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Project Num	20E8928-2b
Quotation	Q20-1410-1
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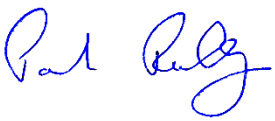
FCC Test Firm Registration	409640
IC Site Registration	IE0001
Date	15th Mar 2021
EUT Description	HUBA
FCC ID	2ATIMHUBA
IC ID	25094-HUBA
Authorised by	**Paul Reilly**
Authorised Signature:	

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 247-2 (Feb 2017)
RSS Gen Issue5 Amd 2 (Feb 2021)

Exhibit A – Technical Report

Table of Contents

Please review in conjunction with report “Sensata Technologies 20E8928-2b HUBA Wifi AppendixCDEF FCCIC.pdf” for remaining items listed above
”

1.0 EUT Description

Model:	HUBA
Type:	Wireless Gateway
Type of radio:	Stand-alone
Transmitter Type:	802.15.4 (Thread), 802.11G 802.11N Wifi
Operating Frequency Range(s):	2.405 GHz - 2.480GHz Thread 2.412-2.462GHz Wifi
Number of Channels:	16 Thread 11 Wifi
Antenna:	Integral
Power configuration:	12 v Battery.
Ports:	None
Classification:	DTS, CYY
HVIN:	HUBA
PMN:	HUBA
Test Standards:	15.247 RSS-247
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2013 KDB 558074 V5 R02

The EUT was a Gateway for use in the vehicles. Its purpose was to relay packets received on the 433MHz band using a transmitter in the 2.4GHz band.
The EUT contained transmitters using Wifi and Thread technology and also a 433MHz receiver.
For Wifi it was possible to switch between 2 internal antennas, one an internal module antenna and the other one a printed pcb antenna.
The Thread radio had its own dedicated pcb antenna.
This report details test carried out on the Wifi transmitter.

Please review in conjunction with report “Sensata Technologies 20E8928-2a HUBA Wifi AppendixCDEF FCCIC.pdf”

1.1 EUT Operation

Operating Conditions during Test:

Conducted measurements were carried out on a sample where the antenna was replaced by cable and SMA.
Radiated measurements were performed on a sample with standard internal antenna.

The EUT was operated in test mode where the channel and modulation was set on the EUT from a laptop.
The EUT was powered from a bench PSU set to 12Vdc. for all tests

Environmental conditions

	Temperature	Relative Humidity
Test	°C	%
Conducted Emissions	20	47
Radiated Emissions <1GHz	17	41
Radiated Emissions >1GHz	21	44

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 21st 22nd Dec 2020, 6th -15th Jan 15th-19th Feb 2021

1.4 Special Software

Tests were performed manually, and no special software was used.

1.5 Description of Test modes

Channel List

Channel	Freq MHz	Channel	Freq MHz
1	2412	7	2442
2	2417	8	2447
3	2422	9	2452
4	2427	10	2457
5	2432	11	2462
6	2437		

Available Data Rates

802.11 G	802.11 N
MB/s	MB/s
6,9,12,18,24,36,48,54	6.5,13,19.5,26,39,52,58.5,65
6,9,12,18,24,36,48,54	6.5,13,19.5,26,39,52,58.5,65
6,9,12,18,24,36,48,54	6.5,13,19.5,26,39,52,58.5,65

Evaluation test for max power test carried out on the following

Channel	Freq	G	N
	MHz	MB/s	MB/s
1	2412	6,9,12,18,24,36,48,54	6.5,13,19.5,26,39,52,58.5,65
6	2437	6,9,12,18,24,36,48,54	6.5,13,19.5,26,39,52,58.5,65
11	2462	6,9,12,18,24,36,48,54	6.5,13,19.5,26,39,52,58.5,65

Complete test was carried out on the worst cases for Ch1 G/N Ch6 G/N and Ch11 G/N

It was found that the highest output levels were recorded on the 802.11G modulation

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

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) which was placed on a turntable allowing 360 degree rotation, in a semi anechoic chamber. 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 above 1GHz 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 were maximised by configuring the EUT and by rotating the EUT and raising the test and antenna from 1 to 4 metres.
The resolution bandwidth was 1MHz and video bandwidth was 3 MHz for peak measurements for radiated emissions above 1GHz.

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 O1 for Horizontal polarization measurements and with the EUT in orientation O2 for Vertical polarisation measurements.
Ref Appendix F for orientations.

3.0 Results for Conducted emissions on the mains

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

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.

802.11G			
Frequency	6dB Bandwidth	Limit Min	Margin
GHz	MHz	KHz	MHz
2.412	16.715	500	16.215
2.437	16.715	500	16.215
2.462	16.715	500	16.215

802.11N

Frequency	6dB Bandwidth	Limit Min	Margin
GHz	MHz	KHz	MHz
2.412	16.715	500	16.215
2.437	16.715	500	16.215
2.462	16.715	500	16.215

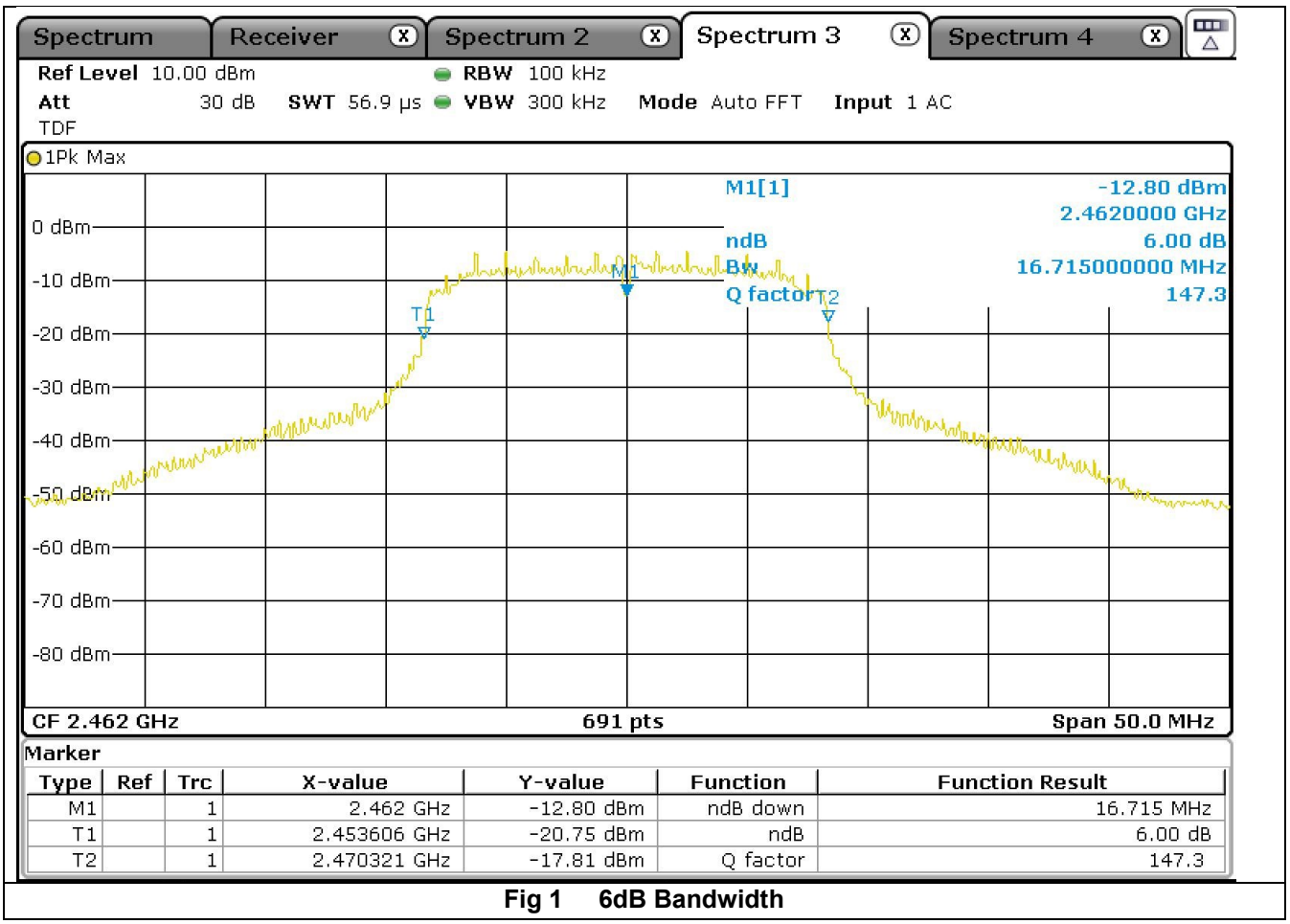


Fig 1 6dB Bandwidth

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).

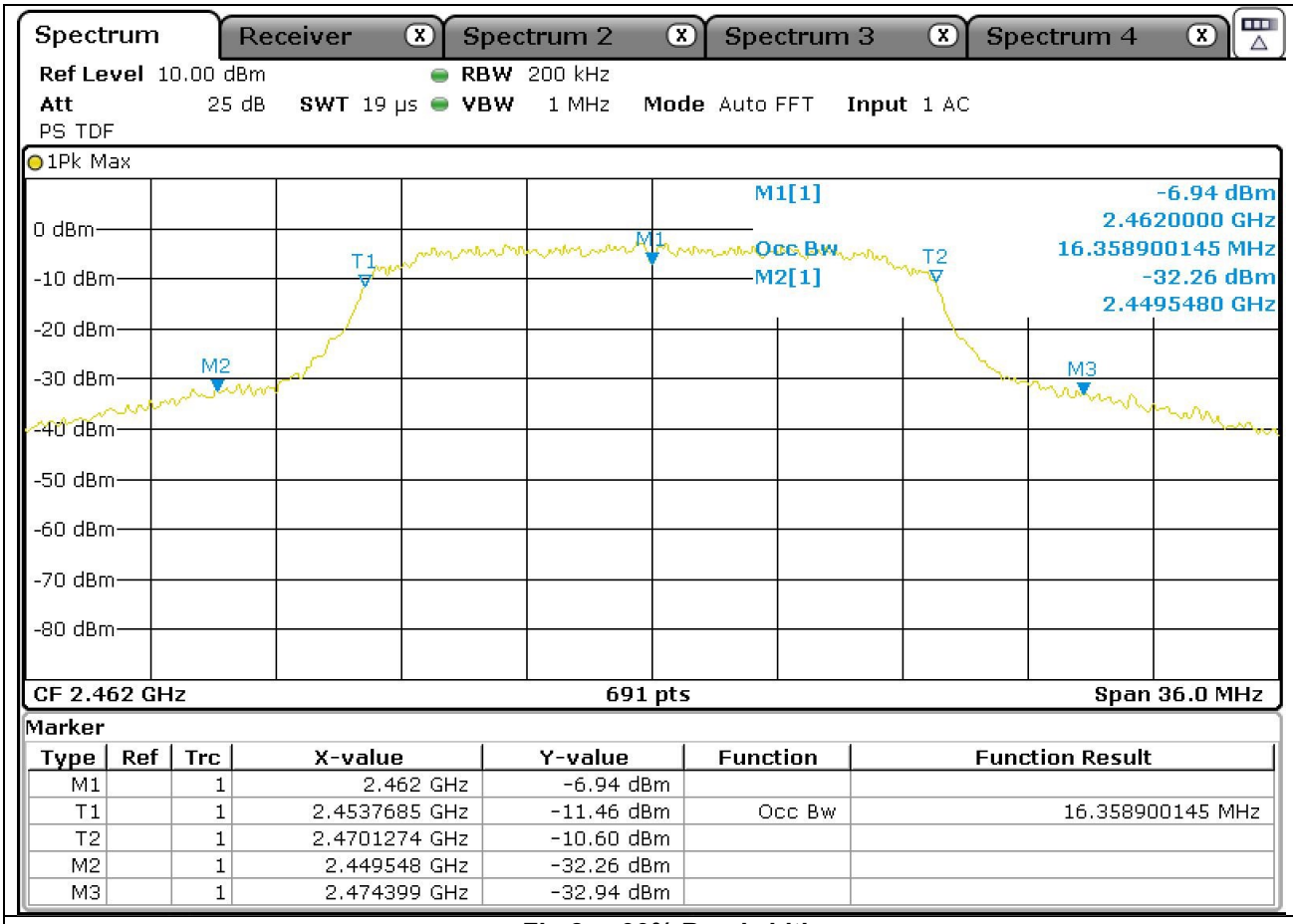
802.11G

Frequency	99% Bandwidth	Limit Min
GHz	MHz	KHz
2.412	16.463	N/A
2.437	16.984	N/A
2.462	16.359	N/A

802.11N

Frequency	99% Bandwidth	Limit
GHz	MHz	MHz
2.412	16.359	N/A
2.437	16.984	N/A
2.462	16.359	N/A

Result :- Pass



Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.462 GHz	-6.94 dBm		
T1		1	2.4537685 GHz	-11.46 dBm	Occ Bw	16.358900145 MHz
T2		1	2.4701274 GHz	-10.60 dBm		
M2		1	2.449548 GHz	-32.26 dBm		
M3		1	2.474399 GHz	-32.94 dBm		

Fig 2 99% Bandwidth

4.2 Duty Cycle

Test Method

As per Ansi 63.10 Section 11.6 KDB 558074 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).

KDB 558074 D01 FAQ section

Results

Toff mS	Period mS	Duty cycle	Duty cycle %
0.02493	1.37899	0.9819	98.19

Duty Cycle >98%

Note the duty cycle results below show how the sample operated during testing.

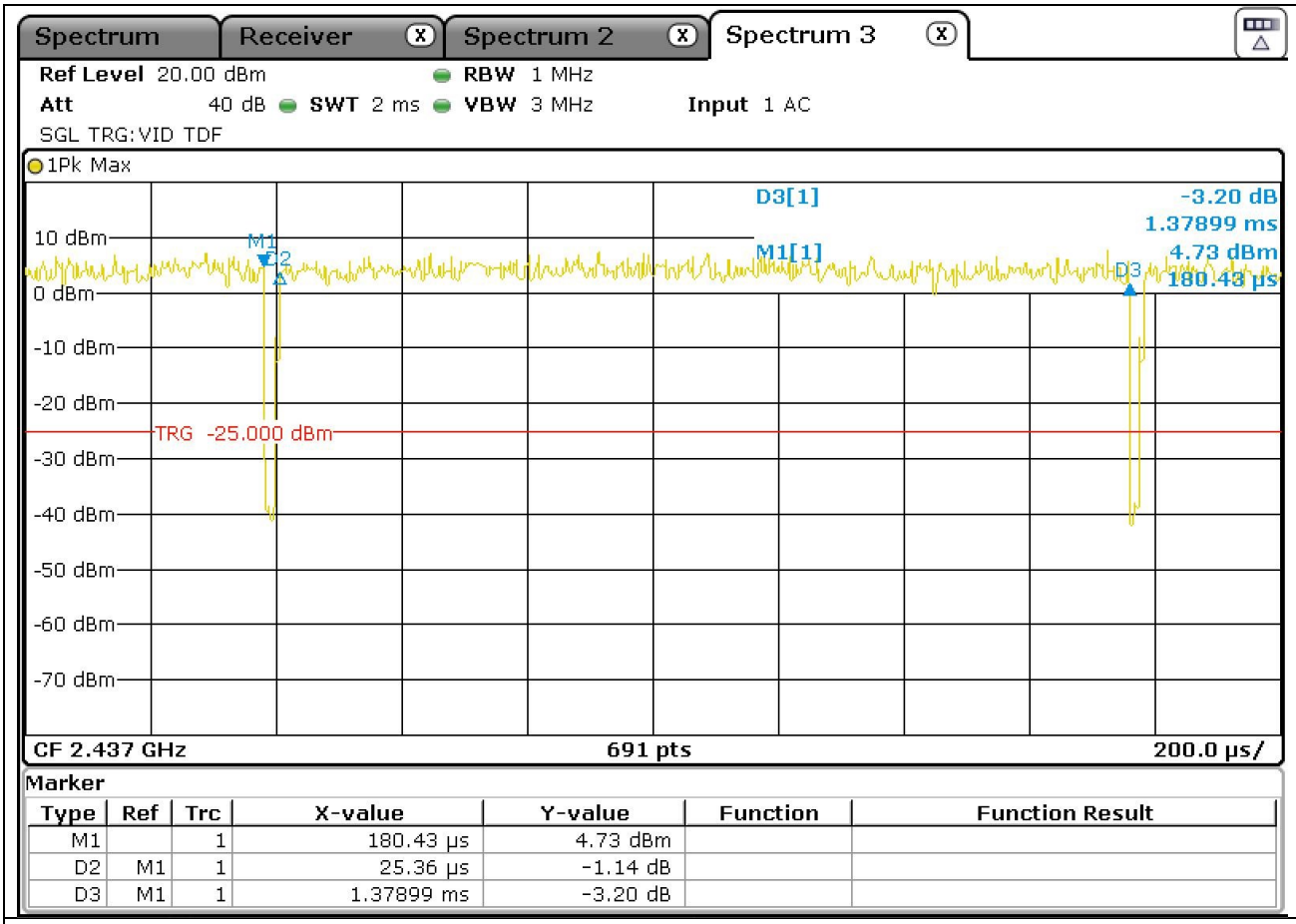


Fig 3a Duty Cycle

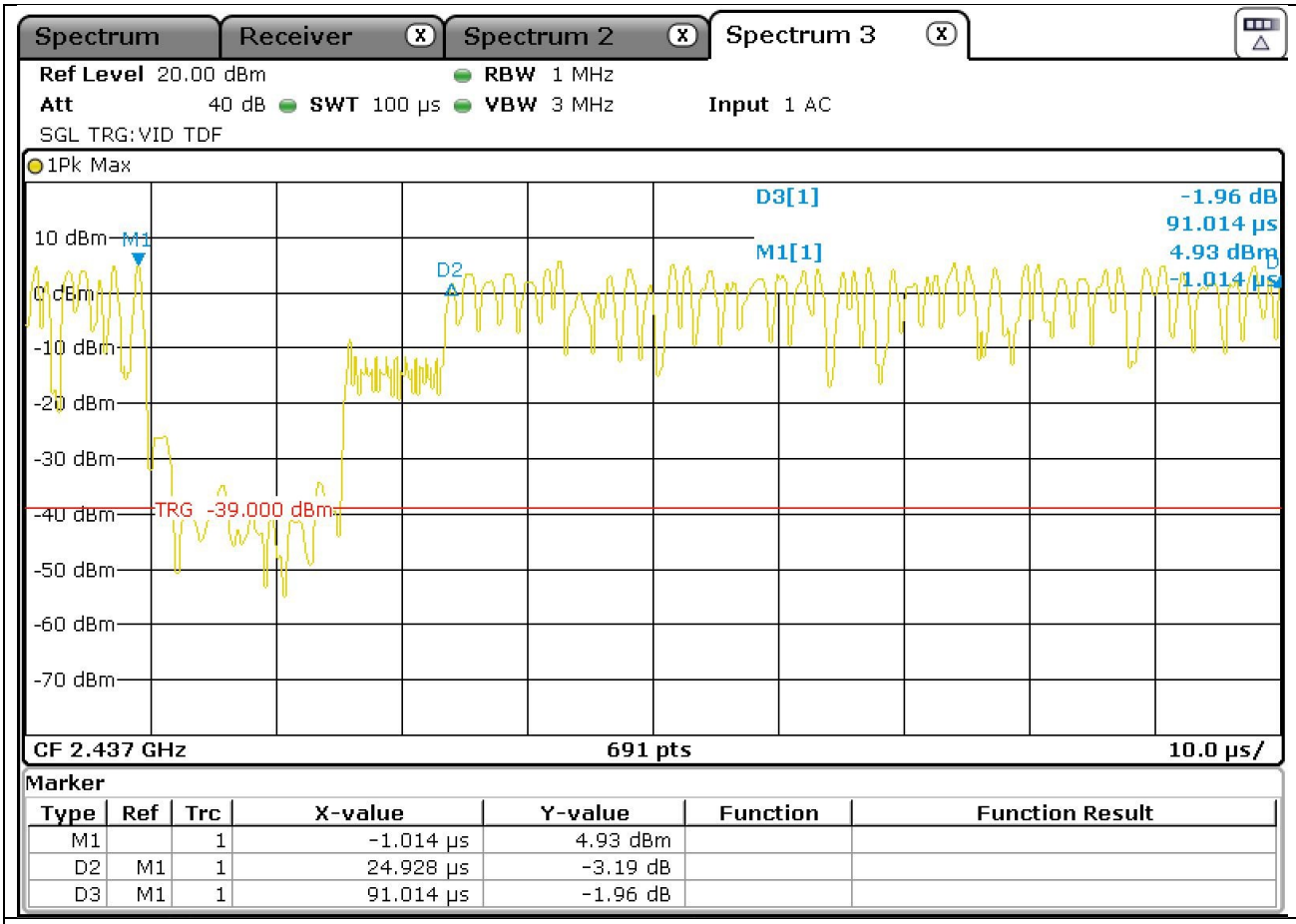


Fig 3b Duty Cycle

4.3 Power Spectral Density

Test Method
As per Ansi 63.10 Section 11.10.2

Ansi 63.10 Section11.10.3 Method AVGPSD-1
Method AVGPSD-1 uses trace averaging with EUT transmitting at full power throughout each sweep. The following procedure may be used when the maximum (average) conducted output power was used to determine compliance to the fundamental output power limit. This is the baseline method for determining the maximum (average) conducted PSD level. If the instrument has a power averaging (rms) detector, then it must be used; otherwise, use the sample detector. The EUT must be configured to transmit continuously ($D \geq 98\%$), or else sweep triggering/signal gating must be implemented to ensure that measurements are made only when the EUT is transmitting at its maximum power control level (no transmitter OFF time to be considered):
a) Set instrument center frequency to DTS channel center frequency.
b) Set span to at least 1.5 times the OBW.
c) Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set VBW ≥ [3 × RBW].
e) Detector = power averaging (rms) or sample detector (when rms not available).
f) Ensure that the number of measurement points in the sweep ≥ [2 × span / RBW].
g) Sweep time = auto couple.
h) Employ trace averaging (rms) mode over a minimum of 100 traces.
i) Use the peak marker function to determine the maximum amplitude level.
j) If the measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced)..

802.11G

Frequency	Measurement	Conducted Peak	Limit	Margin
GHz	dBm	dBm	dBm	dB
2.412	-20.6	-20.6	8	28.6
2.437	-0.8	-0.8	8	8.8
2.462	-20.43	-20.43	8	28.43

802.11N

Frequency	Measurement	Conducted Peak	Limit	Margin
GHz	dBm	dBm	dBm	dB
2.412	-20	-20	8	28
2.437	-0.42	-0.42	8	8.42
2.462	-20.06	-20.06	8	28.06

Result :- Pass

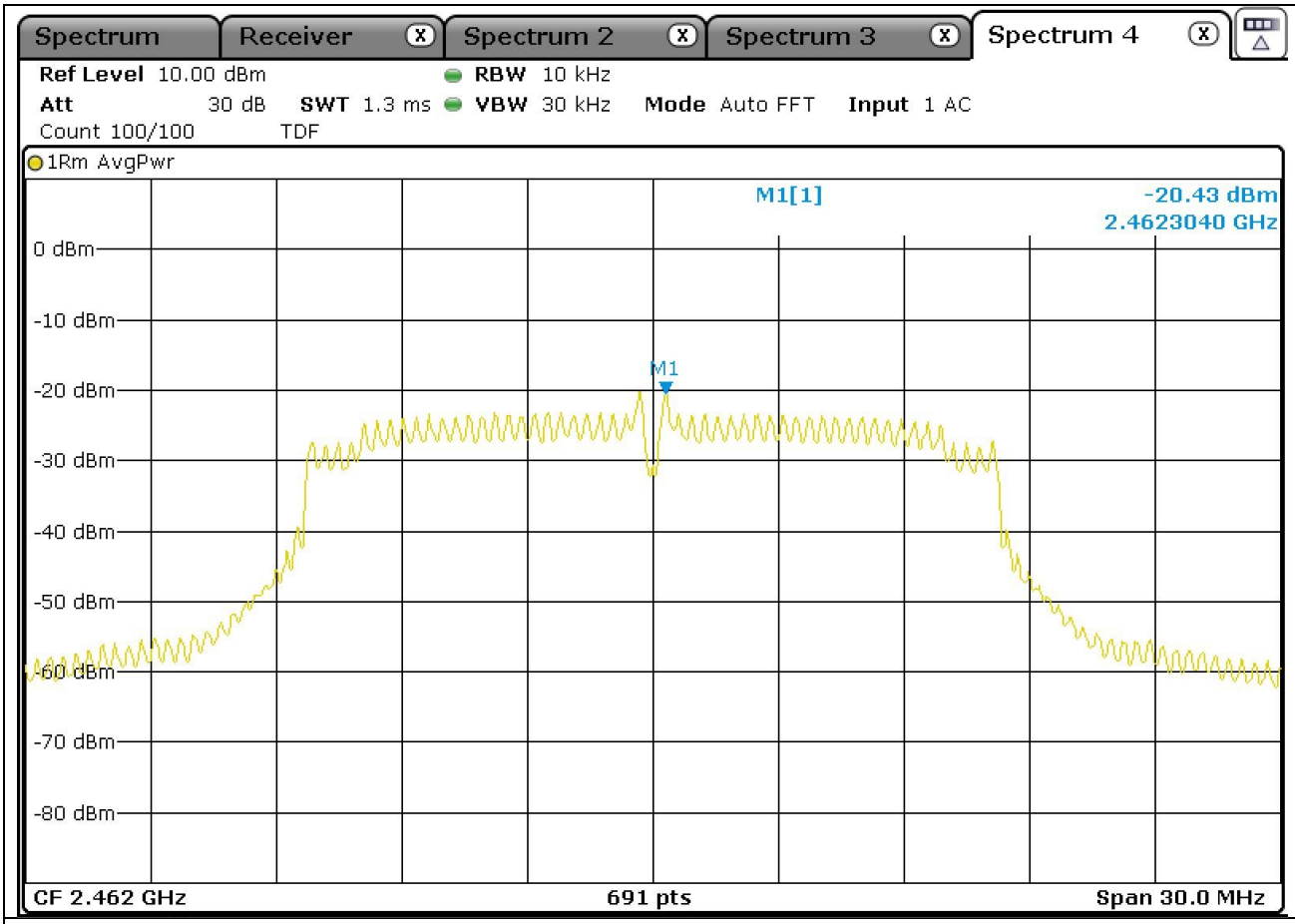


Fig 4 Power Spectral Density

4.4 Output power Conducted

4.4.1 Test Method
As per Ansi 63.10 Section 11.9.2.2

11.9.2.2.2 Method AVGSA-1
Method AVGSA-1 uses trace averaging with the EUT transmitting at full power throughout each sweep. The procedure for this method is as follows:
a) Set span to at least 1.5 times the OBW.
b) Set RBW = 1% to 5% of the OBW, not to exceed 1 MHz.
c) Set VBW ≥ [3 × RBW].
d) Number of points in sweep ≥ [2 × span / RBW]. (This gives bin-to-bin spacing ≤ RBW / 2, so that narrowband signals are not lost between frequency bins.)
e) Sweep time = auto.
f) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
g) If transmit duty cycle < 98%, use a sweep trigger with the level set to enable triggering only on full power pulses. The transmitter shall operate at the maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no OFF intervals) or at duty cycle ≥ 98%, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run.”
h) Trace average at least 100 traces in power averaging (rms) mode.
i) Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function, with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

4.4.2 Results

802.11G

Frequency	Measurement	Conducted Average	Limit	Margin
GHz	dBm	dBm	dBm	dB
2.412	6.86	6.86	30	23.14
2.437	10.35	10.35	30	19.65
2.462	6.36	6.36	30	23.64

802.11N

Frequency	Measurement	Conducted Average	Limit	Margin
GHz	dBm	dBm	dBm	dB
2.412	6.82	6.82	30	23.18
2.437	10.36	10.36	30	19.64
2.462	6.4	6.4	30	23.6

Test Result :- Pass

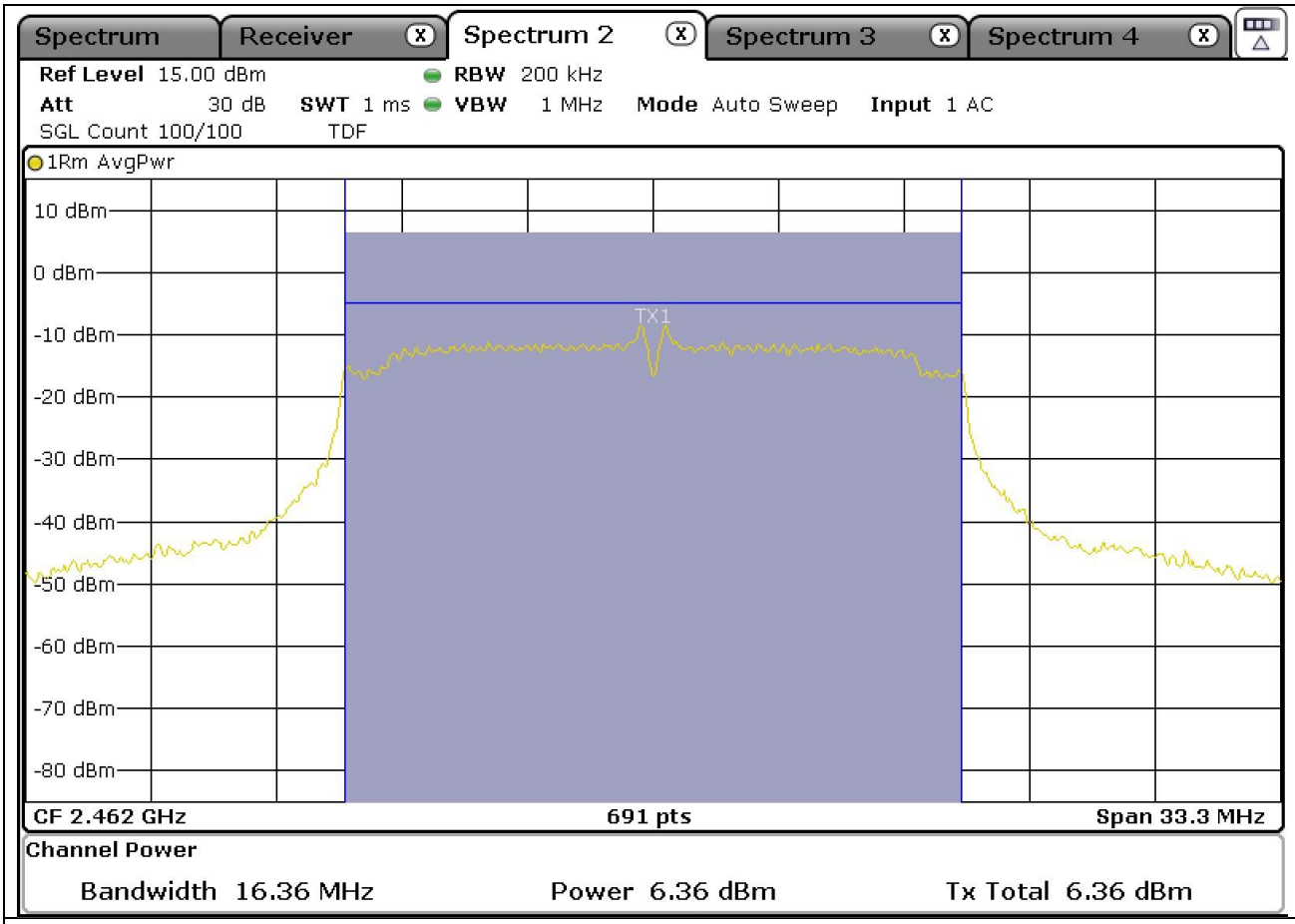


Fig 5 Output power Average Conducted

5. Spurious Emissions Measurements

5.1 Conducted 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 conditions:
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).
b) If maximum conducted (average) output power was used to determine compliance as described in 11.9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 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	100KHz RBW	dBc Limit Min	Margin
GHz	dBm	dB	dB
2.412	-4.31	30	-
4.824	-57.56	30	23.25

Frequency	100KHz RBW	dBc Limit Min	Margin
GHz	dBm	dB	dB
2.437	-0.4	30	-
4.874	-58.13	30	27.73

Frequency	100KHz RBW	dBc Limit Min	Margin
GHz	dBm	dB	dB
2.462	-4.5	30	-
4.924	-59.06	30	24.56

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. 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

5.2.2 Radiated Spurious Emissions PCB antenna

Frequency MHz	Quasi Peak Level dBuV/m	Antenna Polarity	Antenna Factor dB	Cable loss dB	Final Field Strength Quasi Peak dBuV/m	Quasi Peak Limit dBuV/m	Margin dB
57.55	13.3	Vertical	9.7	1	24	40.0	16.0
96.325	14.5	Vertical	9.3	1.1	24.9	43.5	18.6
159.925	18	Vertical	12.1	1.2	31.3	43.5	12.2
592	4.4	Vertical	19.5	1.8	25.7	46.0	20.3
162.75	18.9	Horizontal	12.2	1.2	32.3	43.5	11.2
240	11.2	Horizontal	15.7	1.4	28.3	46.0	17.7
744.075	0.8	Horizontal	21.6	2.1	24.5	46.0	21.5

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
4.824	44.3	32.4	37.1	5.2	Vertical	0.00	44.8	74	29.2
12.060	40.3	40.3	37.1	7.4	Horizontal	0.00	50.9	74	23.2
14.472	39.9	41.8	35.8	9.1	Vertical	0.00	55.0	74	19.0
4.824	43.5	32.4	37.1	5.2	Vertical	0.00	44.0	74	30.0
12.060	41.4	40.3	37.1	7.4	Horizontal	0.00	52.0	74	22.0
14.472	40.3	41.8	35.8	9.1	Horizontal	0.00	55.4	74	18.6

Frequency	Measured Average Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Average Level	Average Limit	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
14.472	32.6	41.8	35.8	9.1	Vertical	0.00	47.66	54	6.3
14.472	32.8	41.8	35.8	9.1	Horizontal	0.00	47.9	54	6.1

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
4.874	44.8	32.4	37.3	5.2	Vertical	0.00	45.1	74	28.9
7.311	37.4	37.7	38	6.7	Vertical	0.00	43.8	74	30.2
12.185	38.5	40.3	37.7	8.9	Horizontal	0.00	50.0	74	24.0
4.874	43.5	32.4	37.3	5.2	Horizontal	0.00	43.8	74	30.2
7.311	40.7	37.7	38	6.7	Horizontal	0.00	47.1	74	26.9
12.185	39.8	40.3	37.7	8.9	Horizontal	0.00	51.3	74	22.7

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
4.924	44.1	32.4	37.3	5.2	Vertical	0.00	44.4	74	29.6
7.386	40.9	37.7	37.5	6.3	Vertical	0.00	47.4	74	26.6
12.310	38.5	40.3	36.4	8.4	Vertical	0.00	50.8	74	23.2
4.924	44.1	32.4	37.3	5.2	Horizontal	0.00	44.4	74	29.6
7.386	40.5	37.7	37.5	6.3	Horizontal	0.00	47.0	74	27.0
12.310	38.4	40.3	36.4	8.4	Horizontal	0.00	50.7	74	23.3

Average measurements were not performed, where recorded peak levels were less than the average limit of 54dBuV/m

Test Result: - Pass

5.2.3 Radiated Spurious Emissions Module antenna

Frequency MHz	Quasi Peak Level dBuV/m	Antenna Polarity	Antenna Factor dB	Cable loss dB	Final Field Strength Quasi Peak dBuV/m	Quasi Peak Limit dBuV/m	Margin dB
50.175	17.9	Vertical	10.1	0.8		40.0	11.2
81.3	18.5	Vertical	9.1	1	28.6	40.0	11.4
96.325	12.1	Vertical	9.3	1.1	22.5	43.5	21.0
154.85	21.4	Vertical	11.9	1.2	34.5	43.5	9.0
592.025	4.8	Vertical	19.5	1.8	26.1	46.0	19.9
640	6	Vertical	20.1	2	28.1	46.0	17.9
703.95	-0.6	Vertical	21	2.1	22.5	46.0	23.5
154.8	21.8	Horizontal	11.9	1.2	34.9	43.5	8.6
336	17.8	Horizontal	15.5	1.5	34.8	46.0	11.2
479.95	2.3	Horizontal	17.8	1.7	21.8	46.0	24.2
744.05	-1	Horizontal	21.6	2.1	22.7	46.0	23.3
792.05	-1.2	Horizontal	21.8	2.2	22.8	46.0	23.2

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
4.824	43.6	32.4	37.1	5.2	Vertical	0.00	44.1	74	29.9
12.060	40.7	40.3	37.1	7.4	Vertical	0.00	51.3	74	22.7
14.472	39.7	41.8	35.8	9.1	Vertical	0.00	54.8	74	19.2
4.824	43.7	32.4	37.1	5.2	Horizontal	0.00	44.2	74	29.8
12.060	40.9	40.3	37.1	7.4	Horizontal	0.00	51.5	74	22.5
14.472	39.1	41.8	35.8	9.1	Horizontal	0.00	54.2	74	19.9

Frequency	Measured Average Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Average Level	Average Limit	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
14.472	31.9	41.8	35.8	9.1	Vertical	0.00	46.99	54	7.0
14.472	33.0	41.8	35.8	9.1	Horizontal	0.00	48.1	54	6.0

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
4.874	43.8	32.4	37.3	5.2	Vertical	0.00	44.1	74	29.9
7.311	39.6	37.7	38	6.7	Vertical	0.00	46.0	74	28.0
12.185	38.6	40.3	37.7	8.9	Vertical	0.00	50.1	74	23.9
4.874	43.0	32.4	37.3	5.2	Horizontal	0.00	43.3	74	30.7
7.311	40.5	37.7	38	6.7	Horizontal	0.00	46.9	74	27.1
12.185	37.7	40.3	37.7	8.9	Horizontal	0.00	49.2	74	24.9

Frequency	Measured Peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Duty Cycle Correction	Final Peak Level	Average Limit +20dB	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dB	dBuV/m	dBuV/m	dB
4.924	45.0	32.4	37.3	5.2	Vertical	0.00	45.3	74	28.7
7.386	40.1	37.7	37.5	6.3	Vertical	0.00	46.6	74	27.4
12.310	37.9	40.3	36.4	8.4	Vertical	0.00	50.2	74	23.8
4.924	43.4	32.4	37.3	5.2	Horizontal	0.00	43.7	74	30.3
7.386	41.6	37.7	37.5	6.3	Horizontal	0.00	48.1	74	26.0
12.310	38.1	40.3	36.4	8.4	Horizontal	0.00	50.4	74	23.6

Average measurements were not performed, where recorded peak levels were less than the average limit of 54dBuV/m

Test Result: - Pass

5.3 Radiated Power at fundamental

5.3.1 Radiated Power at fundamental-PCB Antenna

802.11G

Frequency	Measured Average Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Final Average Level	Transmitted power	Limit	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dBuV/m	dBm	dBm	dB
2.412	105.2	27.4	38.5	3.5	Vertical	97.6	2.4	30.0	27.6
2.412	104.6	27.4	38.5	3.5	Horizontal	97.0	1.8	30.0	28.2
2.437	110.6	27.4	38.5	3.5	Vertical	103.0	7.8	30.0	22.3
2.437	110.3	27.4	38.5	3.5	Horizontal	102.7	7.5	30.0	22.5
2.462	103.9	28.7	38.3	3.4	Vertical	97.7	2.5	30.0	27.5
2.462	105.2	28.7	38.3	3.4	Horizontal	99.0	3.8	30.0	26.2

802.11N

Frequency	Measured Average Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Final Average Level	Transmitted power	Limit	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dBuV/m	dBm	dBm	dB
2.412	105.7	27.4	38.5	3.5	Vertical	98.1	2.9	30.0	27.1
2.412	105.2	27.4	38.5	3.5	Horizontal	97.6	2.4	30.0	27.6
2.437	109.4	27.4	38.5	3.5	Vertical	101.8	6.6	30.0	23.5
2.437	107.9	27.4	38.5	3.5	Horizontal	100.3	5.1	30.0	24.9
2.462	106.0	28.7	38.3	3.4	Vertical	99.8	4.6	30.0	25.4
2.462	104.8	28.7	38.3	3.4	Horizontal	98.6	3.4	30.0	26.6

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

EIRP (dBm) = E3m (dBuV/m) – 95.2

Test result Pass

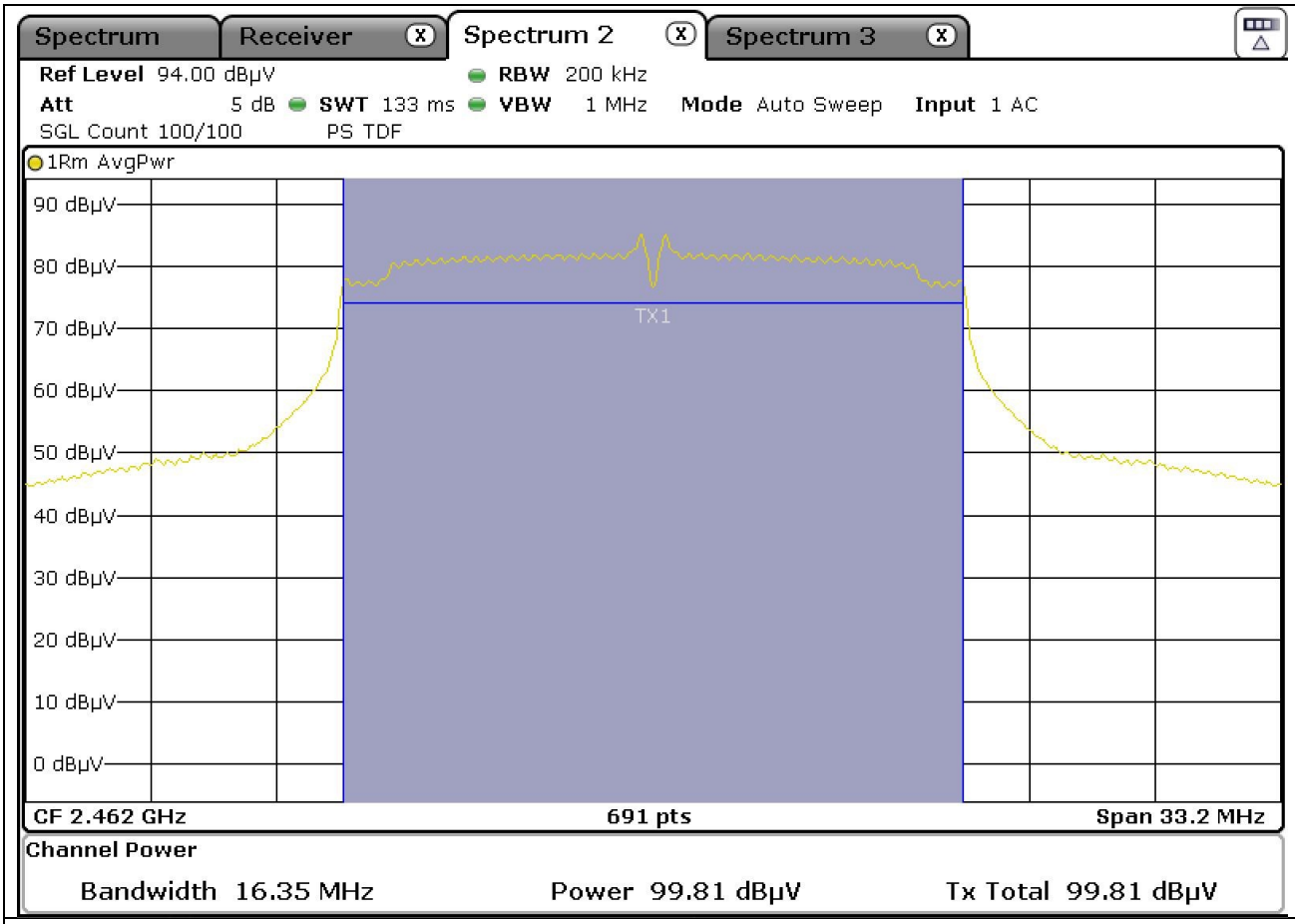


Fig 6 Output power Average Radiated

5.3.2 Radiated Power at fundamental- Module Antenna

802.11G

Frequency	Measured Average Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Final Peak Level	Transmitted power	Limit	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dBuV/m	dBm	dBm	dB
2.412	105.3	27.4	38.5	3.5	Vertical	96.10	0.9	30.0	29.1
2.412	106.6	27.4	38.5	3.5	Horizontal	97.43	2.2	30.0	27.8
2.437	108.9	27.4	38.5	3.5	Vertical	100.53	5.3	30.0	24.7
2.437	107.9	27.4	38.5	3.5	Horizontal	100.26	5.1	30.0	24.9
2.480	107.6	28.7	38.3	3.4	Vertical	96.66	1.5	30.0	28.5
2.480	107.6	28.7	38.3	3.4	Horizontal	95.75	0.5	30.0	29.5

802.11N

Frequency	Measured Average Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	Final Peak Level	Transmitted power	Limit	Margin
GHz	dBuV/m	dB	dB	dB	V/H	dBuV/m	dBm	dBm	dB
2.412	108.9	27.4	38.5	3.5	Vertical	96.01	0.8	30.0	29.2
2.412	108.9	27.4	38.5	3.5	Horizontal	95.76	0.6	30.0	29.4
2.437	108.9	27.4	38.5	3.5	Vertical	99.33	4.1	30.0	25.9
2.437	107.9	27.4	38.5	3.5	Horizontal	99.24	4.0	30.0	26.0
2.480	107.6	28.7	38.3	3.4	Vertical	95.72	0.5	30.0	29.5
2.480	107.6	28.7	38.3	3.4	Horizontal	95.62	0.4	30.0	29.6

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

EIRP (dBm) = E3m (dBuV/m) – 95.2

Test Result Pass

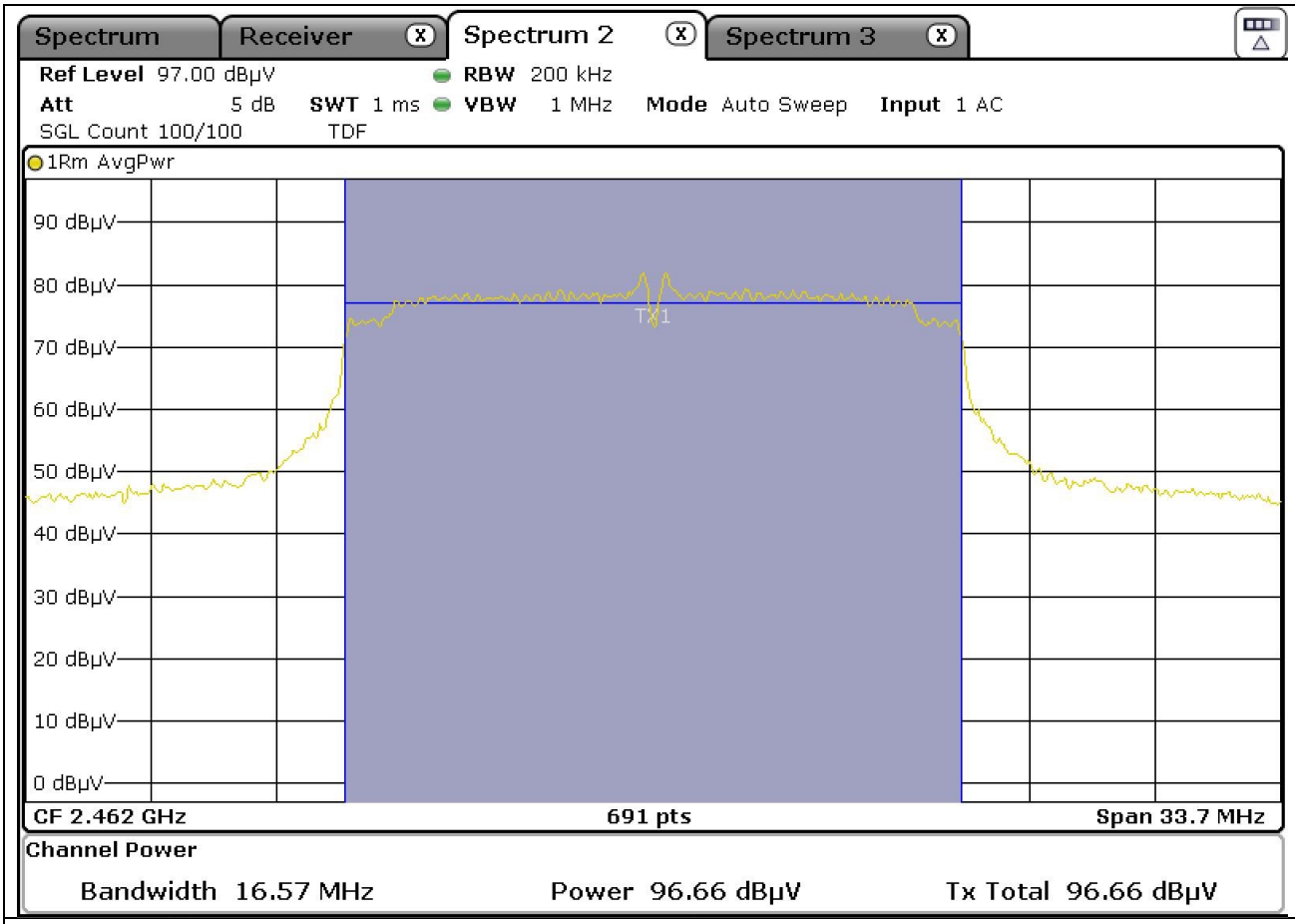


Fig 7 Output power Average Radiated

6 List of Test Equipment

Instrument	Manufacturer	Model	Serial Num	CEI Ref	Cal Due Date	Cal Interval Months
Spectrum Analyser 30Hz-40GHz	Rohde & Schwarz	FSP40	100053	850	11-Dec-21	36
Test Receiver 3.6GHz	Rohde & Schwarz	ESR	1316.3003k03-101625-s	869	28-May-23	36
Antenna Biconical	Schwarzbeck	VHBB 9124	9124 667	871	03-Sep-21	36
Antenna Horn	EMCO	3115	9905-5809	655	14-Mar-21	24
Anechoic Chamber	CEI	SAR 10M	845	845	16-May-22	36
Antenna Log Periodic	Chase	UPA6108	1072	609	03-Sep-21	36
Fully Anechoic Chamber	CEI	FAR 3M	906	906	22-Mar-21	36
Microwave Preamplifier	Hewlett Packard	83017A	3123A00175	805	30-Sep-21	12
Antenna Horn Standard Gain 18-26.5GHz	A-Info	LB-42-25-C-KF	J2021091103028	877	05-Oct-21	12

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

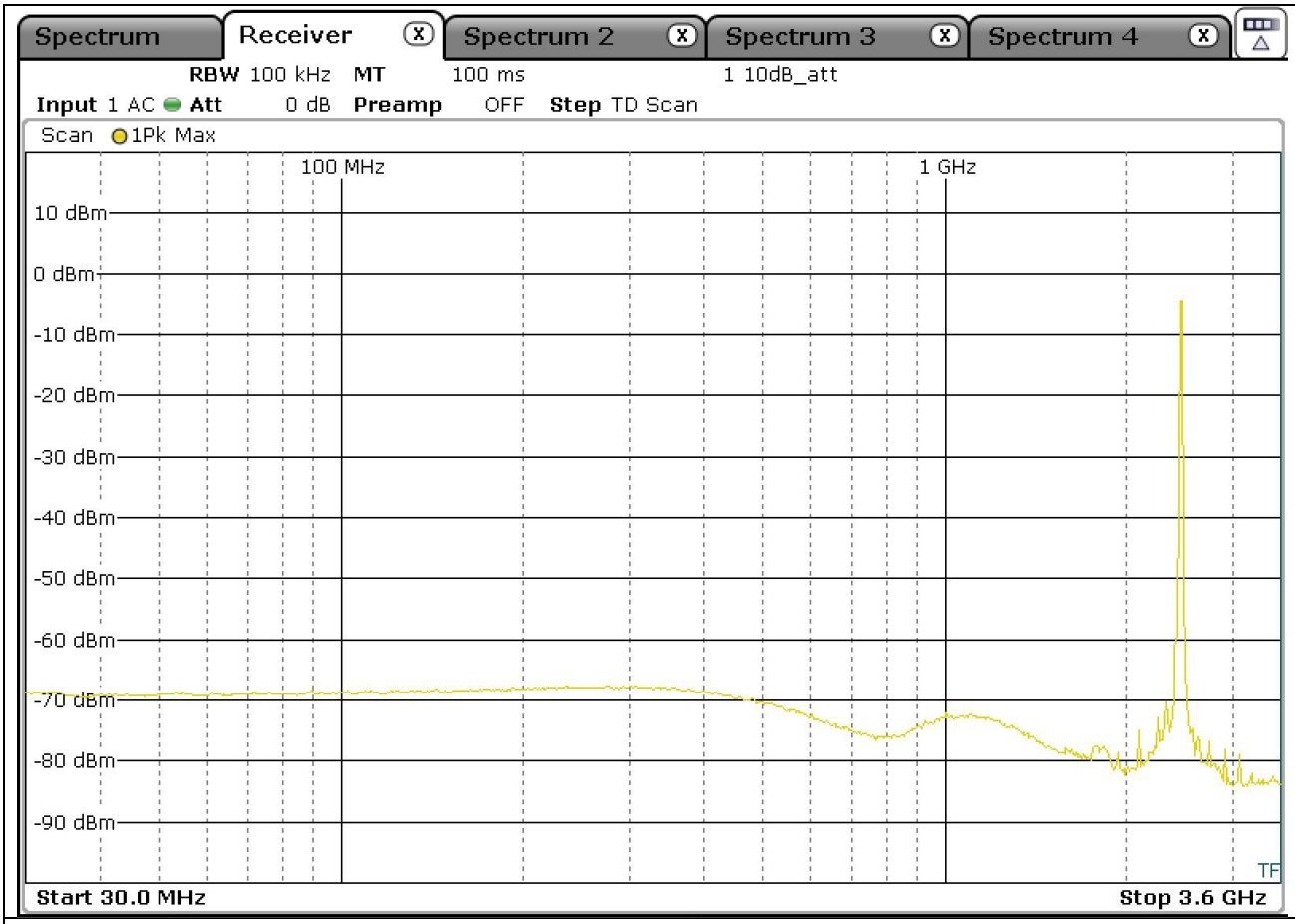


Fig A1 High Channel Conducted Spurious Emissions 30MHz -3.6GHz

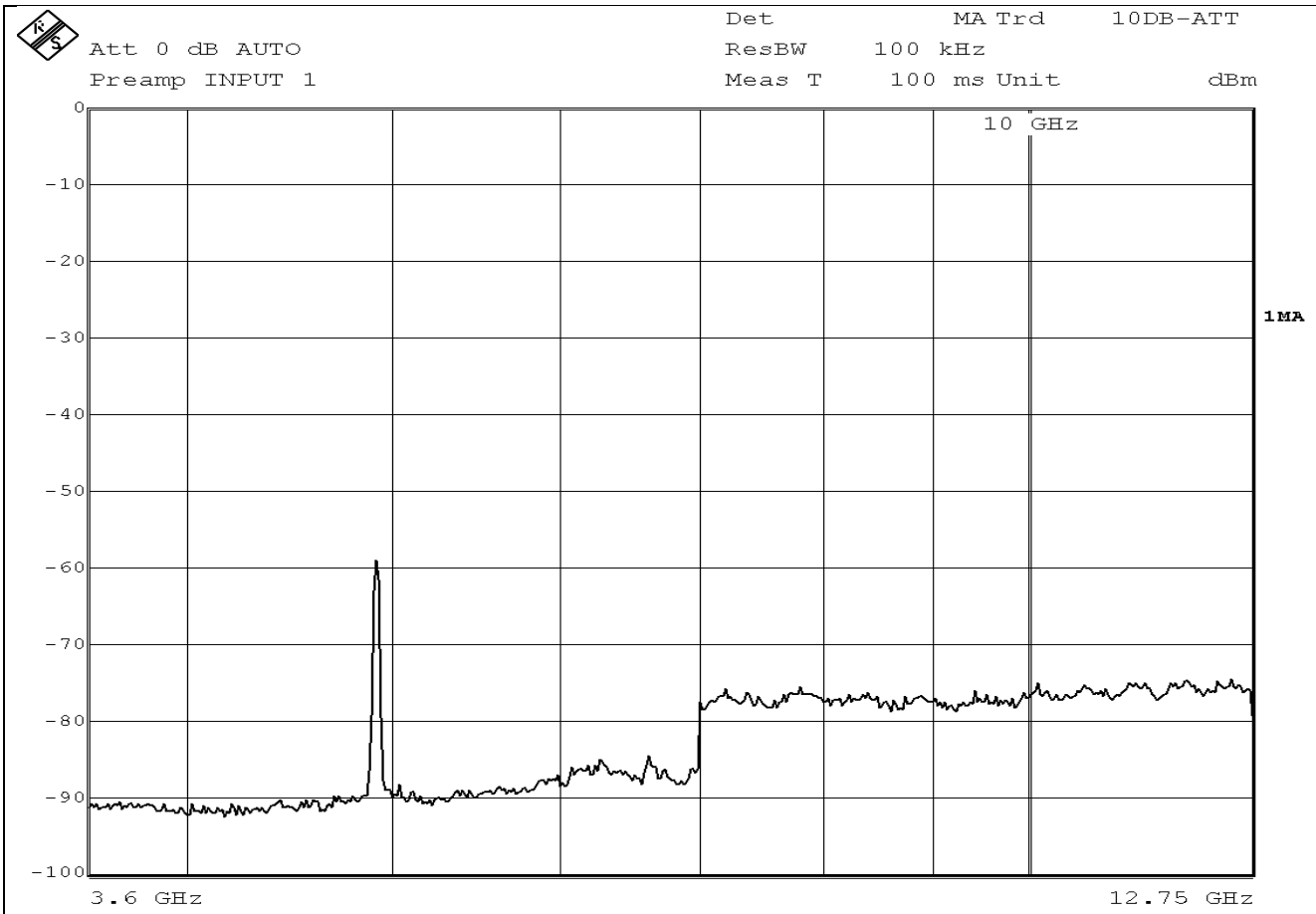


Fig A2 High Channel Conducted Spurious Emissions 3.6GHz-12.75GHz

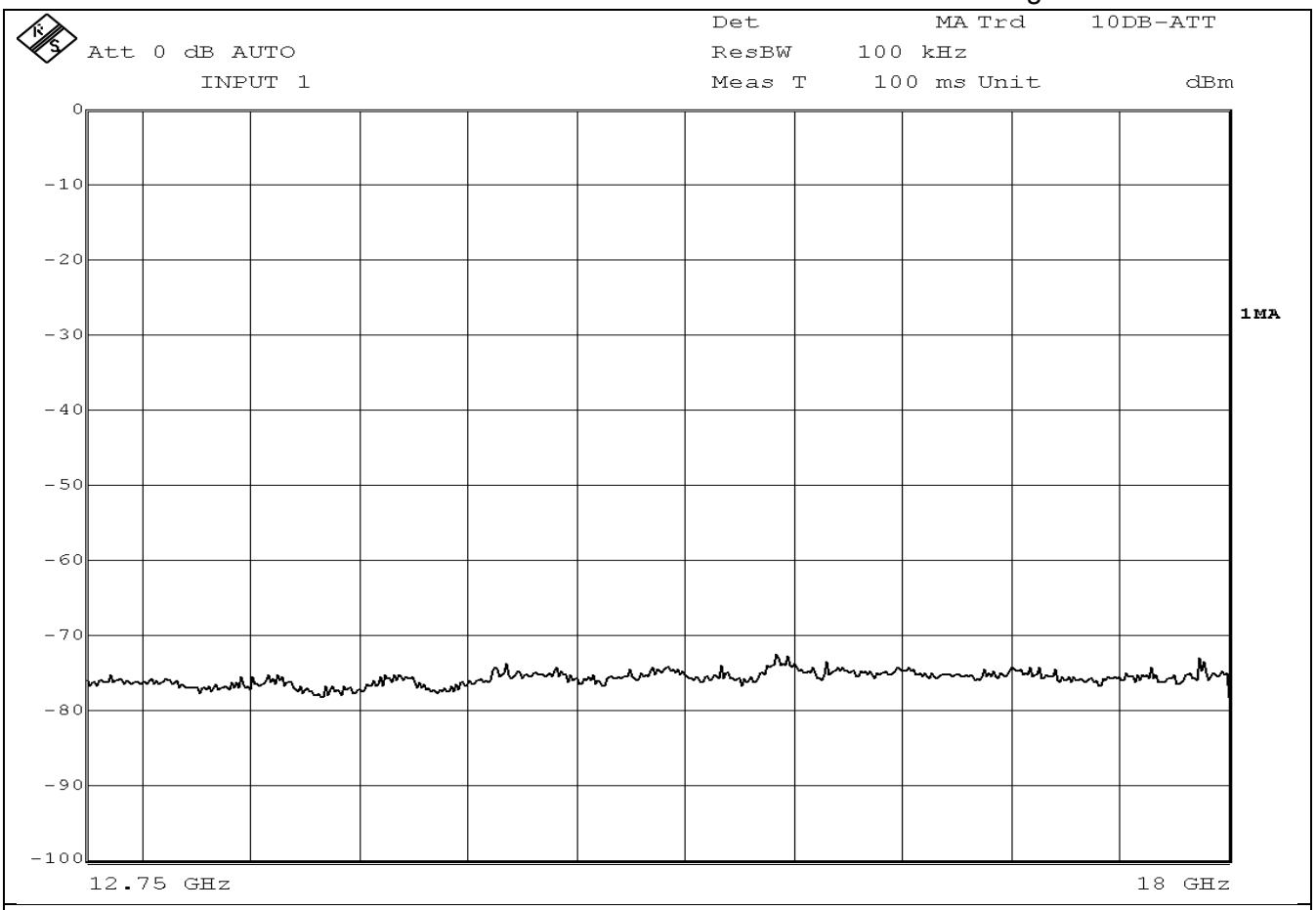


Fig A3 High Channel Conducted Spurious Emissions 12.75GHz -18GHz

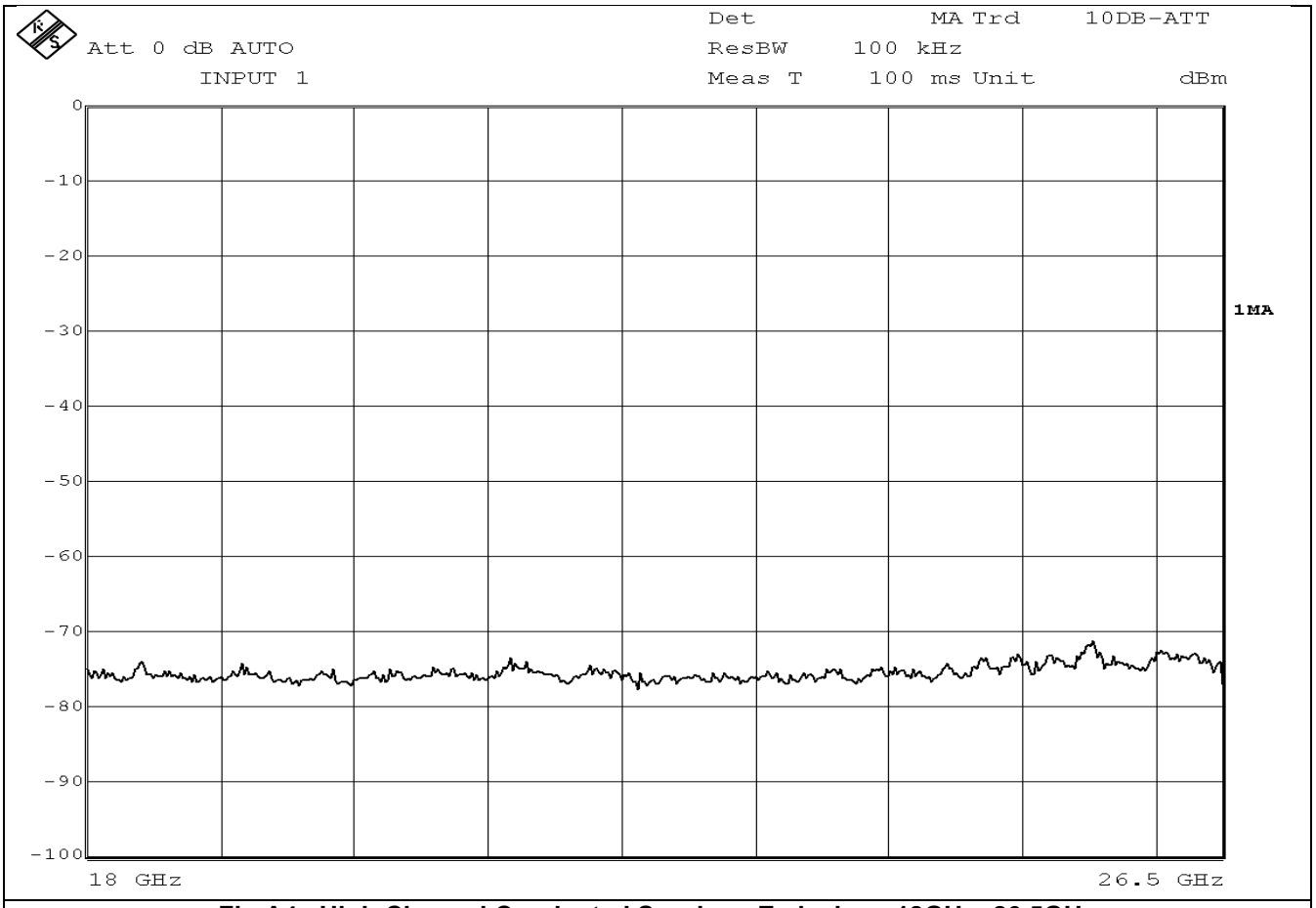


Fig A4 High Channel Conducted Spurious Emissions 18GHz -26.5GHz

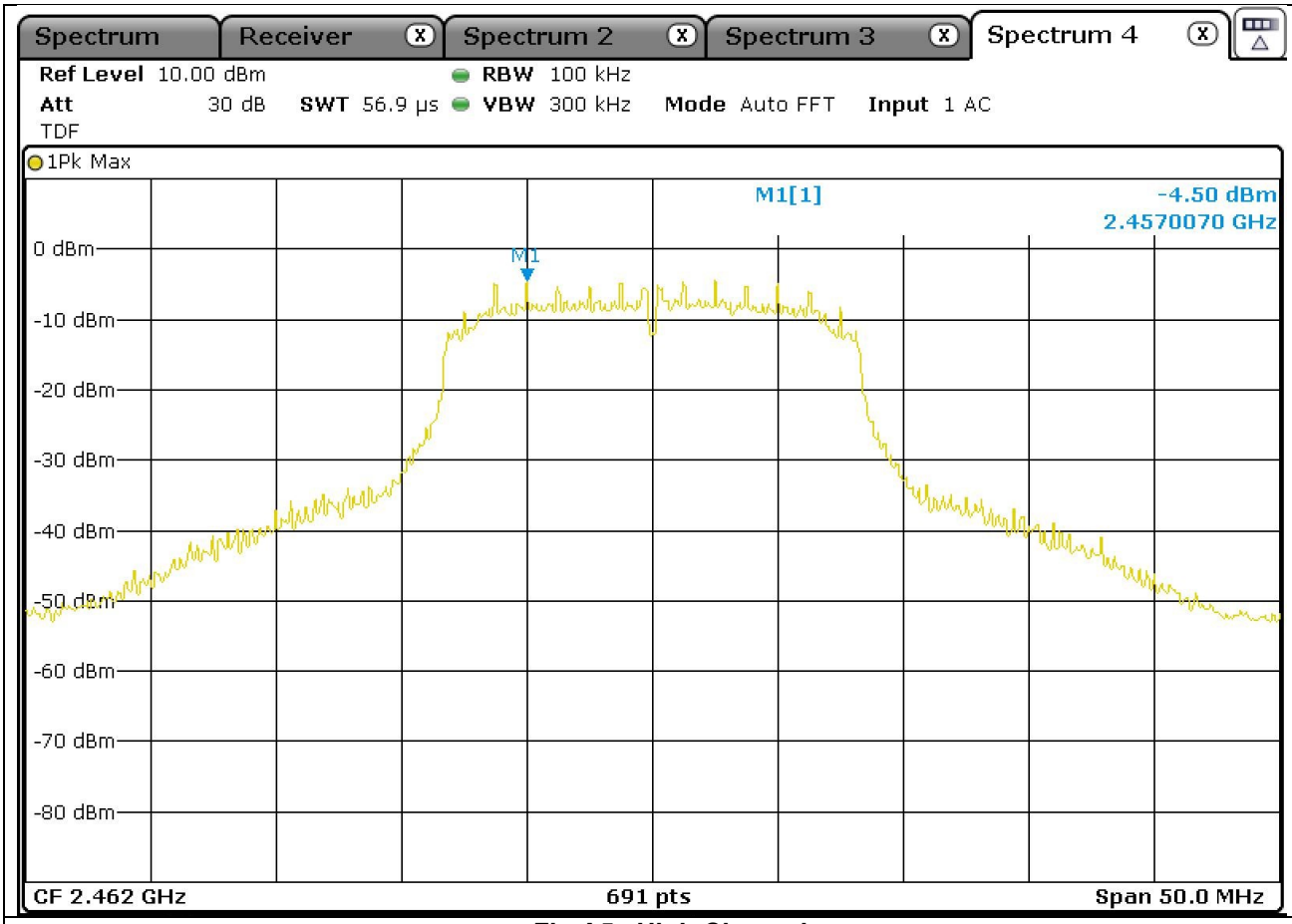


Fig A5 High Channel

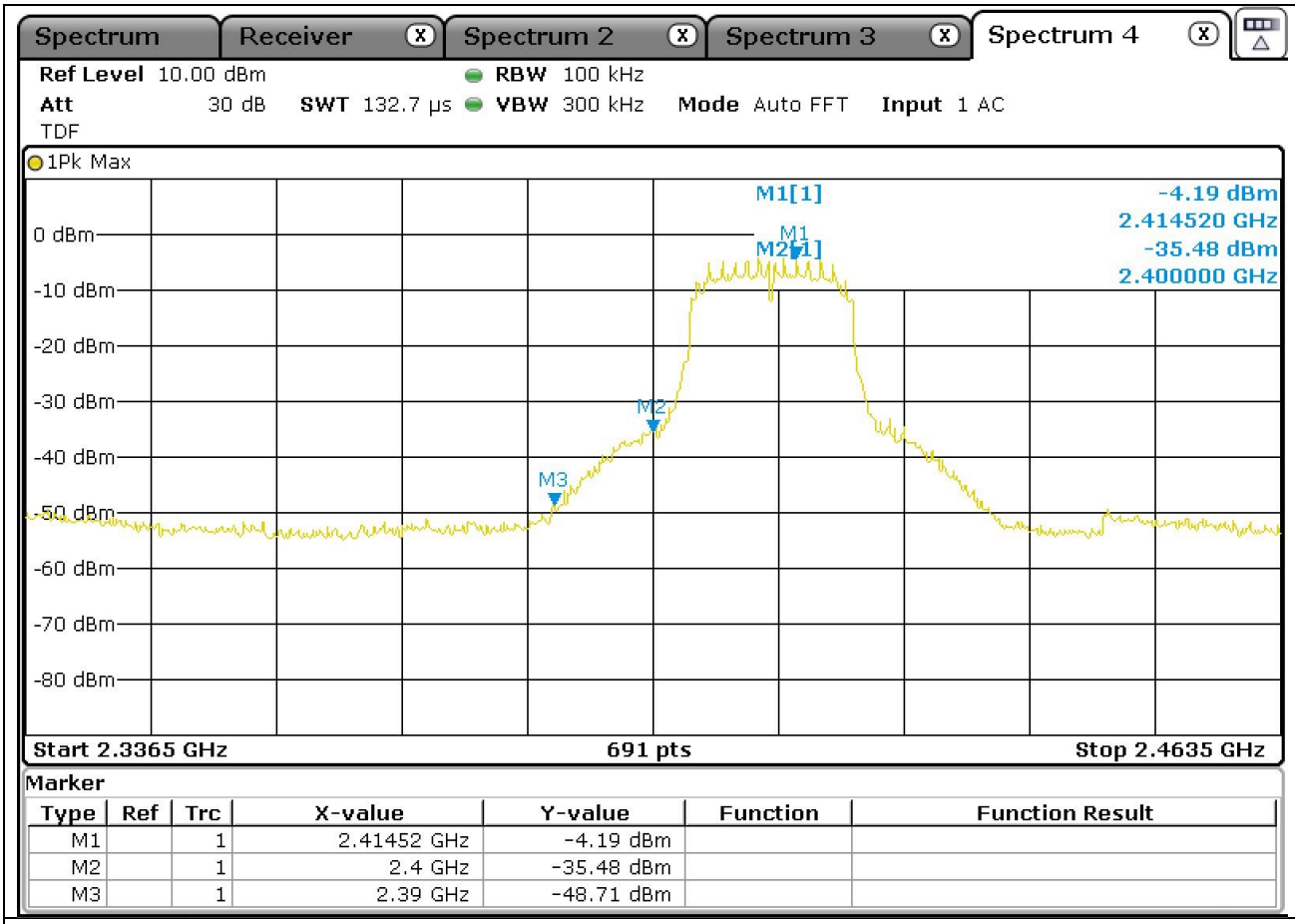


Fig A6 Lower Band Edge Low Channel Conducted

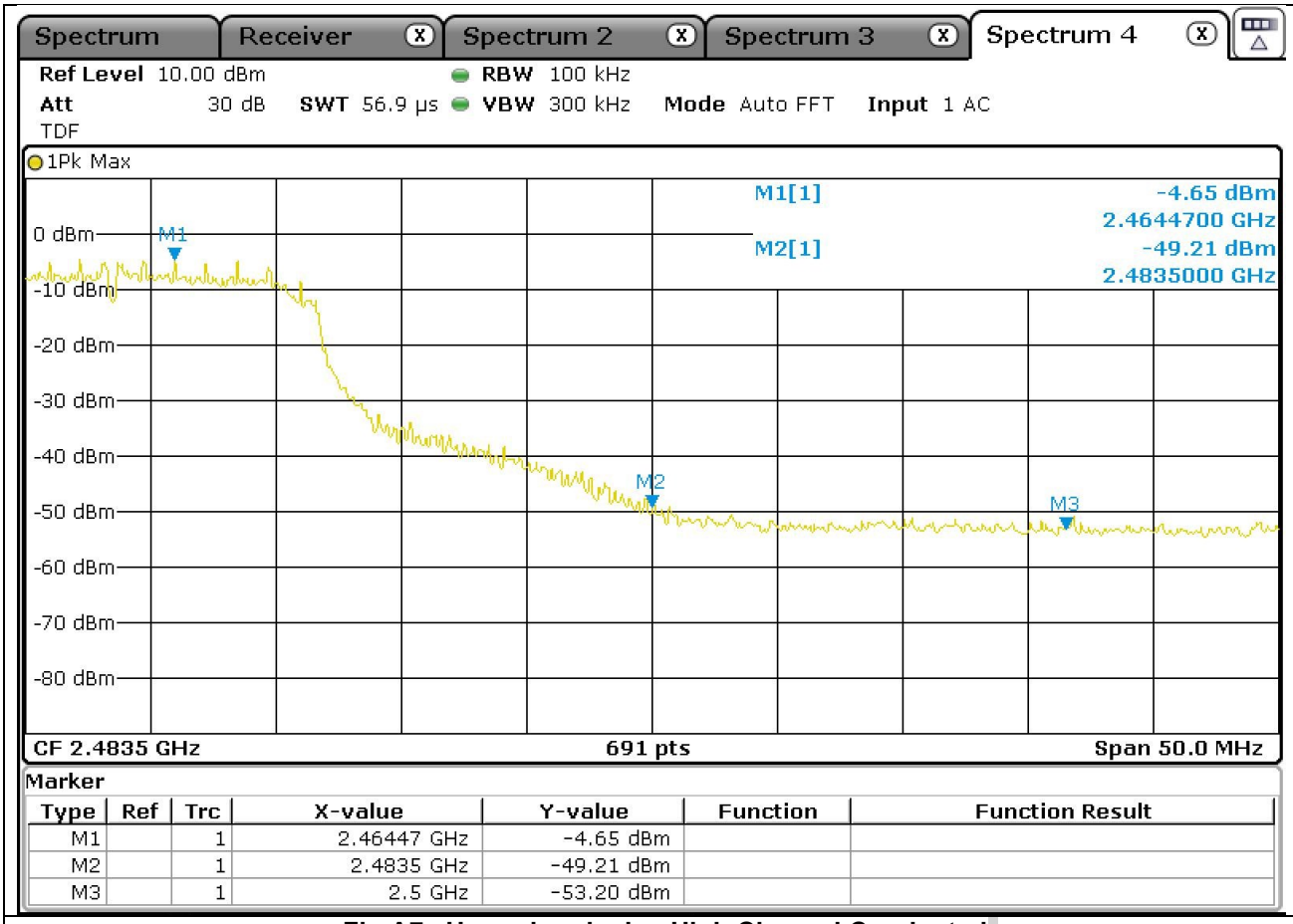


Fig A7 Upper band edge High Channel Conducted-

Appendix B

Radiated tests for Band Edges /Restricted band PCB antenna

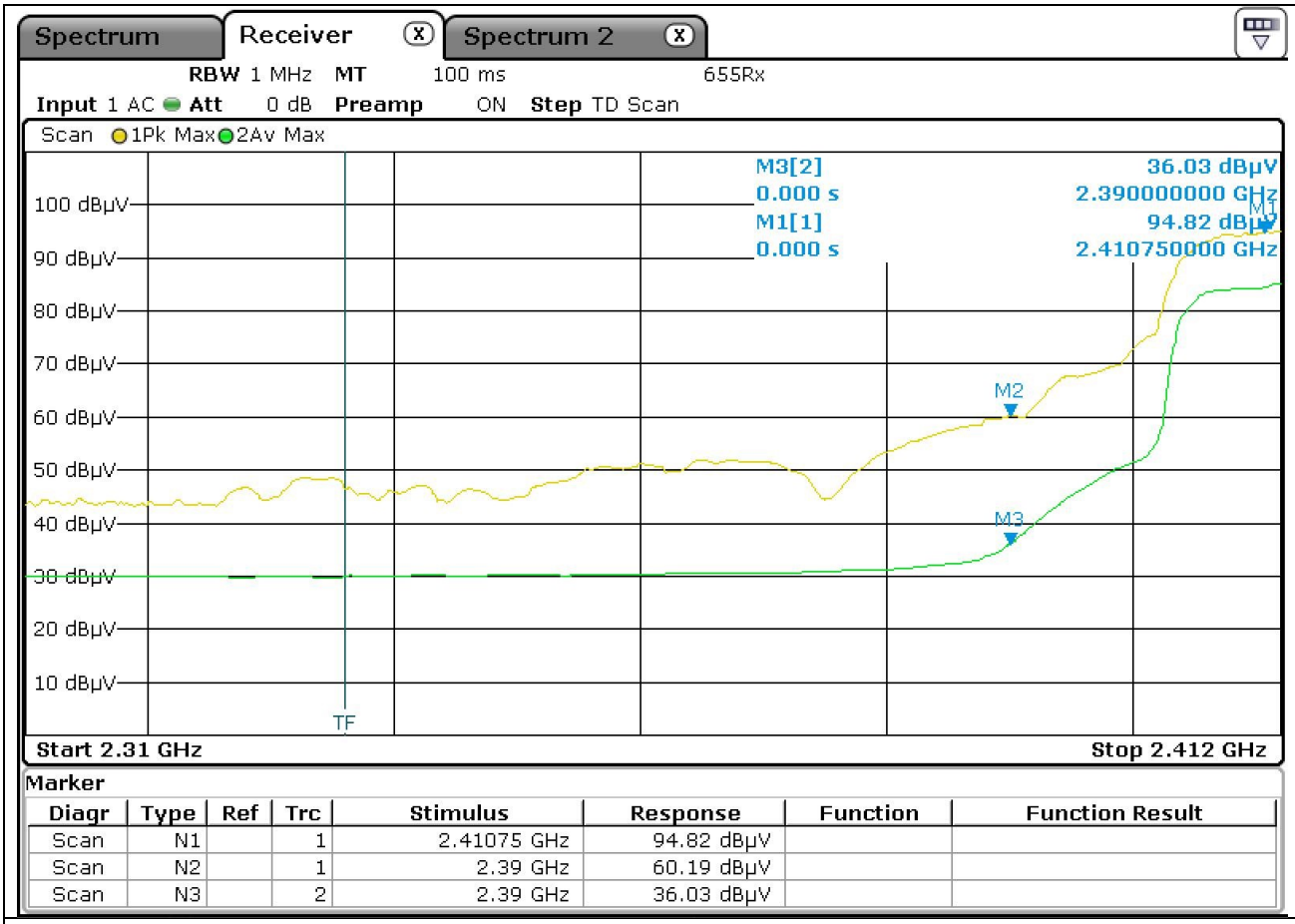


Fig B1 Low Channel Band Edge Vertical peak and average at 3 metres

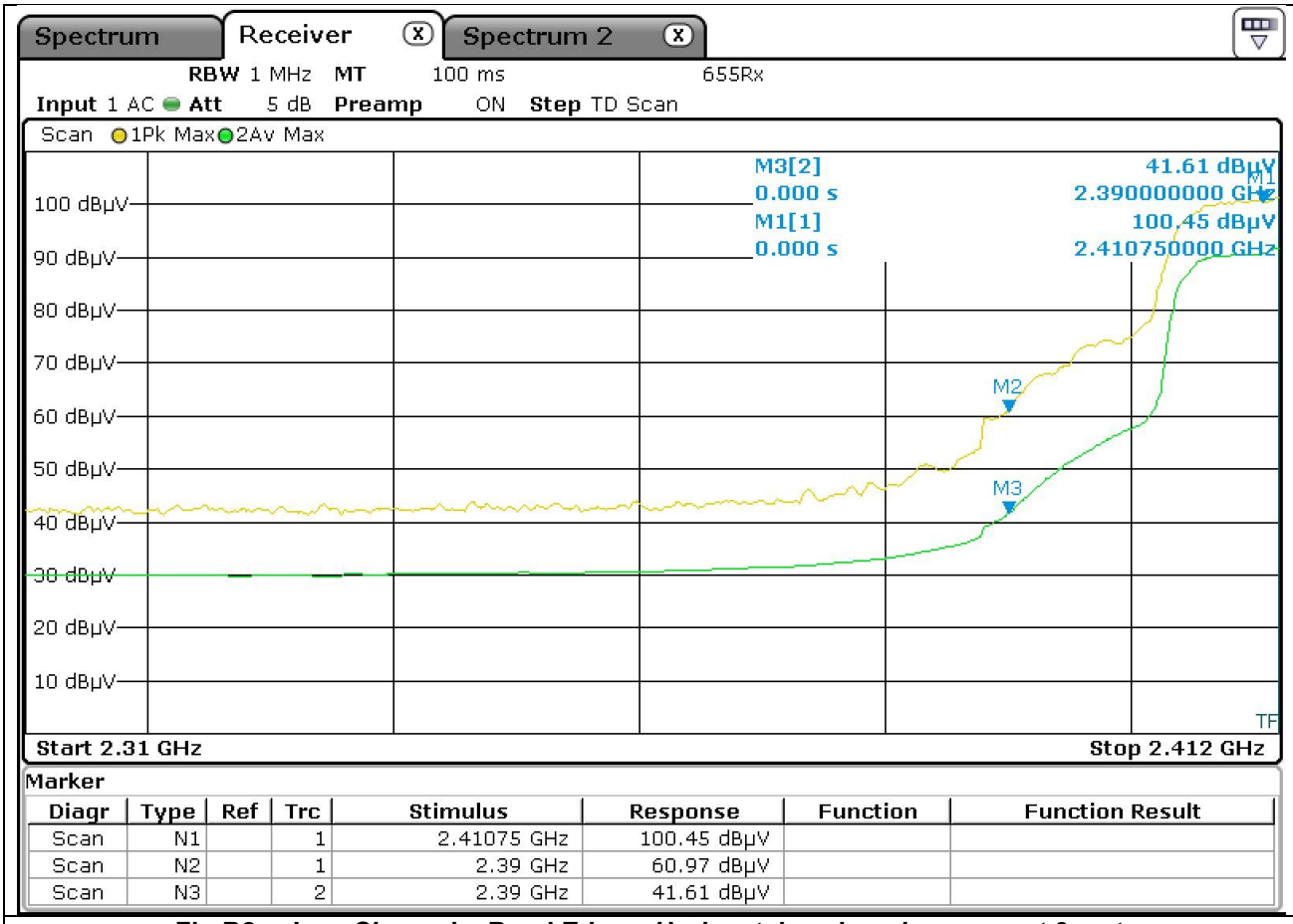
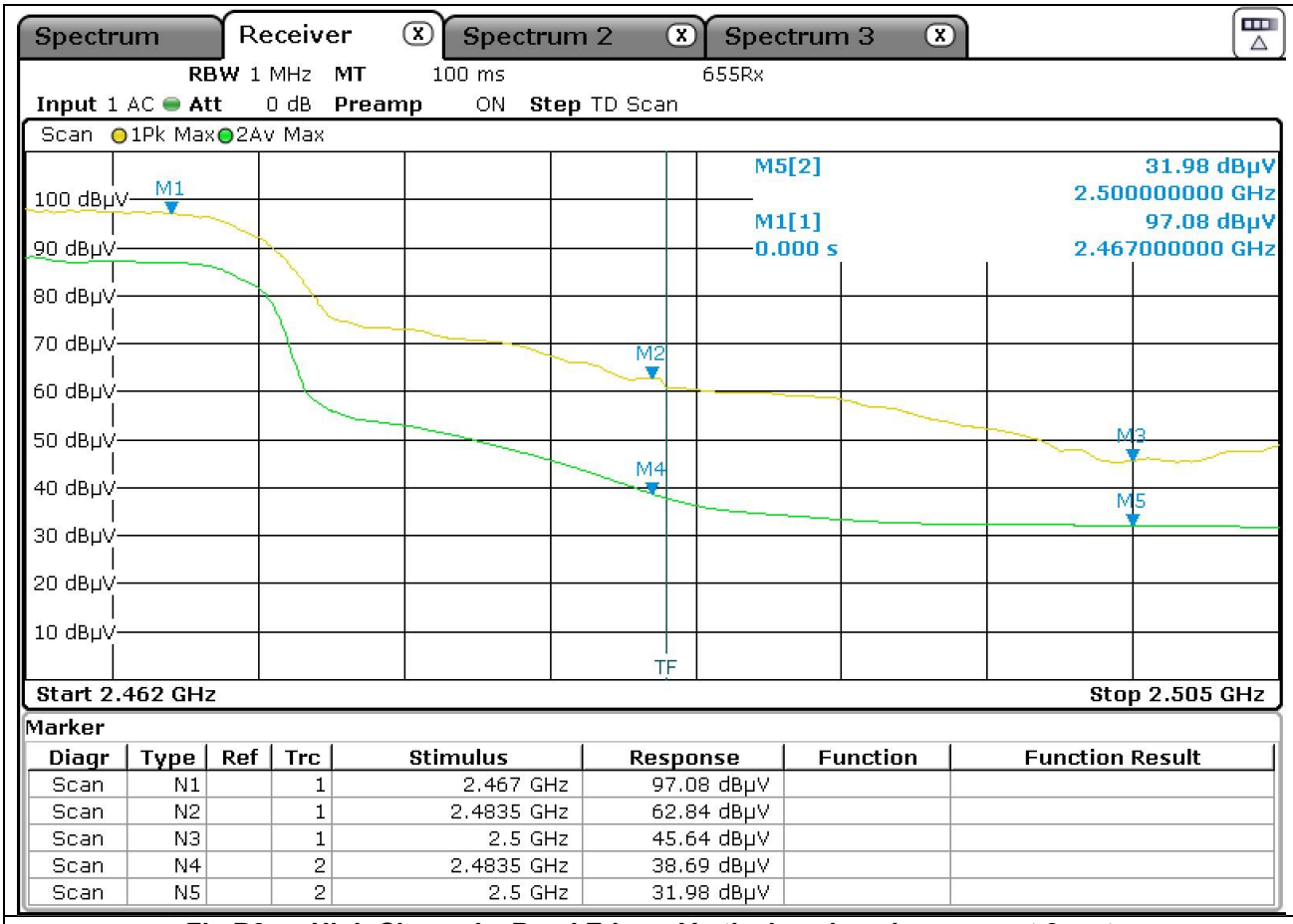


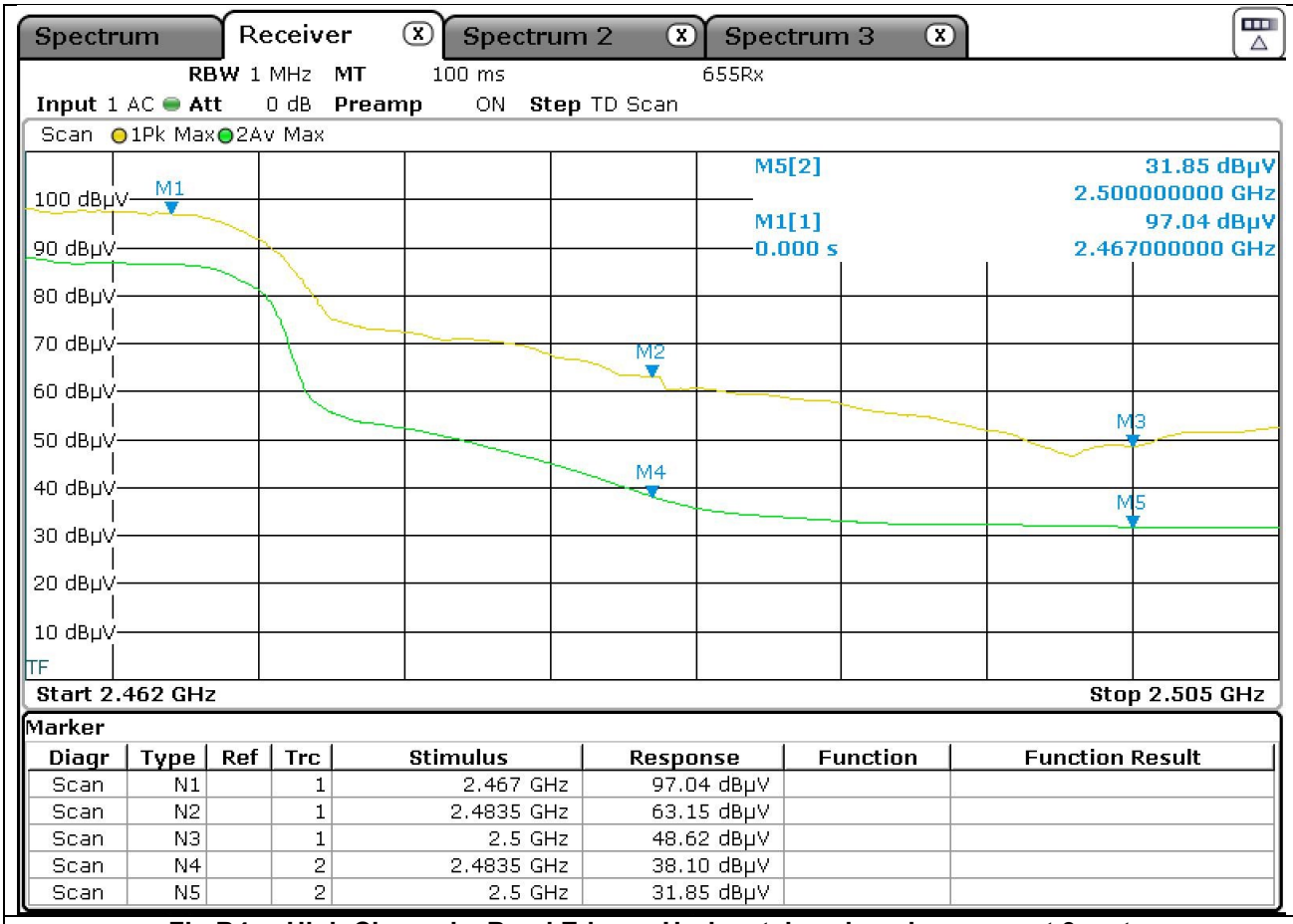
Fig B2 Low Channel Band Edge Horizontal peak and average at 3 metres



Marker

Diagr	Type	Ref	Trc	Stimulus	Response	Function	Function Result
Scan	N1		1	2.467 GHz	97.08 dBµV		
Scan	N2		1	2.4835 GHz	62.84 dBµV		
Scan	N3		1	2.5 GHz	45.64 dBµV		
Scan	N4		2	2.4835 GHz	38.69 dBµV		
Scan	N5		2	2.5 GHz	31.98 dBµV		

Fig B3 High Channel Band Edge Vertical peak and average at 3 metres



Marker

Diagr	Type	Ref	Trc	Stimulus	Response	Function	Function Result
Scan	N1		1	2.467 GHz	97.04 dBµV		
Scan	N2		1	2.4835 GHz	63.15 dBµV		
Scan	N3		1	2.5 GHz	48.62 dBµV		
Scan	N4		2	2.4835 GHz	38.10 dBµV		
Scan	N5		2	2.5 GHz	31.85 dBµV		

Fig B4 High Channel Band Edge Horizontal peak and average at 3 metres