	Pass
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions	Pass
15.205 15.209	RSS Gen 8.9 RSS Gen 8.10	Radiated Spurious Emissions	Pass
	RSS Gen 6.7	99% bandwidth	Pass

RSS 247 Issue 3 Aug 2023
RSS-Gen Issue 5 Apr 2018 + Amd1 Mar 2019 + Amd2 Feb 2021

Exhibit A – Technical Report

Table of Contents

Ref report “Alps 24E10894-1a Hati BLE FCCIC Part 2 of 2 for appendices C,D,E”,F

1.0 EUT Description

FCC ID	2AT4V-HATI
IC ID	26629-HATI
Type:	Asset Tracker
Type of radio:	Stand-alone

BLE

Type of radio:	Stand-alone
Transmitter Type:	BLE
Operating Frequency Range(s):	2.402 GHz - 2.480GHz
Number of Channels:	40
Power configuration:	3.7v Battery.
Ports:	None
Classification:	DTS
BLE Antenna Type :	Chip antenna
BLE Antenna Gain Max:	5 dBi
Antenna Impedance:	50 ohms
Test Standards:	15.247 RSS-247
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2013

The EUT was an asset tracker reporting on the BLE and cellular networks.

The EUT contains a custom BLE radio and a pre certified cellular module from Quectel
FCC ID: XMR2021BC660KGL, IC: 10224A-2021BC660GL
This report details test carried out on the custom BLE transmitter with the cellular module off.

There are multiple EUT models based on the same artwork and firmware and the only difference is in how the EUT is powered,
i.e. a) battery only,
b) powered from battery and external dc source and
c) powered from battery / external mains adapter.

All models were tested and the worst case results are reported here.

1.1 EUT Operation

Operating Conditions during Test:

Conducted measurements were carried out on a sample (labelled “EVA2KV”) where the antenna was replaced by cable and SMA.
The EUT was powered from mains to DC power adapter from CUI INC
model: SW16-12-E.

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 one sample of the of EUT (labelled “C6MZLK”), with BLE active and the cellular switched off.
The EUT was powered from mains to DC power adapter from CUI INC
model: SW16-12-E.
Radiated Emissions were performed in CE mode

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 27th and 30th Sept and 10th Oct 2024.

1.4 Description of Test modes

Channel List

Channel	Channel	Freq MHz
Low	1	2402
Mid	19	2426
High	39	2480

All tests were performed with the EUT on the low mid and high channels.

2 Emissions Measurements

2.1 Conducted Emissions Measurements

Radio Conducted measurements were carried out on the EUT as per section 1.1 above.

All results were measured as conducted on the antenna except radiated spurious emissions.

2.2 Radiated Emissions Measurements

Radiated Power measurements were made at the Compliance Engineering Ireland Ltd anechoic chamber located in Dunshaughlin, Co. Meath, Ireland to determine the radio noise radiated from the EUT. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.
The EUT was centred on a motorized turntable, which allows 360 degree rotation.

Emissions below 1GHz were measured using a test antenna positioned at a distance of 3 metres from the EUT (as measured from the closest point of the EUT). 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. In this case the resolution bandwidth was 100kHz.

Emissions in the 1GHz-18GHz range were measured using a horn antenna located at 3 metres distance from the EUT in a fully anechoic chamber.
The radiated emissions were maximised by configuring the EUT and by rotating the EUT, and by raising and lowering the test antenna from 1 to 4 metres.
Emissions above 18GHz were measured using a horn antenna located at 1 metre distance from the EUT in a fully anechoic chamber. The radiated emissions peaks where detected were maximised by configuring the EUT and by rotating the EUT and raising the test and antenna from 1 to 4 metres.
In this case the resolution bandwidth was 1MHz and video bandwidth was 3 MHz. for peak measurements. The Video bandwidth was changed to 10Hz for Average measurements (as per ANSI 63.10 2013 Section 4.1.4.2.3)

A pre-scan was performed to determine the worst case EUT orientation for the radiated measurements.
All radiated tests were performed with the EUT in orientation O3 for Horizontal polarization measurements and with the EUT in orientation O2 for Vertical polarisation measurements.
Ref Appendix D for orientations.

3.0 Results for Conducted emissions on the mains

Test not performed as the host for the EUT is battery powered only

Detector	Frequency	Reading	Margin	Phase
QP/ Ave	MHz	dBuV	dB	L/N
Quasi-Peak	0.1500	27.03	-38.97	Live
Average	0.5055	11.61	-34.39	Live
Quasi-Peak	0.5100	39.27	-16.73	Live
Quasi-Peak	1.6823	29.13	-26.87	Live
Quasi-Peak	2.753	28.05	-27.95	Live
Quasi-Peak	3.824	25.77	-30.23	Live
Average	28.685	6.30	-43.7	Live
Quasi-Peak	29.949	9.85	-50.15	Live

Detector	Frequency	Reading	Margin	Phase
QP/ Ave	MHz	dBuV	dB	L/N
Quasi-Peak	0.1500	36.82	-29.18	Neutral
Average	0.5055	12.14	-33.86	Neutral
Quasi-Peak	0.5100	39.62	-16.38	Neutral
Quasi-Peak	1.6823	28.88	-27.12	Neutral
Quasi-Peak	2.7533	27.04	-28.96	Neutral
Quasi-Peak	3.8243	24.30	-31.7	Neutral
Average	28.6845	6.34	-43.66	Neutral
Quasi-Peak	29.9490	11.39	-48.61	Neutral

Test Result: Pass

4. Conducted Measurements

4.1 Bandwidth

4.1.1 6dB bandwidth

Test Method
As per Ansi 63.10 Section 11.8.2

Ansi63.10 Section **11.8.2 Option 2**
The automatic bandwidth measurement capability of an instrument may be employed using the *X* dB bandwidth mode with *X* set to 6 dB, if the functionality described in 11.8.1 (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, and peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥6 dB.

Limit for 6dB Bandwidth = 500KHz min

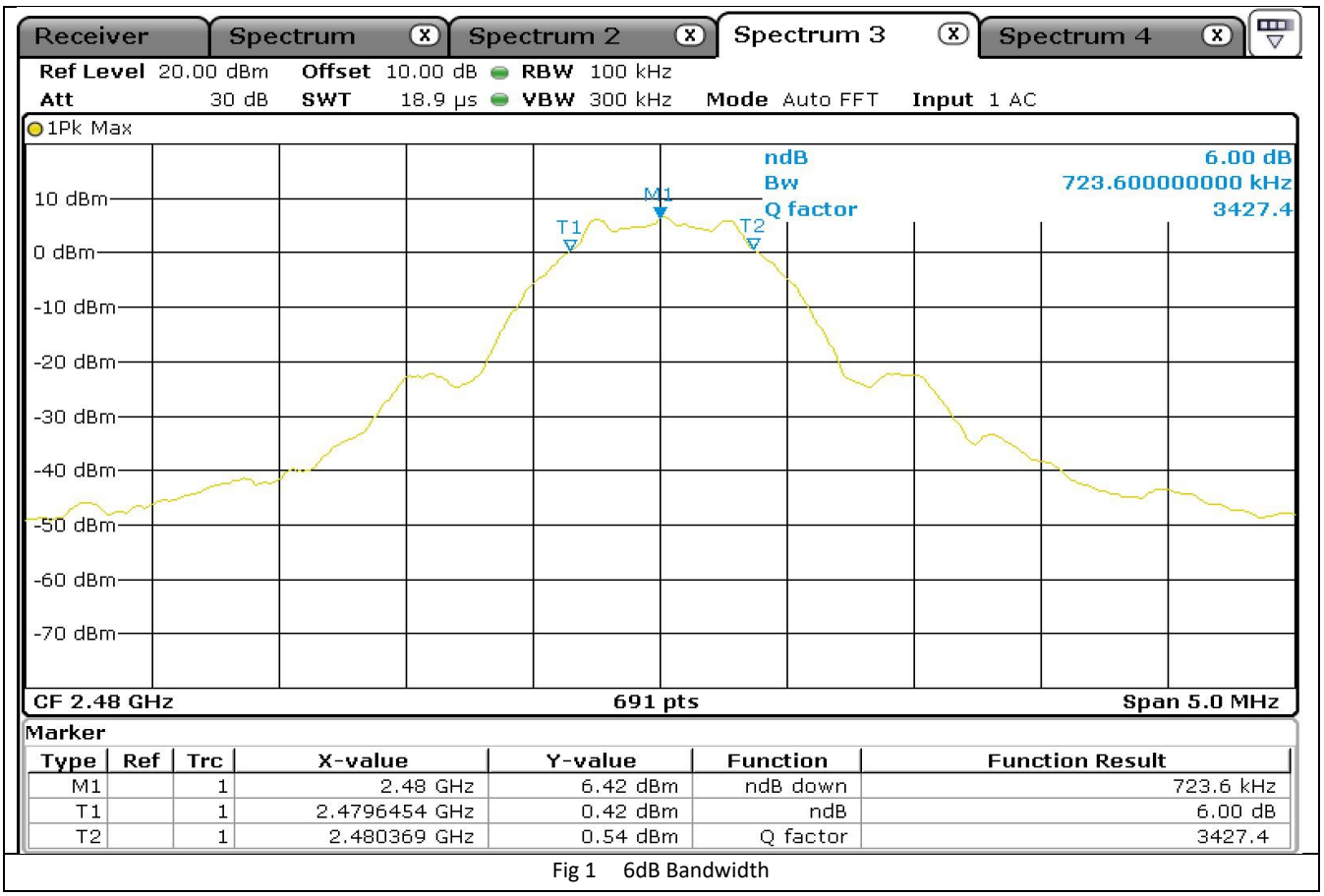


Fig 1 6dB Bandwidth

Frequency	6dB Bandwidth	Limit Min	Margin
GHz	KHz	KHz	KHz
2.402	723.60	500	223.60
2.426	709.1	500	209.10
2.48	723.6	500	223.60

Result :- Pass

4.1.2 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).

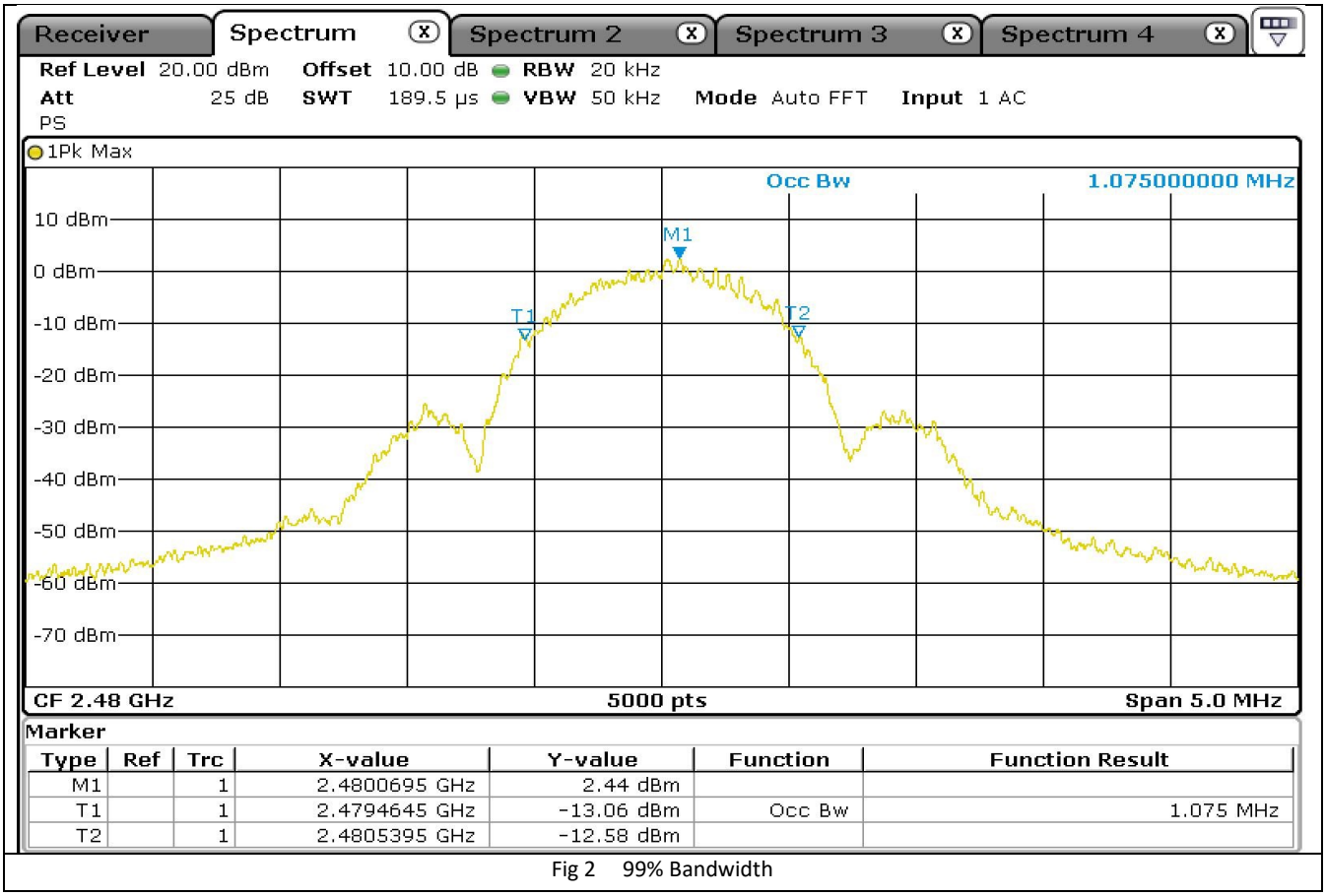


Fig 2 99% Bandwidth

Frequency	99% Bandwidth
GHz	MHz
2.402	1.06
2.426	1.067
2.48	1.075

Result :- Pass

4.2 Duty Cycle

Test Method
As per Ansi 63.10 Section 11.6 zero span measurement method

Ansi63.10 Section **11.6 Duty cycle (*D*), transmission duration (*T*), and maximum power control level**
Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (i.e., with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be used to ensure that measurements are made only during transmissions at the maximum power control level. Such sweep triggering/signal gating techniques will require knowledge of the minimum transmission duration (*T*) over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation. Sweep triggering/signal gating techniques can then be used if the measurement/sweep time of the analyzer can be set such that it does not exceed *T* at any time that data are being acquired (i.e., no transmitter OFF-time is to be considered).

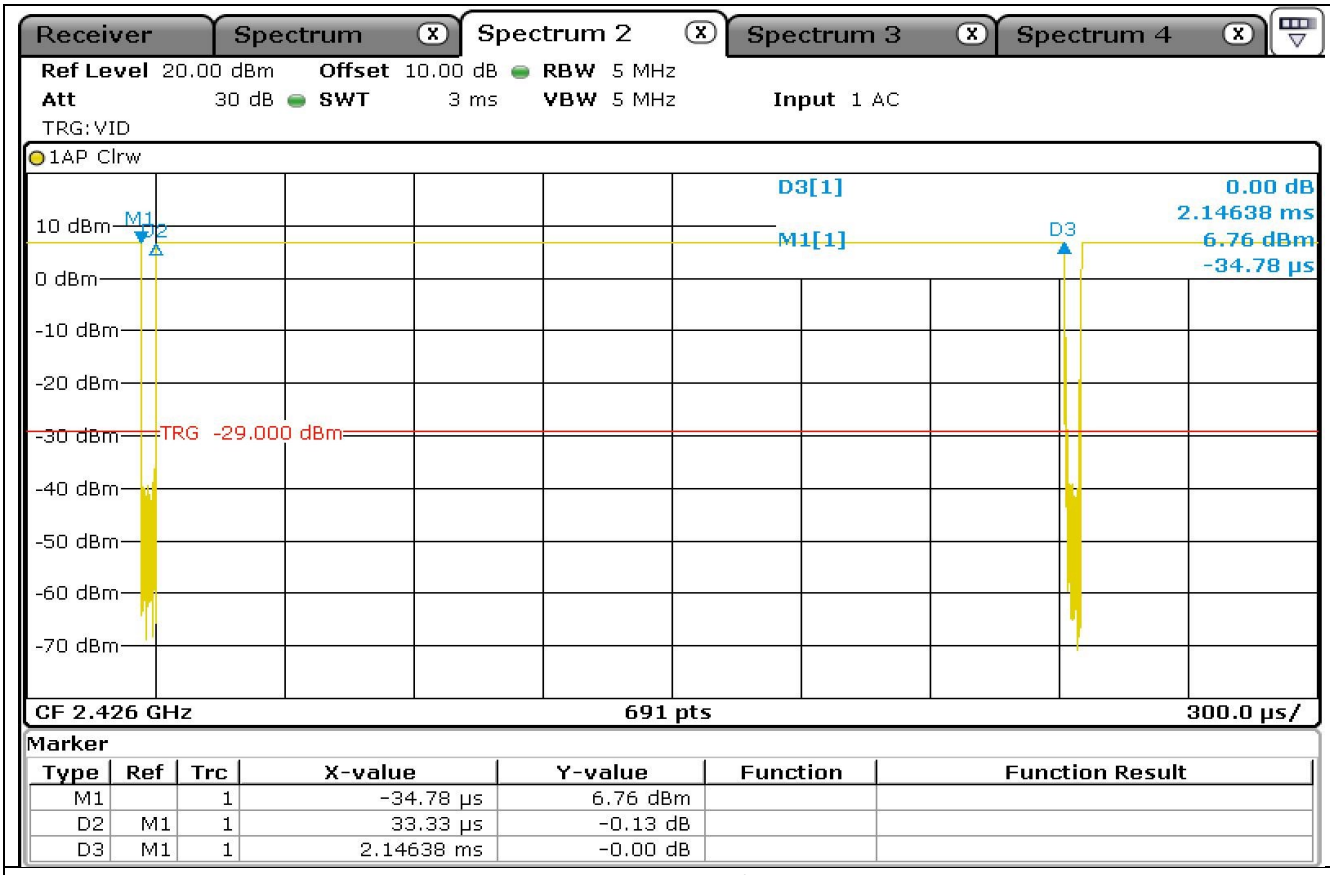


Fig 3 Duty Cycle

Duty Cycle =
Note the duty cycle results above shows how the sample operated during testing.

One Period uS	Pulse Width uS	Duty Cycle	Duty Cycle
2146.38	**33.3**	**0.9845**	**98.45%**

4.3 Power Spectral Density

Test Method
As per Ansi 63.10 Section 11.10.2

Ansi63.10 Section **Section 11.10.2 Method PKPSD (peak PSD)**
The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:
a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

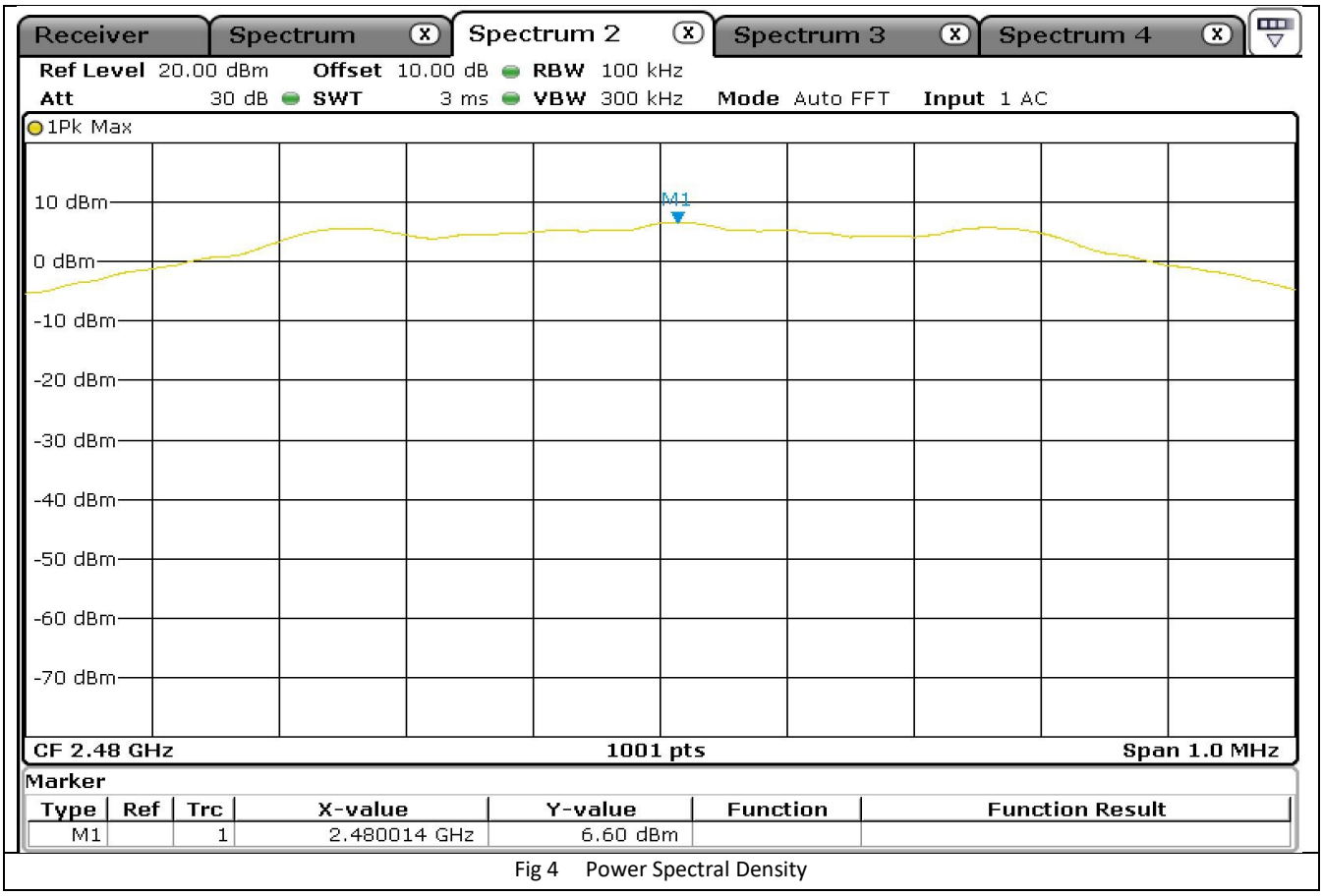


Fig 4 Power Spectral Density

Frequency	Conducted Peak	Limit	Margin
GHz	dBm	dBm	dB
2.402	6.69	8	1.31
2.426	6.68	8	1.32
2.48	6.6	8	1.40

Result :- Pass

4.4 Output power Conducted

4.4.1 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 ≥ 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.

4.4.2 Results

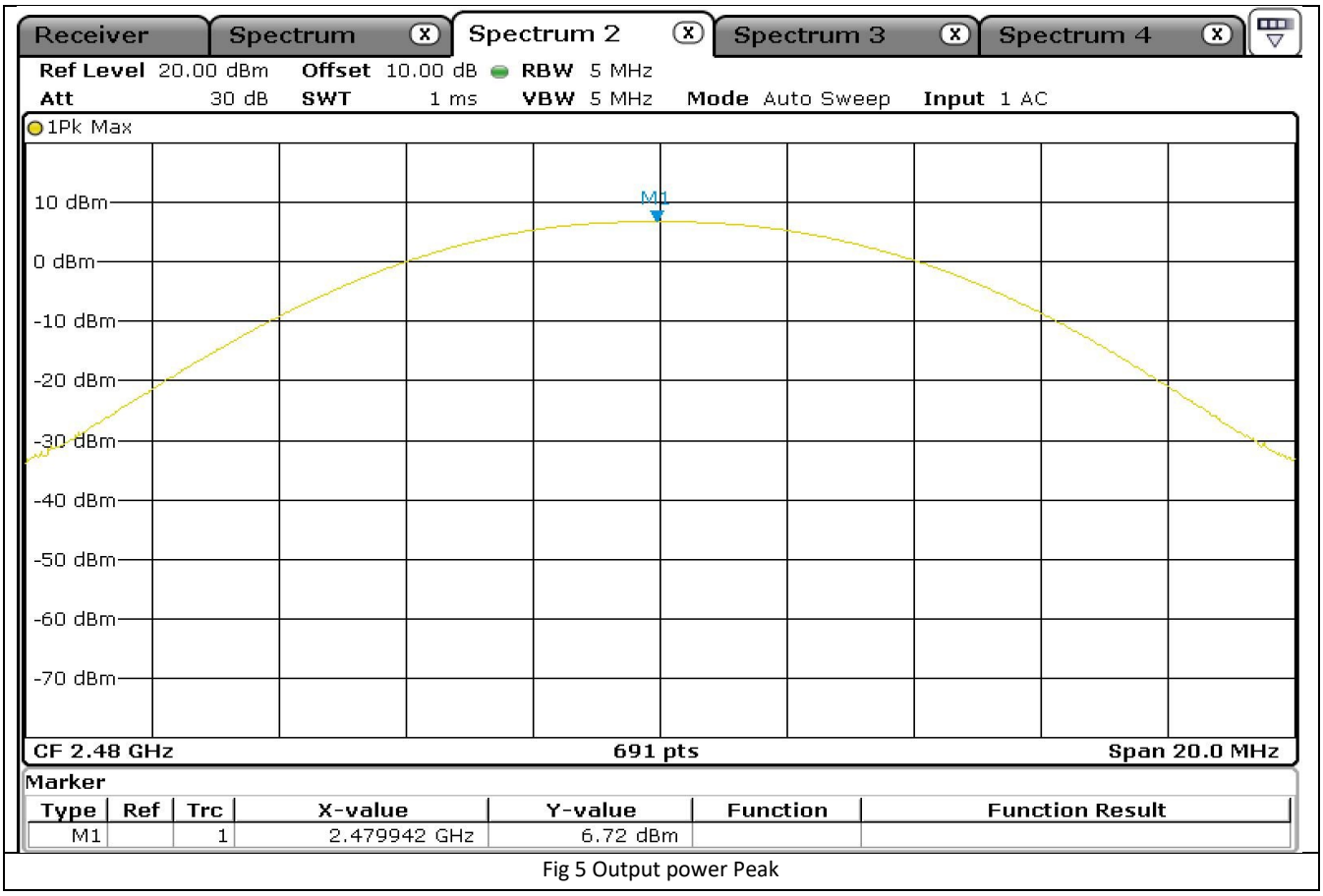


Fig 5 Output power Peak

Frequency	Conducted Measurement Peak	Limit	Margin
GHz	dBm	dBm	dB
2.402	6.74	30	23.26
2.426	6.79	30	23.21
2.48	6.72	30	23.28

Test Result :- Pass

5. Spurious Emissions Measurements

5.1 Conducted Spurious Emissions

5.1.1 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 conditions89:
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).

5.1.2 Results

Frequency	Peak 100KHz RBW	dBc Limit Min	Margin	Result
GHz	dBm	dB	dB	P/F
2.402	6.83	20	-	-
4.804	-63.89	20	50.72	Pass
7.206	-73.51	20	60.34	Pass
9.608	-75.78	20	62.61	Pass
12.01	-50.82	20	37.65	Pass
2.529	-42.27	20	29.1	Pass
2.274	-43.26	20	30.09	Pass

Frequency	Peak 100KHz RBW	dBc Limit Min	Margin	Result
GHz	dBm	dB	dB	P/F
2.426	6.61	20	-	-
4.852	-61.65	20	48.26	Pass
7.278	-70.43	20	57.04	Pass
9.704	-75.49	20	62.1	Pass
12.13	-51.08	20	37.69	Pass
2.298	-42.74	20	29.35	Pass
2.554	-43.03	20	29.64	Pass

Frequency	Peak 100KHz RBW	dBc Limit Min	Margin	Result
GHz	dBm	dB	dB	P/F
2.48	6.67	20	-	-
4.96	-68.96	20	55.63	Pass
7.44	-65.32	20	51.99	Pass
9.92	-70.51	20	57.18	Pass
12.4	-56.95	20	43.62	Pass
2.532	-42.85	20	29.52	Pass
2.608	-41.92	20	28.59	Pass

Ref Appendix A for Scans

Test Result: - Pass

5.2 Radiated Spurious Emissions in Restricted bands

5.2.1 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.92 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

As per Ansi 63.10 Section 11.12.2.5.2

5.2.2 Low Channel

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
2.258	27.3	O2	Vertical	28	0	4.7	60.0	54.0	14.0	Pass
2.274	28.3	O1	Horizontal	28	0	4.7	61.0	54.0	13.0	Pass
4.804	47.9	O2	Vertical	33.1	39.3	7.8	49.5	54.0	24.5	Pass
12.010	44.7	O2	Vertical	39.2	37.3	10.9	57.5	54.0	16.5	Pass
4.804	50.1	O1	Horizontal	33.1	39.3	7.8	51.7	54.0	22.3	Pass
12.010	44.9	O1	Horizontal	39.2	37.3	10.9	57.7	54.0	16.3	Pass

Final Field Strength Peak (dBuV/m) =Reading Peak (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB)
Calculation Example **60 = 27.3 + 28 - 0 + 4.7**

Frequency	Reading Average	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Average	Average Limit	Margin	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
2.258	1.7	O2	Vertical	28	0	4.7	34.4	54.0	19.6	Pass
2.274	11.0	O1	Horizontal	28	0	4.7	43.7	54.0	10.3	Pass
12.010	34.6	O2	Vertical	39.2	37.3	10.9	47.4	54.0	6.5	Pass
12.010	34.8	O1	Horizontal	39.2	37.3	10.9	47.6	54.0	6.3	Pass

Final Field Strength Average (dBuV/m) =Reading Average (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB)
Calculation Example **34.4 = 1.7 + 28 - 0 + 4.7**

Test Result Pass

5.2.3 Mid Channel

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
2.282	14.4	O2	Vertical	28	0	4.7	47.1	54.0	26.9	Pass
2.282	18.5	O1	Horizontal	28	0	4.7	51.2	54.0	22.8	Pass
4.852	48.2	O2	Vertical	33.2	39	7.8	50.2	54.0	23.8	Pass
7.278	49.4	O2	Vertical	36.2	40.6	10.1	55.1	54.0	18.9	Pass
12.130	44.1	O2	Vertical	39.1	37	10.9	57.1	54.0	16.9	Pass
4.852	48.2	O1	Horizontal	33.2	39	7.8	50.2	54.0	23.8	Pass
7.278	49.8	O1	Horizontal	36.2	40.6	10.1	55.5	54.0	18.5	Pass
12.130	44.7	O1	Horizontal	39.1	37	10.9	57.7	54.0	16.3	Pass

Final Field Strength Peak (dBuV/m) =Reading Peak (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB)
Calculation Example **47.1 = 14.4 + 28 - 0 + 4.7**

Frequency	Reading Average	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Average	Average Limit	Margin	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
7.278	42.4	O2	Vertical	36.2	40.6	10.1	48.1	54.0	5.9	Pass
12.130	34.4	O2	Vertical	39.1	37	10.9	47.4	54.0	6.6	Pass
7.278	45.2	O1	Horizontal	36.2	40.6	10.1	50.9	54.0	3.1	Pass
12.130	34.6	O1	Horizontal	39.1	37	10.9	47.6	54.0	6.3	Pass

Final Field Strength Average (dBuV/m) =Reading Average (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB)
Calculation Example **48.1 = 42.4 + 36.2 - 40.6 + 10.1**

Test Result Pass

5.2.4 High Channel

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
2.352	24.4	O2	Vertical	28.4	0	4.8	57.6	54.0	16.4	Pass
4.960	48.7	O2	Vertical	33.5	39.2	8	51.0	54.0	23.0	Pass
7.440	49.8	O2	Vertical	36.6	40.8	10.4	56.0	54.0	18.0	Pass
12.400	43.0	O1	Vertical	39	37.1	11.3	56.2	54.0	17.8	Pass
2.352	24.2	O1	Horizontal	28.4	0	4.8	57.4	54.0	16.6	Pass
4.960	49.2	O1	Horizontal	33.5	39.2	8	51.5	54.0	22.5	Pass
7.440	50.4	O1	Horizontal	36.6	40.8	10.4	56.6	54.0	17.4	Pass
12.400	43.4	O1	Horizontal	39	37.1	11.3	56.6	54.0	17.4	Pass

Final Field Strength Peak (dBuV/m) =Reading Peak (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB)
Calculation Example **57.6 = 24.4 + 28.4 - 0 + 4.8**

Frequency	Reading Average	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Average	Average Limit	Margin	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB	P/F
2.352	7.0	O2	Vertical	28.4	0	4.8	40.2	54.0	13.8	Pass
7.440	43.0	O2	Vertical	36.6	40.8	10.4	49.2	54.0	4.8	Pass
12.400	32.8	O1	Vertical	39	37.1	11.3	46.0	54.0	8.0	Pass
2.352	7.1	O1	Horizontal	28.4	0	4.8	40.3	54.0	13.7	Pass
7.440	46.4	O1	Horizontal	36.6	40.8	10.4	52.6	54.0	1.4	Pass
12.400	33.3	O1	Horizontal	39	37.1	11.3	46.5	54.0	7.5	Pass

Final Field Strength Average (dBuV/m) =Reading Average (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB)
Calculation Example **40.2 = 7 + 28.4 - 0 + 4.8**

Test Result Pass

5.3 Radiated Band Edge / Restricted band Measurements

11.13.3.2 Peak detection

When using a peak detector to measure unwanted emissions at or near the band edge (within 2 MHz of the authorized band), the following integration procedure can be used:

a) Set instrument center frequency to the frequency of the emission to be measured (must be within 2 MHz of the authorized band edge).
b) Set span to 2 MHz.
c) RBW = 100 kHz.
d) VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto.
g) Trace mode = max hold.
h) Allow sweep to continue until the trace stabilizes (required measurement time may increase for low-duty-cycle applications).
i) Compute the power by integrating the spectrum over 1 MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency ($f_{emission}$) ± 0.5 MHz. If the instrument does not have a band power function, then sum the amplitude levels (in power units) at 100 kHz intervals extending across the 1 MHz spectrum defined by $f_{emission}$ ± 0.5 MHz.

11.12.2.5.1 Trace averaging with continuous EUT transmission at full power

If the EUT can be configured or modified to transmit continuously (D ≥ 98%), then the average emission levels shall be measured using the following method (with EUT transmitting continuously):

a) RBW = 1 MHz (unless otherwise specified).
b) VBW ≥ [3 × RBW].
c) Detector = RMS (power averaging), if [span / (# of points in sweep)] ≤ (RBW / 2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
d) Averaging type = power (i.e., rms):
1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
2) Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
e) Sweep time = auto.
f) Perform a trace average of at least 100 traces.

5.3.1 Result Radiated Restricted Band and band edge near 2.4 GHz band

The EUT meets the Peak limit of 74 dBuV/m and the Average limit of 54dBuV/m.

Ref Appendix B for scans and results

Test Result: - Pass

5.4 Radiated Power at fundamental

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Transmitted Power	Limit	Margin	Result
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBm	dBm	dB	P/F
2.402	66.9	O2	Vertical	28.6	0	4.8	100.3	5.1	36.0	30.9	Pass
2.402	67.9	O1	Horizontal	28.6	0	4.8	101.3	6.1	36.0	29.9	Pass
2.426	66.5	O2	Vertical	28.6	0	4.8	99.9	4.7	36.0	31.3	Pass
2.426	66.5	O1	Horizontal	28.6	0	4.8	99.9	4.7	36.0	31.3	Pass
2.480	65.6	O2	Vertical	28.6	0	4.9	99.1	3.9	36.0	32.1	Pass
2.480	66.6	O1	Horizontal	28.6	0	4.9	100.1	4.9	36.0	31.1	Pass

Final Field Strength Peak (dBuV/m) =Reading Peak (dBuV/m) + Antenna Factor (dB)- Pre-amp Gain (dB) +Cable Loss (dB)
Calculation Example **100.1 = 66.6 + 28.6 - 0 + 4.9**

Transmitted power (dBm) = Final Field Strength Peak (dBuV/m) -95.2 dB
Calculation Example **5.1 = 100.3 - 95.2**

Note the Radiated field strength was measured at 3 metres and
the conversion formula below was used to determine the EIRP in dBm

$$EIRP\ (dBm) = E_{3m}\ (dBuV/m) - 95.2$$

6 List of Test Equipment

Instrument	Manufacturer	Model	Serial Num	CEI Ref	Cal Date	Cal Interval Months
Microwave Preamplifier	Hewlett Packard	83017A	3123A00175	805	29-Sep-23	12
Spectrum Analyser 30Hz-40GHz	Rohde & Schwarz	FSP40	100053	850	08-Dec-21	36
Test Receiver 3.6GHz	Rohde & Schwarz	ESR	1316.3003k03-101625-s	869	23-May-23	36
Antenna Horn	EMCO	3115	2363	1100	19-Feb-23	36
Fully Anechoic Chamber	CEI	FAR 3M	906	906	11-May-23	36
Anechoic Chamber	CEI	SAR 10M	845	845	10-Sep-22	36
Antenna Biconical	Schwarzbeck	VHBB 9124	9124 667	871	04-Oct-21	36
Antenna Log Periodic	AH Systems	SAS200/510	1001	784	14-Nov-22	36
Antenna Horn Standard Gain 18-26.5GHz	A-Info	LB-42-25-C-KF	J2021091103028	877	29-Sep-23	12
Cable 20m				1213	02-Aug-24	12
Cable purple Ktype 1.8m				917	02-Aug-24	12
Cable HF Ktype 1.5m				705	02-Aug-24	12
LISN	Rohde & Schwarz	ESH3-Z5	825460/003	604	22-Feb-23	36

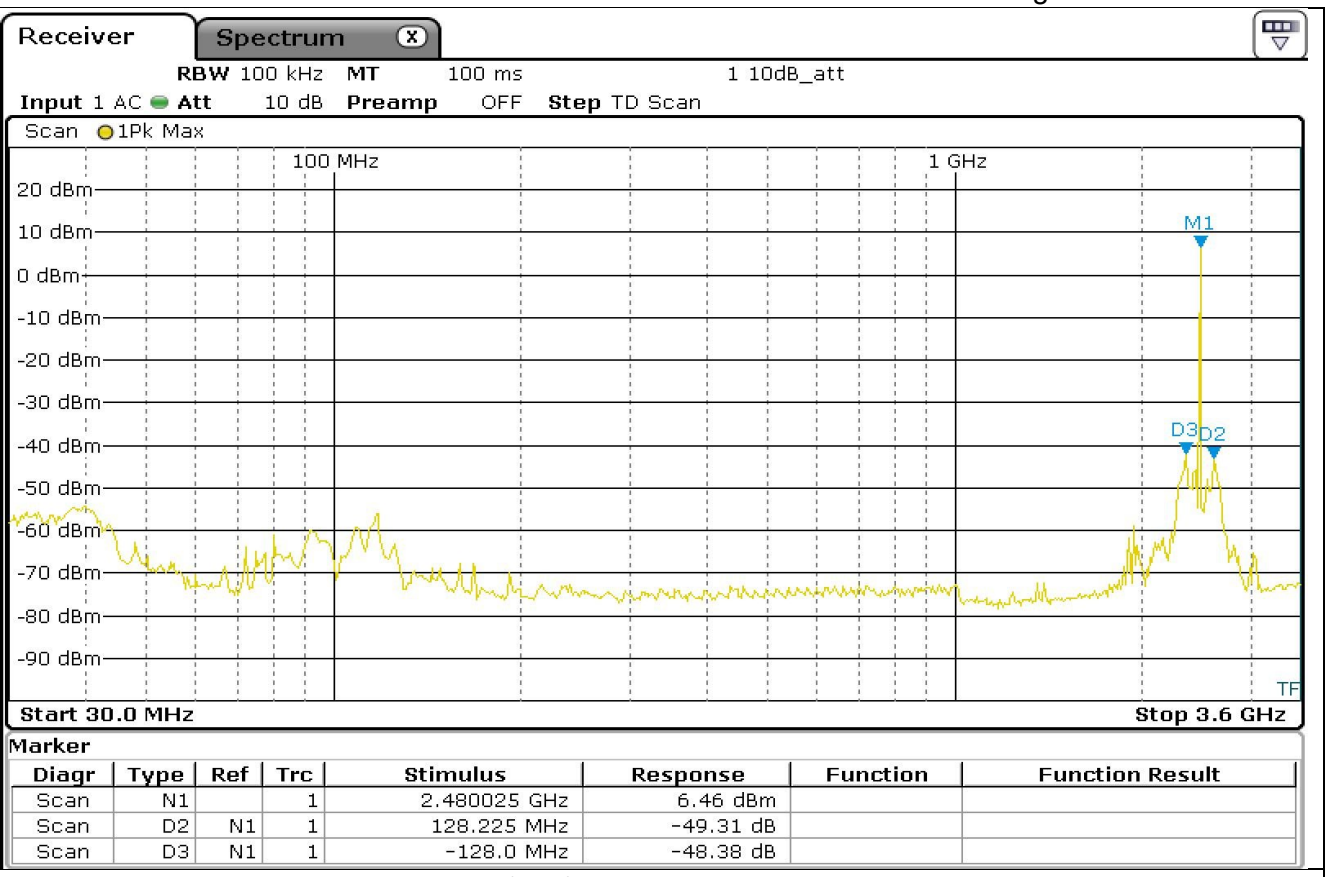
7 Measurement Uncertainties

Measurement	Uncertainty
Radio Frequency	+/- $5x10^{-7}$
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	+/- $5x10^{-7}$
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.

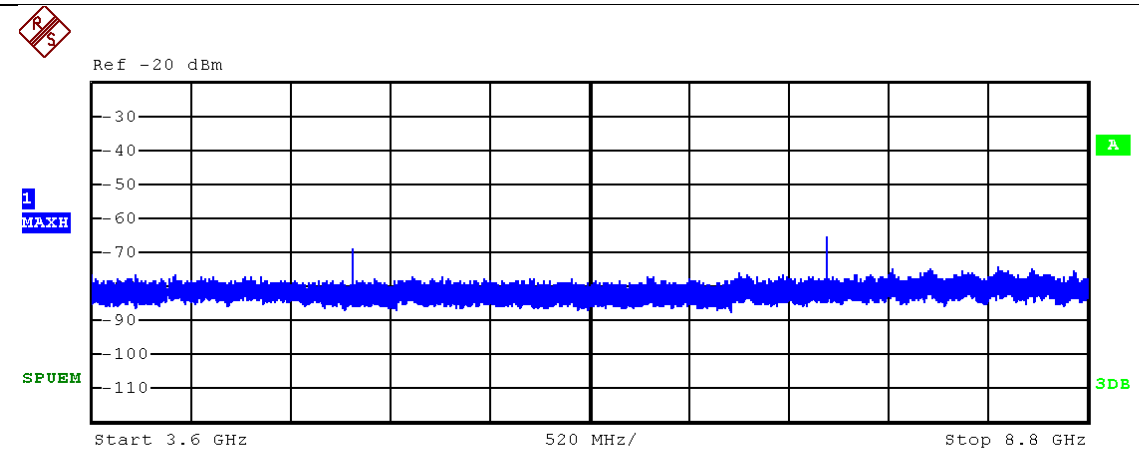
Appendix A Conducted Measurements on the Antenna Port



Marker

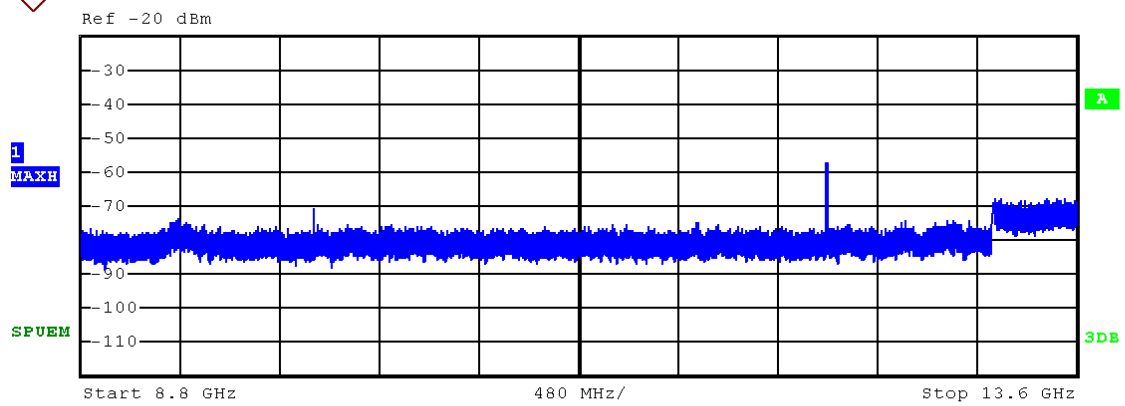
Diagr	Type	Ref	Trc	Stimulus	Response	Function	Function Result
Scan	N1		1	2.480025 GHz	6.46 dBm		
Scan	D2	N1	1	128.225 MHz	-49.31 dB		
Scan	D3	N1	1	-128.0 MHz	-48.38 dB		

Fig A1 Conducted Spurious Emissions 30MHz -3.6GHz



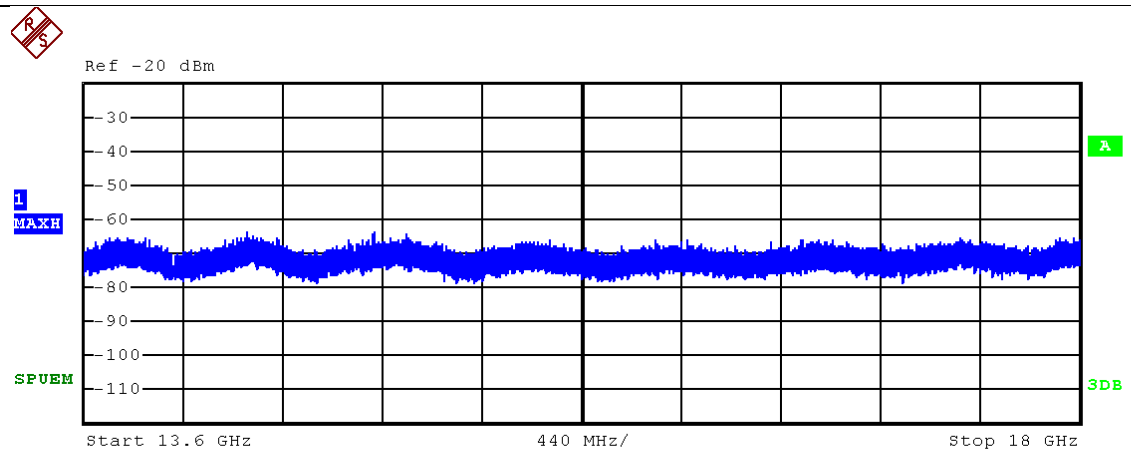
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
3.600 G	4.000 G	100.00 k	3.830000 G	-76.31	-200.00
4.000 G	4.800 G	100.00 k	4.034100 G	-76.35	-200.00
4.800 G	5.200 G	100.00 k	4.960550 G	-68.68	-200.00
5.200 G	5.600 G	100.00 k	5.431800 G	-77.22	-200.00
5.600 G	6.000 G	100.00 k	5.893150 G	-77.36	-200.00
6.000 G	6.400 G	100.00 k	6.104700 G	-77.82	-200.00
6.400 G	6.800 G	100.00 k	6.505600 G	-77.13	-200.00
6.800 G	7.200 G	100.00 k	6.981350 G	-76.08	-200.00
7.200 G	7.600 G	100.00 k	7.440050 G	-65.32	-200.00
7.600 G	8.000 G	100.00 k	7.975600 G	-74.62	-200.00
8.000 G	8.400 G	100.00 k	8.333150 G	-73.81	-200.00
8.400 G	8.800 G	100.00 k	8.506250 G	-74.68	-200.00

Fig A2 Conducted Spurious Emissions 3.6GHz-8.8GHz



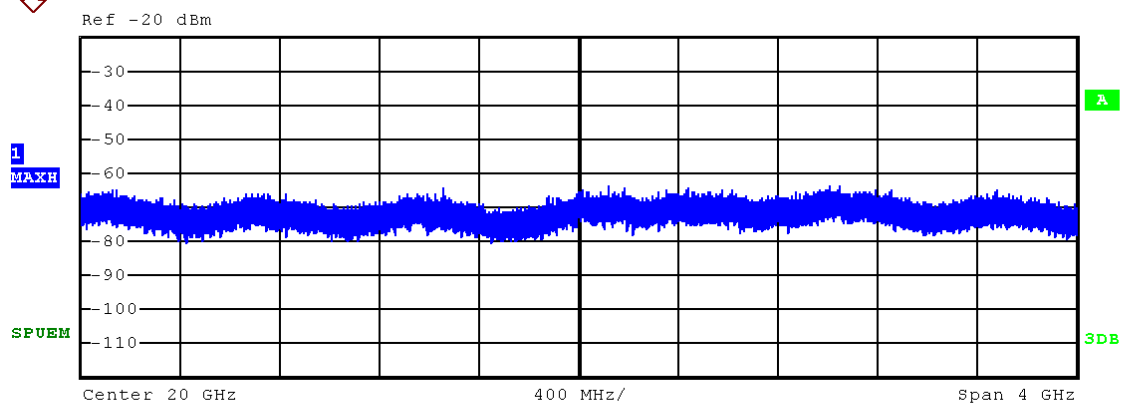
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
8.800 G	9.200 G	100.00 k	9.198050 G	-76.53	-200.00
9.200 G	9.600 G	100.00 k	9.266300 G	-73.45	-200.00
9.600 G	10.000 G	100.00 k	9.919050 G	-70.54	-200.00
10.000 G	10.400 G	100.00 k	10.089300 G	-75.48	-200.00
10.400 G	10.800 G	100.00 k	10.425700 G	-75.79	-200.00
10.800 G	11.200 G	100.00 k	11.037000 G	-75.75	-200.00
11.200 G	11.600 G	100.00 k	11.429850 G	-75.41	-200.00
11.600 G	12.000 G	100.00 k	11.771200 G	-74.63	-200.00
12.000 G	12.400 G	100.00 k	12.398900 G	-56.95	-200.00
12.400 G	12.800 G	100.00 k	12.401350 G	-57.24	-200.00
12.800 G	13.200 G	100.00 k	13.083400 G	-73.92	-200.00
13.200 G	13.600 G	100.00 k	13.235550 G	-67.66	-200.00

Fig A3 Conducted Spurious Emissions 8.8GHz-13.6GHz



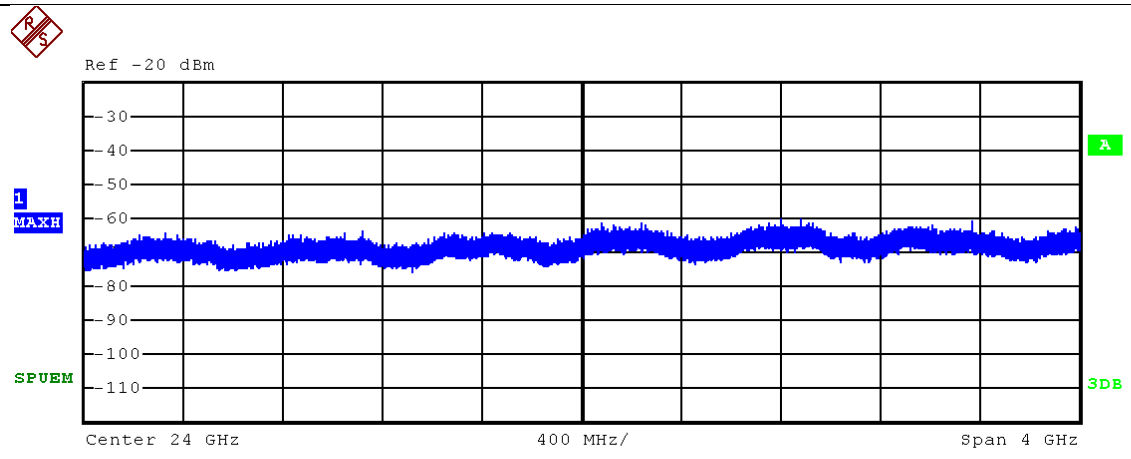
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
13.600 G	14.000 G	100.00 k	13.796500 G	-65.12	-200.00
14.000 G	14.400 G	100.00 k	14.323750 G	-63.59	-200.00
14.400 G	14.800 G	100.00 k	14.455650 G	-65.60	-200.00
14.800 G	15.200 G	100.00 k	14.881600 G	-63.78	-200.00
15.200 G	15.600 G	100.00 k	15.572300 G	-66.53	-200.00
15.600 G	16.000 G	100.00 k	15.662300 G	-66.01	-200.00
16.000 G	16.400 G	100.00 k	16.127900 G	-66.17	-200.00
16.400 G	16.800 G	100.00 k	16.769150 G	-66.02	-200.00
16.800 G	17.200 G	100.00 k	16.911500 G	-65.92	-200.00
17.200 G	17.600 G	100.00 k	17.471000 G	-65.19	-200.00
17.600 G	18.000 G	100.00 k	17.910150 G	-65.54	-200.00

Fig A4 Conducted Spurious Emissions 13.6GHz -18GHz



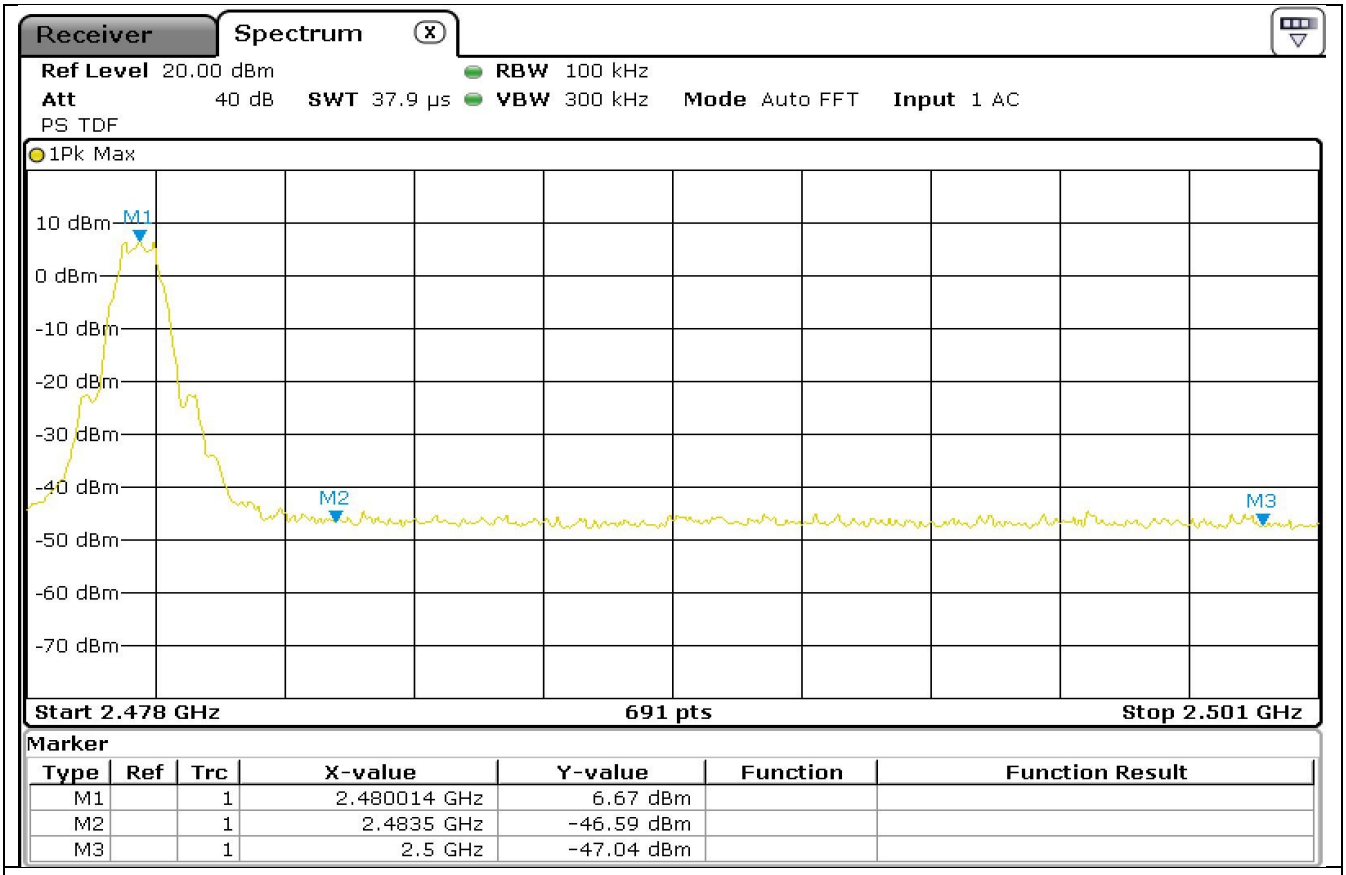
Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
18.000 G	18.400 G	100.00 k	18.125600 G	-64.71	-200.00
18.400 G	18.800 G	100.00 k	18.685200 G	-65.68	-200.00
18.800 G	19.200 G	100.00 k	18.824550 G	-66.08	-200.00
19.200 G	19.600 G	100.00 k	19.453050 G	-64.44	-200.00
19.600 G	20.000 G	100.00 k	19.988750 G	-65.78	-200.00
20.000 G	20.400 G	100.00 k	20.123400 G	-63.84	-200.00
20.400 G	20.800 G	100.00 k	20.442200 G	-64.30	-200.00
20.800 G	21.200 G	100.00 k	21.048650 G	-63.29	-200.00
21.200 G	21.600 G	100.00 k	21.259250 G	-64.49	-200.00
21.600 G	22.000 G	100.00 k	21.680300 G	-64.72	-200.00

Fig A4 Conducted Spurious Emissions 18GHz -22GHz



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
22.000 G	22.400 G	100.00 k	22.324600 G	-64.43	-200.00
22.400 G	22.800 G	100.00 k	22.402150 G	-65.83	-200.00
22.800 G	23.200 G	100.00 k	23.121950 G	-63.57	-200.00
23.200 G	23.600 G	100.00 k	23.486450 G	-63.97	-200.00
23.600 G	24.000 G	100.00 k	23.712150 G	-64.06	-200.00
24.000 G	24.400 G	100.00 k	24.238600 G	-61.09	-200.00
24.400 G	24.800 G	100.00 k	24.749000 G	-61.35	-200.00
24.800 G	25.200 G	100.00 k	24.800800 G	-60.25	-200.00
25.200 G	25.600 G	100.00 k	25.568750 G	-60.44	-200.00
25.600 G	26.000 G	100.00 k	25.987800 G	-62.14	-200.00

Fig A4 Conducted Spurious Emissions 22GHz -26GHz



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.480014 GHz	6.67 dBm		
M2		1	2.4835 GHz	-46.59 dBm		
M3		1	2.5 GHz	-47.04 dBm		

Fig A5 Carrier power 100KHz RBW

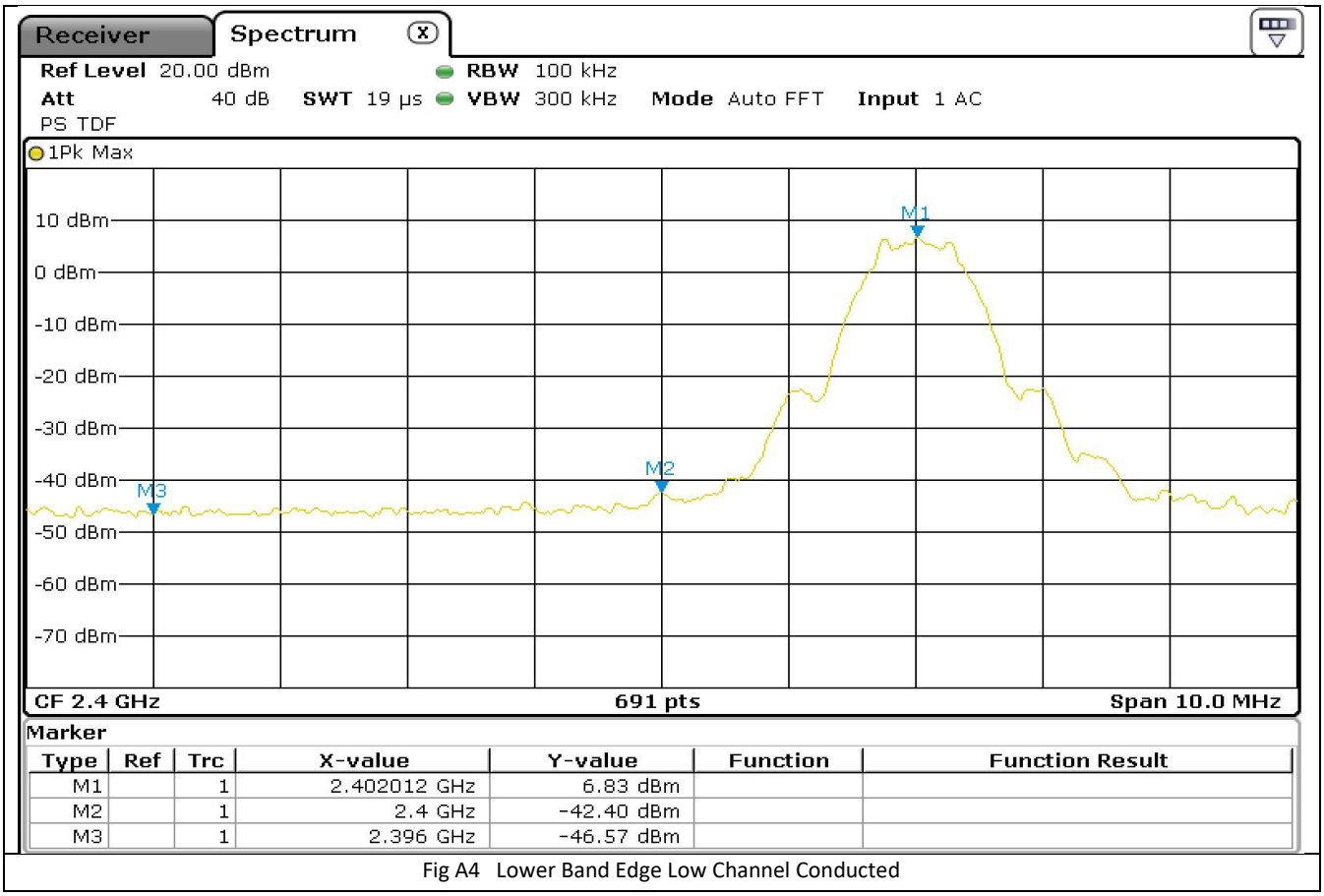


Fig A4 Lower Band Edge Low Channel Conducted

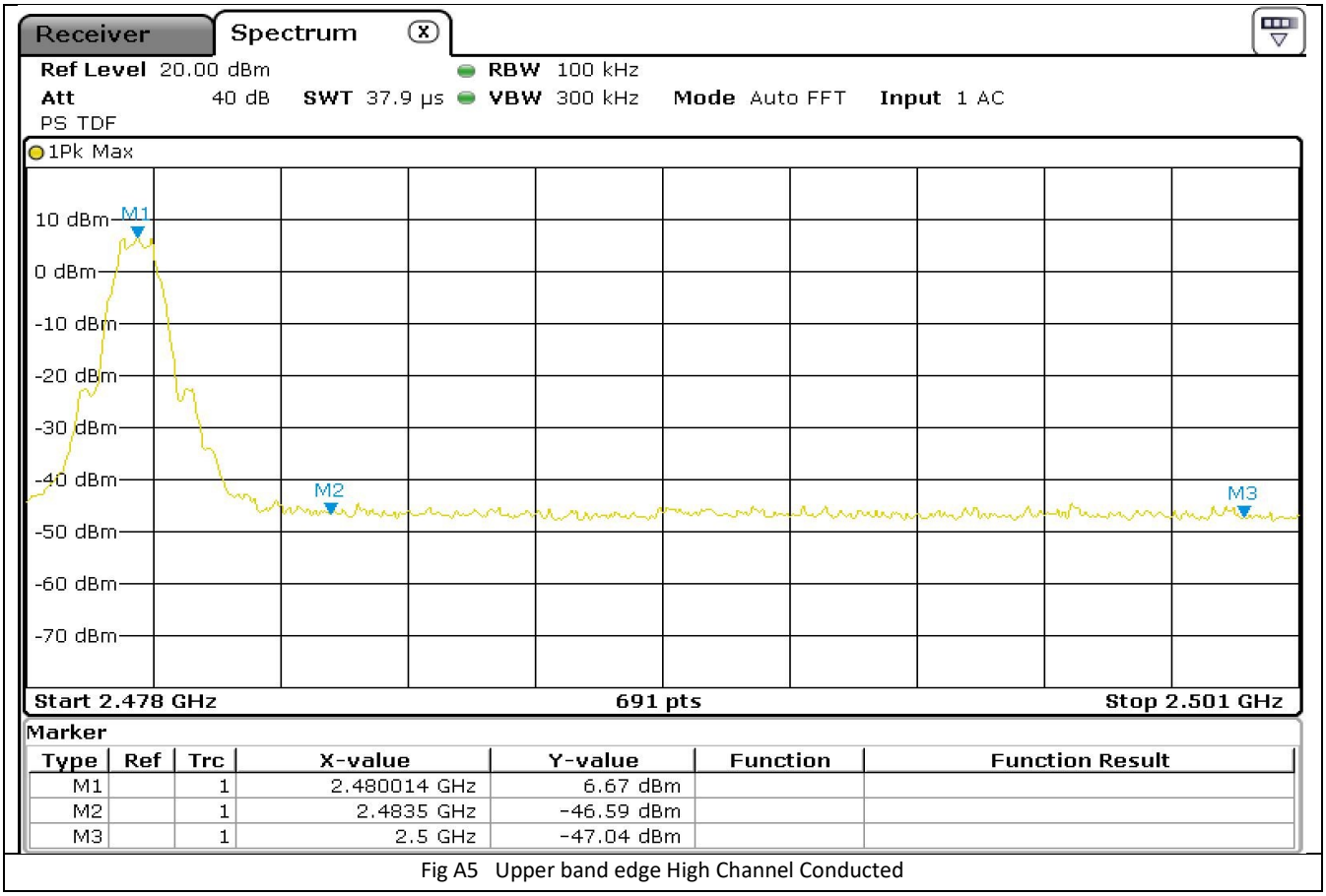
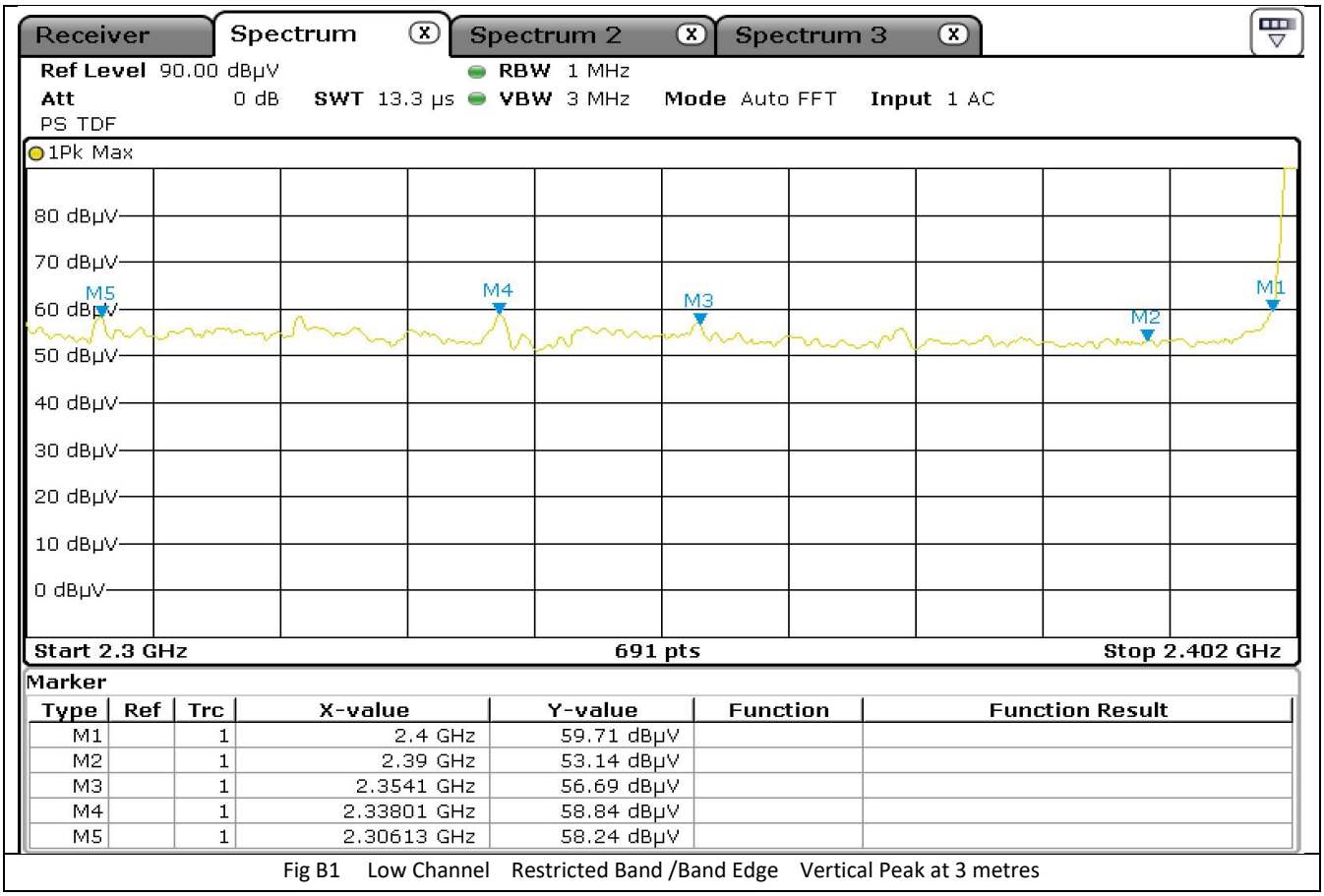


Fig A5 Upper band edge High Channel Conducted

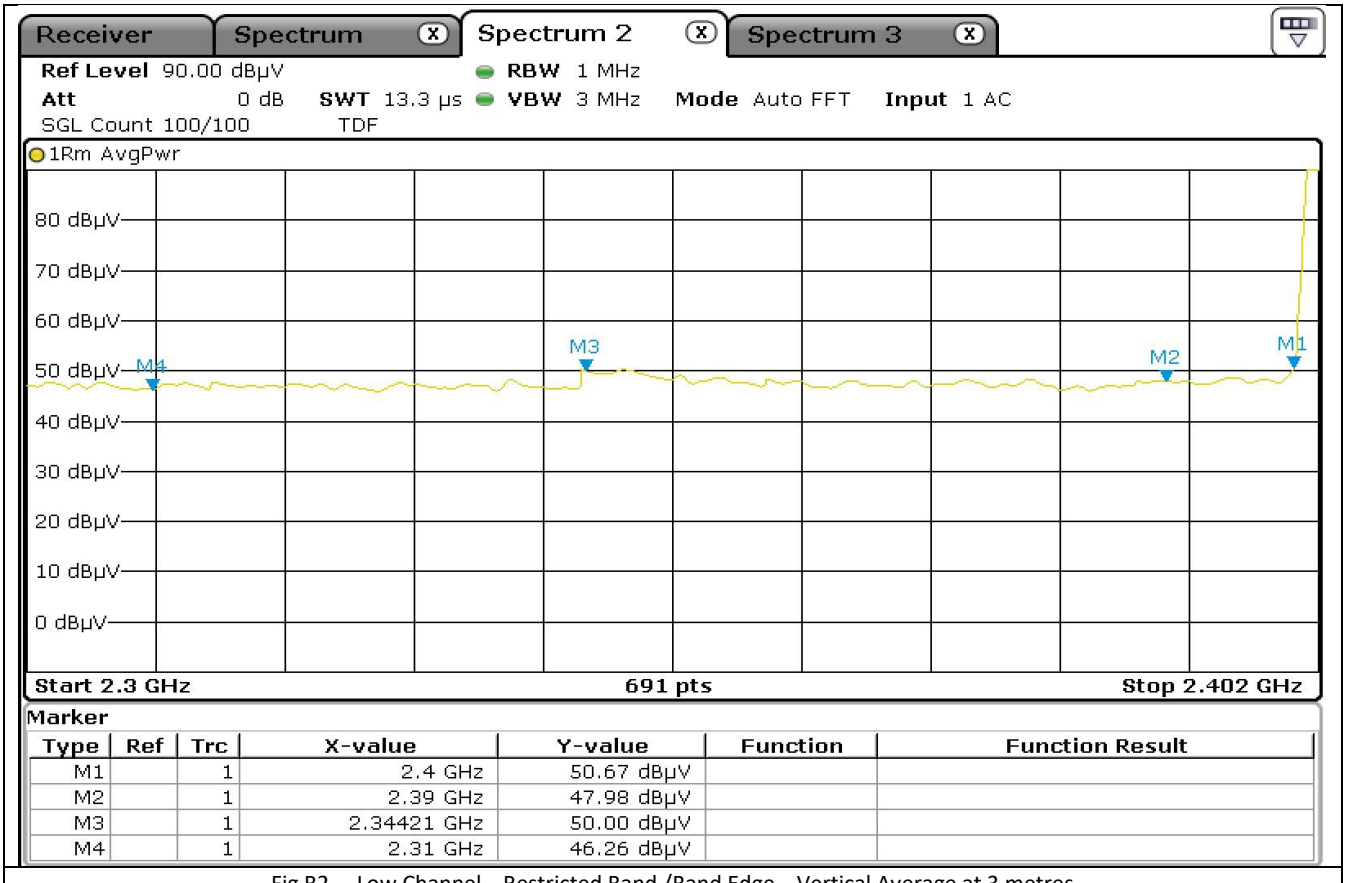
Appendix B Radiated tests for Band Edges /Restricted band



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4 GHz	59.71 dBµV		
M2		1	2.39 GHz	53.14 dBµV		
M3		1	2.3541 GHz	56.69 dBµV		
M4		1	2.33801 GHz	58.84 dBµV		
M5		1	2.30613 GHz	58.24 dBµV		

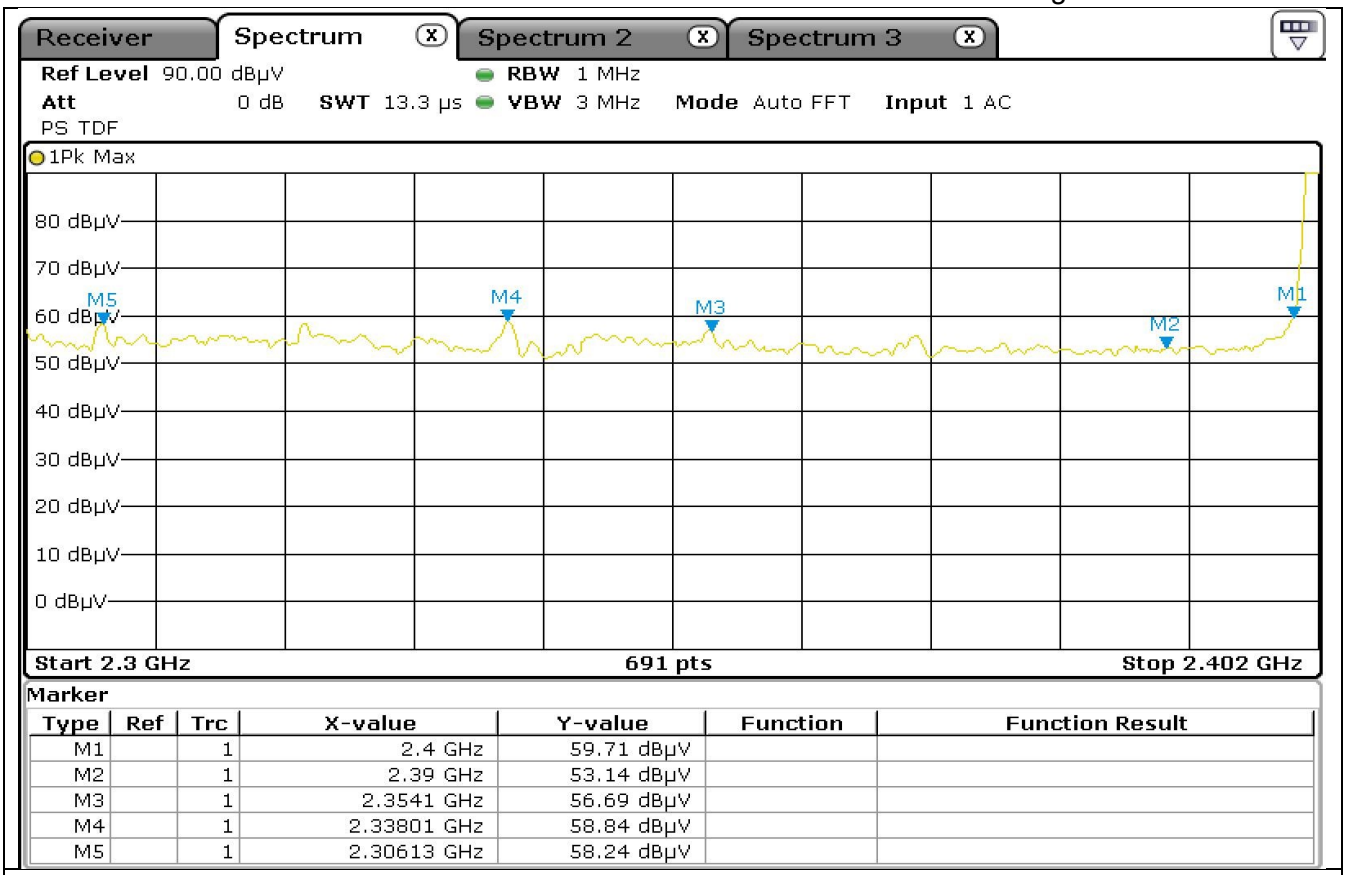
Fig B1 Low Channel Restricted Band /Band Edge Vertical Peak at 3 metres



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4 GHz	50.67 dBµV		
M2		1	2.39 GHz	47.98 dBµV		
M3		1	2.34421 GHz	50.00 dBµV		
M4		1	2.31 GHz	46.26 dBµV		

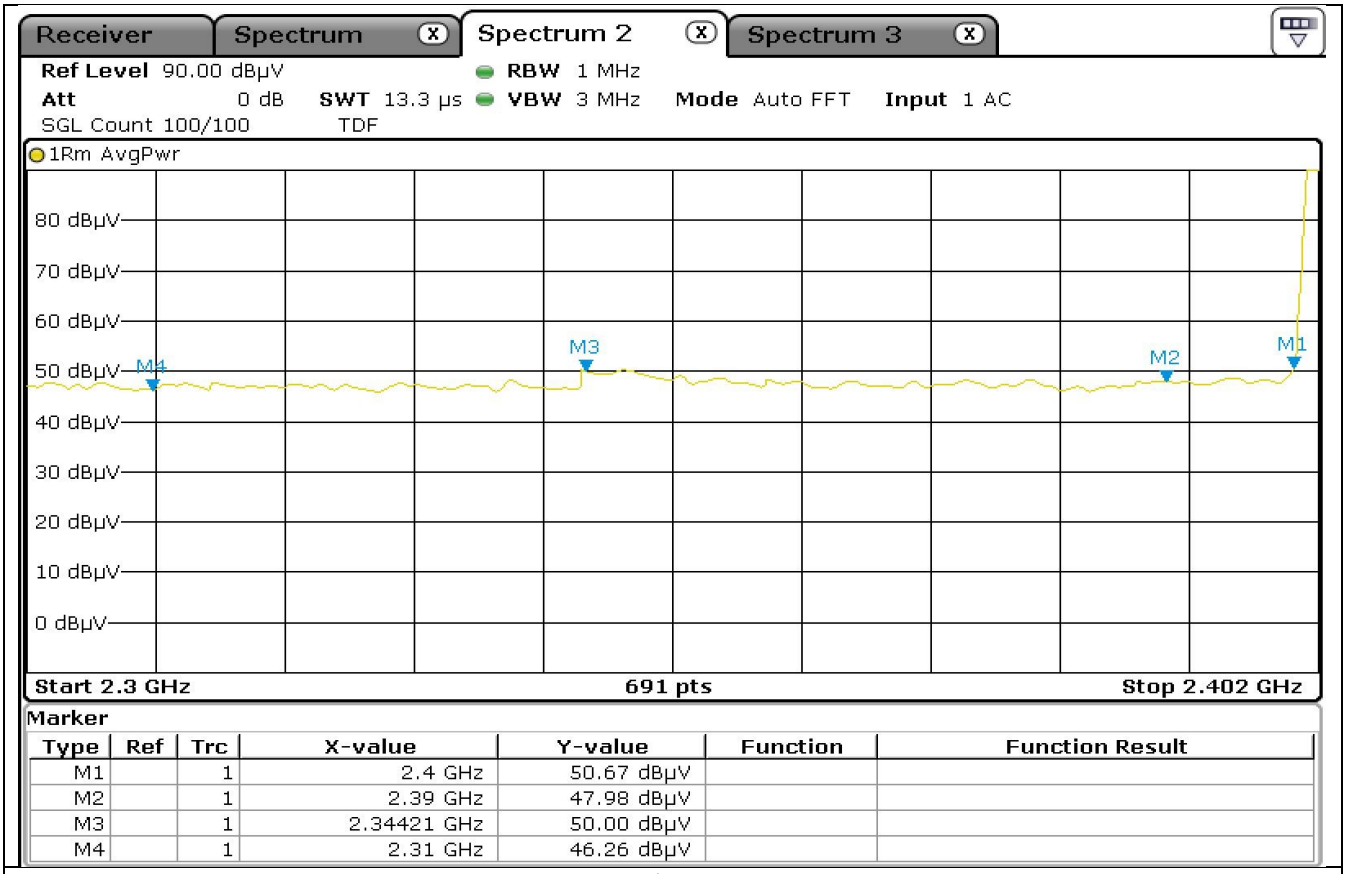
Fig B2 Low Channel Restricted Band /Band Edge Vertical Average at 3 metres



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4 GHz	59.71 dBµV		
M2		1	2.39 GHz	53.14 dBµV		
M3		1	2.3541 GHz	56.69 dBµV		
M4		1	2.33801 GHz	58.84 dBµV		
M5		1	2.30613 GHz	58.24 dBµV		

Fig B3 Low Channel Restricted Band /Band Edge Horizontal Peak at 3 metres



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4 GHz	50.67 dBµV		
M2		1	2.39 GHz	47.98 dBµV		
M3		1	2.34421 GHz	50.00 dBµV		
M4		1	2.31 GHz	46.26 dBµV		

Fig B4 Low Channel Restricted Band /Band Edge Horizontal Average at 3 metres

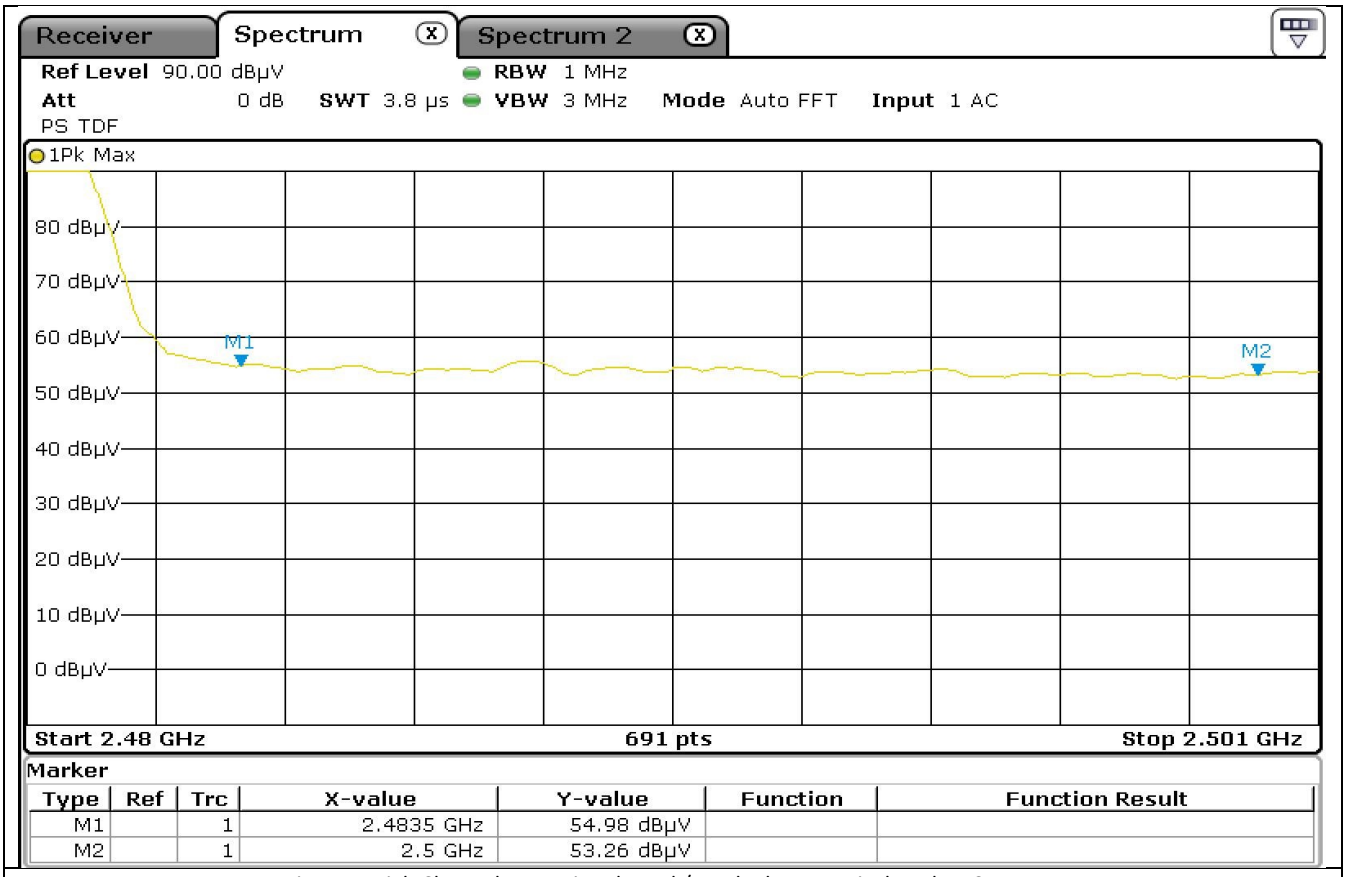


Fig B5 High Channel Restricted Band /Band Edge Vertical Peak at 3 metres

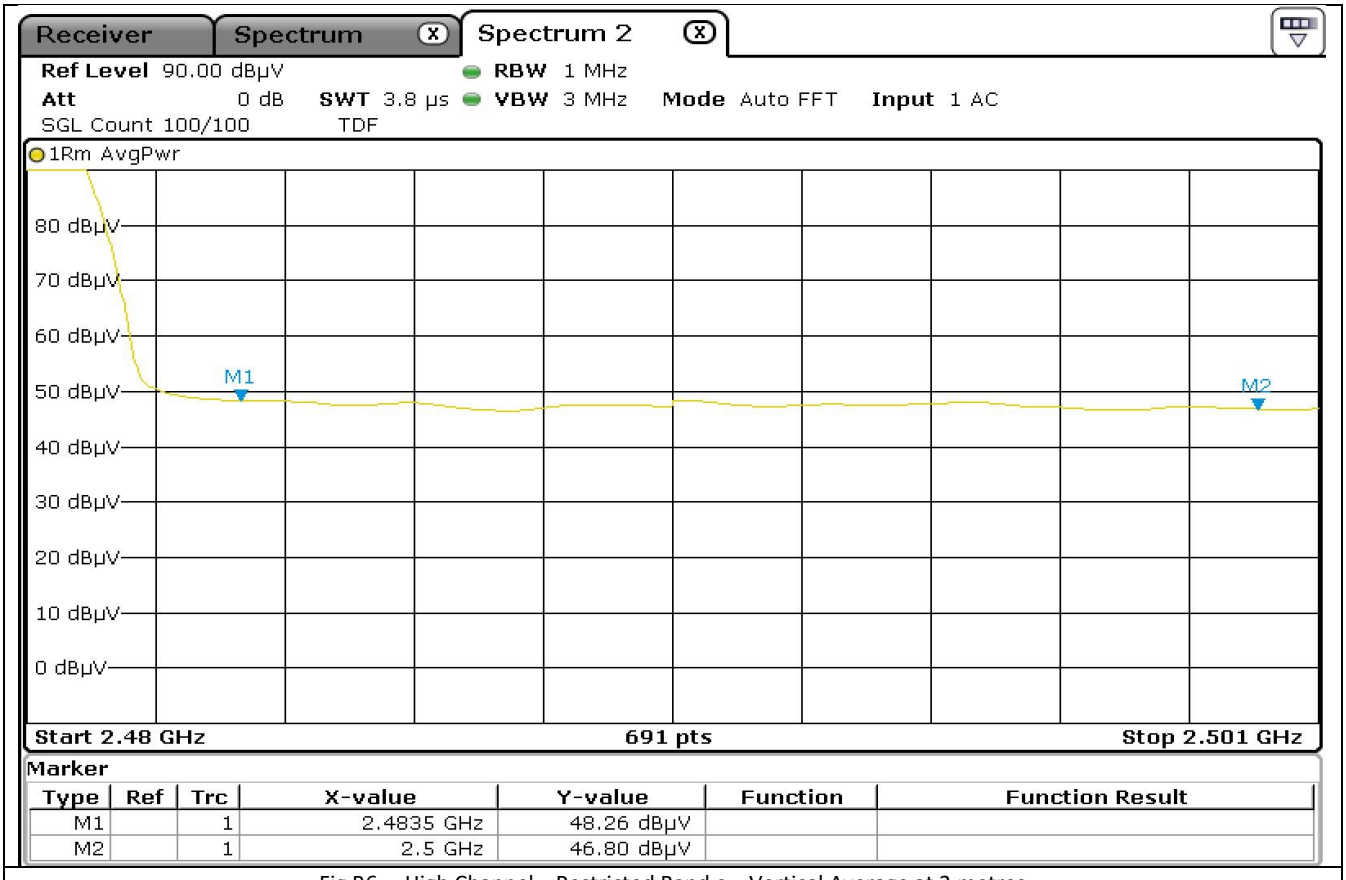


Fig B6 High Channel Restricted Band e Vertical Average at 3 metres

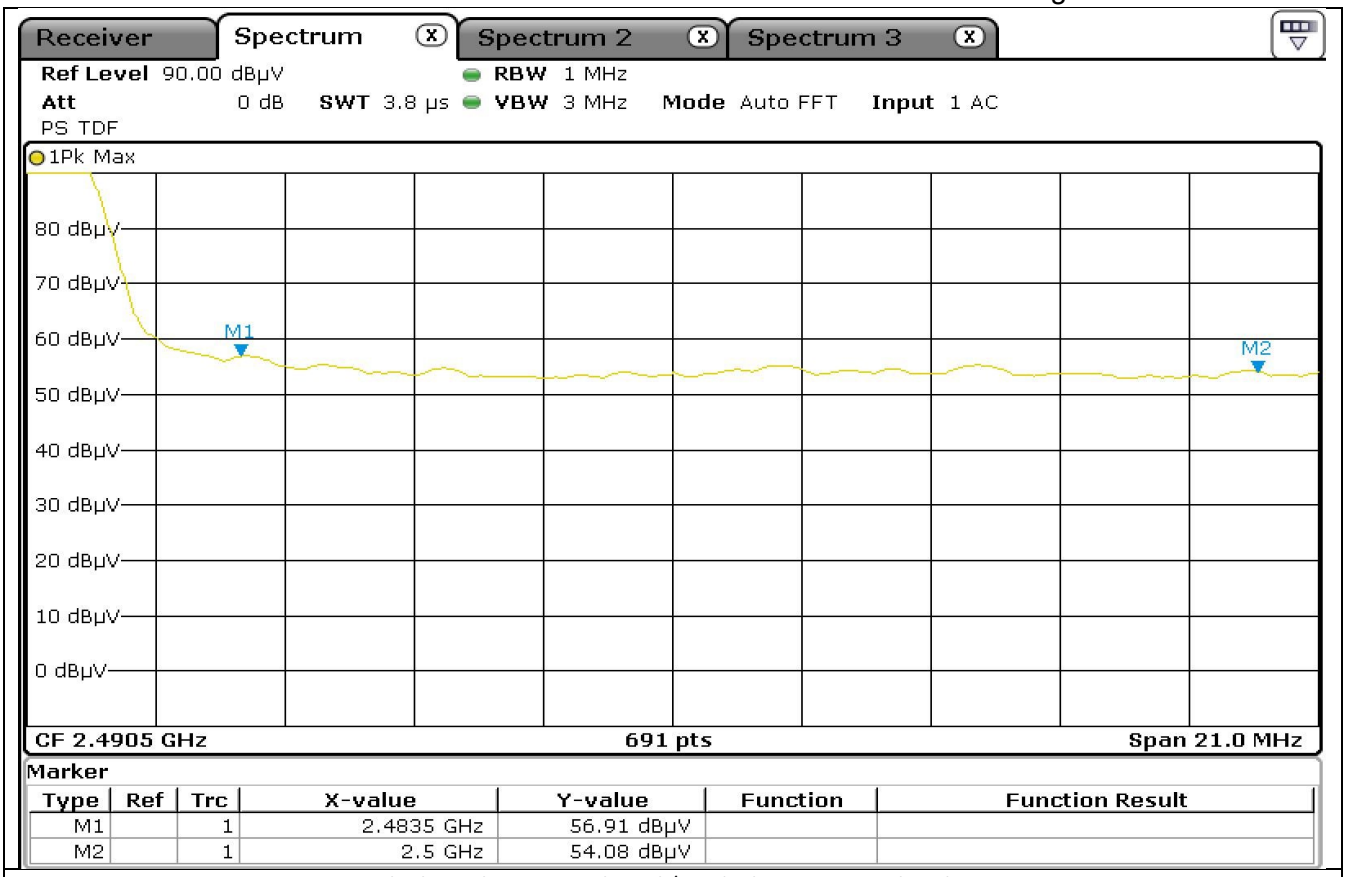


Fig B7 High Channel Restricted Band /Band Edge Horizontal Peak at 3 metres

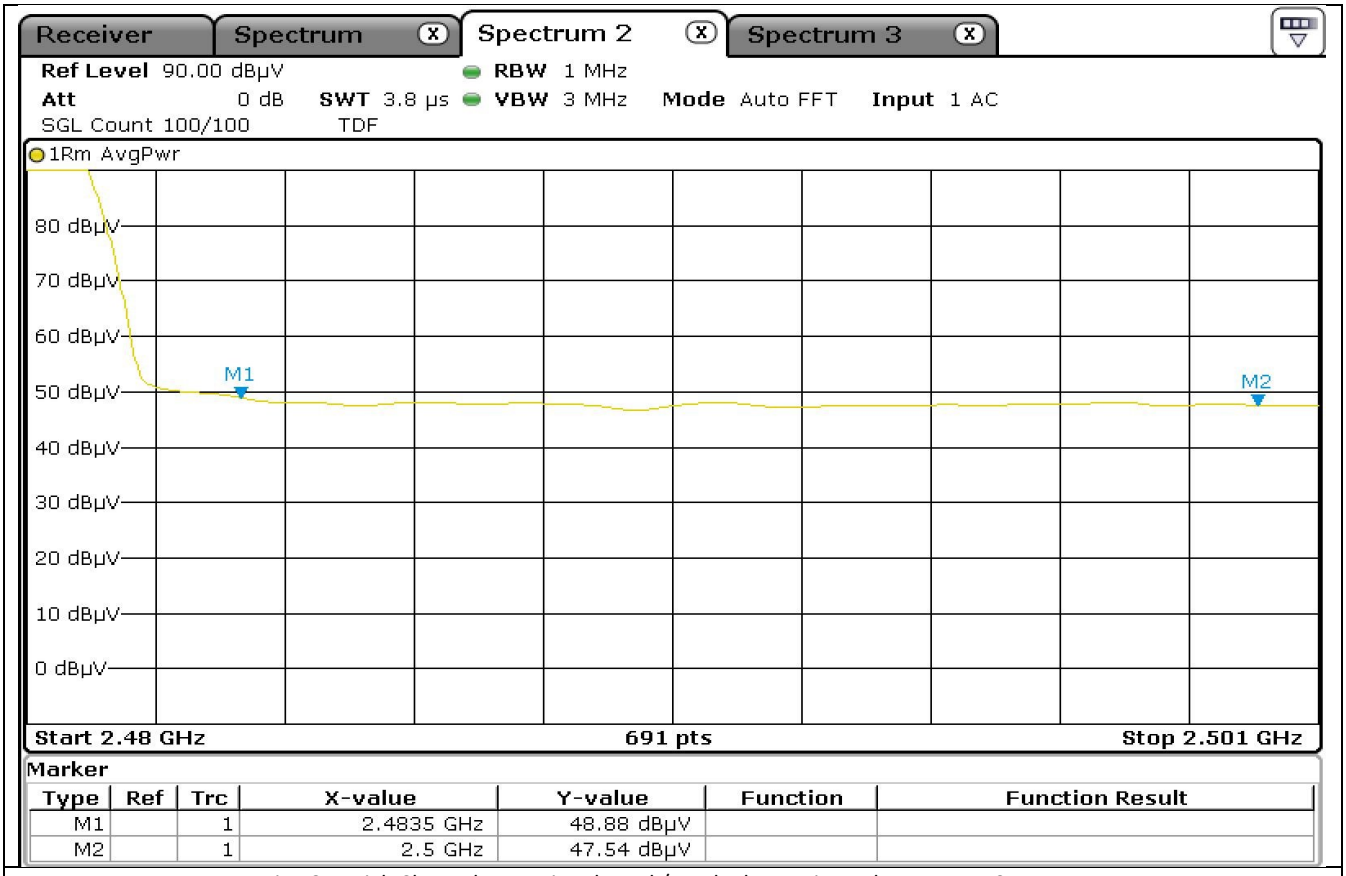


Fig B8 High Channel Restricted Band /Band edge Horizontal Average at 3 metres

Ref report “Alps 24E10894-1a Hati BLE FCCIC Part 2 of 2 for appendices C,D,E”